Effects of Antibiotics and Probiotics on Suckling Pig and Weaned Pig Performance

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ABSTRACT

Effects of various antibiotics or a probiotic on growth and death loss in suckling pigs and the effect of a probiotic on nursery pig performance were determined. In Experiment 1, suckling pigs received either oxytetracycline (n = 21), erythromycin (n = 21), penicillin G procaine (n = 21), or tylosin (n = 22) i.m., or no antibiotic (n = 21), within 24 hours after farrowing. There was no effect of treatment ($P = 0.83$) on survival until weaning, and pig body weights at 7 ($P = 0.84$), 14 ($P = 0.96$), and 21 ($P = 0.90$) days of age were not different among groups. In Experiment 2, suckling pigs received an oral gavage of 2 mL of probiotic (5×10^6 lactobacillus and streptococcus colony forming units/mL) (n = 94) or vegetable oil (n = 87) within 24 hours after farrowing. There was no effect of treatment ($P = 0.65$) on survival until weaning, and pig body weight at 7 ($P = 0.63$), 14 ($P = 0.55$), and 21 ($P = 0.24$) days of age were not different between groups. In Experiment 3, weaned pigs were placed in nursery pens (4 pigs/pen) with either pigs from different litters (MIXED) or littermate pigs (NON-MIXED). Treatments included: 1) probiotic (4 mL) and NON-MIXED pigs, 2) vehicle and NON-MIXED pigs, 3) probiotic and MIXED pigs, and 4) vehicle and MIXED pigs. Probiotic or vehicle was administered as an oral gavage on the day of weaning; there were 4 pens per treatment. There were tendencies for effects of treatment × grouping for average daily gain ($P = 0.11$) and feed consumed ($P = 0.12$). For MIXED pens, there was an effect of probiotic treatment on average daily gain ($P = 0.05$) and feed consumed (approached significance, $P = 0.08$). In summary, administration of antibiotics or probiotics to neonatal pigs showed no benefit on preweaning performance. However, a probiotic tended to enhance average daily gain and feed consumption in pigs that were weaned into pens with non-littermates.

INTRODUCTION

Efficient and profitable operation of commercial swine units is often limited by high mortality, morbidity, and poor performance in suckling pigs and pigs in the nursery phase of production. Death losses of pre-weaning pigs and nursery pigs are typically 12.2% and 2.4%, respectively.[1] Moreover, 0.4% of pigs classified as "stunted" because of un-thriftiness or poor growth are removed from nurseries nationwide.[1]

Antibiotics are routinely used on North American swine farms and are administered in the form of medicated water or as feed additives. The addition of antimicrobial products to nursery feeds is especially effective with typical improvements in growth rates and feed conversion efficiencies of up to 16% and 6%, respectively.[2] Industry surveys suggest that more than 82% of U.S. swine farms with nursery pigs use antimicrobial feed additives in diet formulations.[3] And although few experiments have been conducted to assess effects on performance, suckling pigs on more than 44% of all operations are routinely given injectable antibiotics during post-farrowing processing or at weaning for prophylactic and treatment purposes.[4]

Because of the concern that resistant microbes may develop that compromise the effectiveness of antibiotics for treating human and animal diseases, the routine use of antibiotics on commercial swine farms faces an uncertain future. For example, the U.S. Food and Drug Administration has called for an extensive re-evaluation of continued use of antimicrobial feed additives.[5] Excessive and improper use of injectable antibiotics is also a concern. Thus, there is interest in alternatives to antibacterial products such as probiotics. Probiotics are viable microbial cultures that purportedly increase the gastrointestinal population of beneficial bacteria that competitively exclude bacteria that may compromise health and growth performance.[2]

The objectives of the experiments described herein were to determine the effects of injectable antibiotics or a probiotic, administered within 24 hours after farrowing, on growth and death loss in suckling pigs and to determine the effect of a probiotic, administered at weaning, on nursery pig performance.

MATERIALS AND METHODS

All experiments were conducted at the University of Maryland Eastern Shore Swine Research and Education Facility (Princess Anne, MD) and protocols were approved by the Institutional Animal Care and Use Committee.

Experiment 1

The objective was to determine the effects of various antibiotics, administered within 24 hours after farrowing, on growth and death loss in suckling pigs. Nine multiparous Yorkshire sows were mated to Yorkshire or Poland China boars and were moved on approximately Day 110 of gestation to individual farrowing crates in an environmentally controlled, mechanically ventilated building. During lactation, sows had ad libitum access to water and a commercially prepared diet (Southern States Cooperative, Baltimore, MD) that met or exceeded the recommendations for the various nutrients as put forth by the National Research Council.[6] Sows farrowed a total of 106 live pigs (11.8 pigs/litter) that were utilized in the experiment.

Within 24 hours after farrowing, pigs were subjected to the following processing procedures: ears notched for identification, needle teeth resected, tails docked, and injected with 200 mg iron dextran (Iron Hydrogenated Dextran; Duravet, Inc., Blue Springs, MO). Additionally, pigs within each litter received an i.m. injection of either oxytetracycline (20 mg/kg body weight; Liquamycin; Pfizer Animal Health, New York, NY) (n = 21), erythromycin (8.6 mg/kg body weight; Gallimycin; AgriLabs, St. Josephs, MO) (n = 21), penicillin G procaine (6667 units/kg body weight; Agri-cillin; AgriLabs) (n = 21), or tylosin (8.9 mg/kg body weight; Tylan-50; Elanco Animal Health, Indianapolis, IN) (n = 22). Remaining pigs (n = 21) received no antibiotic and served as untreated controls. Pigs were weighed at birth and at 7, 14, and 21 (weaning) days of age.

Experiment 2

The objective was to determine the effects of a probiotic, administered within 24 hours after farrowing, on growth and death loss in suckling pigs. Multiparous Yorkshire sows (n = 10) and Yorkshire gilts (n = 10) were mated to Yorkshire or Poland China boars and were moved on approximately Day 110 of gestation to individual farrowing crates. During lactation, sows were fed as described for Experiment 1. Sows farrowed a total of 181 live pigs (9.1 pigs/litter) that were utilized in the experiment.

Within 24 hours after farrowing, pigs were subjected to the following processing procedures: ears notched for identification, needle teeth resected, tails docked, and injected with 100 mg iron dextran. Additionally, pigs within each litter received an oral gavage of 2 mL of probiotic (Probios Oral Suspension; Chr. Hansen Biosystems, Milwaukee, WI; 5×10^6 lactobacillus and streptococcus colony forming units/mL) (n = 94) or vegetable oil (n = 87). Pigs were weighed at birth and at 7, 14, and 21 (weaning) days of age.

Experiment 3

The objective was to determine the effects of a probiotic, administered at weaning, on growth performance in nursery pigs. We hypothesized that potential positive effects of the probiotic may be more evident in pigs subjected to the stress of mixing littermates at weaning. Thus, pigs in this study were grouped in pens either with pigs from different litters (MIXED) or littermate pigs (NON-MIXED).

Yorkshire pigs were weaned at 28.9 ± 0.5 days of age into a clean, disinfected nursery with supplemental heat and a negative pressure ventilation system. Pens were equipped with Tribar metal flooring (Hog Slat Inc., Newton Grove, NC), a nipple drinker, and a standard nursery feeder.

A 2 × 2 factorial arrangement was used to provide 4 treatments with 4 replicate pens per treatment. Four pigs were housed in each pen with 0.56 m^2 of floor space provided per pig. Treatments included: 1) probiotic administered to NON-MIXED pigs, 2) vehicle administered to NON-MIXED pigs, 3) probiotic administered to MIXED pigs, and 4) vehicle administered to MIXED pigs. Probiotic (Probios Oral Suspension; 4 mL; 5×10^6 lactobacillus and streptococcus colony forming units/mL) or vehicle was administered as an oral gavage on the day of weaning.

During the 3-week trial, pigs were allowed ad libitum access to commercially prepared nursery diets (Southern States Cooperative). A Phase I diet was fed during Week 1, and a Phase II diet was fed during Weeks 2 and 3. Pigs were weighed on the day of weaning (Week 0) and at the end of Weeks 1, 2, and 3. Pen feed consumption and feed conversion efficiency (Feed:Gain) were determined at the end of the trial.

Statistical Analyses

For Experiments 1 and 2, pig weights at birth and at 7, 14, and 21 days of age were subjected to analysis of variance for a randomized block design using the generalized linear models procedure of SAS (SAS Institute Inc., Cary, NC). The model included treatment and litter (block) as possible sources of variation. Pre-weaning death loss for the various treatments was compared using chi-square analysis.

For Experiment 3, pig weights at weaning (Week 0), Weeks 1, 2, and 3, average daily gain, feed consumed, and feed conversion efficiency were subjected to analysis of variance. The model included treatment (probiotic or vehicle) and grouping (MIXED or NON-MIXED) and treatment × grouping as possible sources of variation.

RESULTS AND DISCUSSION

Experiment 1

Shortly after birth, pigs on commercial operations are often subjected to a variety of procedures such as needle teeth resection, tail docking, and castration.[7] At the time of processing, pigs are often administered an antibiotic as a prophylactic measure.[4] This is done in efforts to enhance pig survival rates because death losses of pre-weaning pigs can exceed 12%.[1]

Table 1. Body Weights in Pigs Receiving I.M. Injections of Various Antibiotics Within 24 Hours After Farrowing.

		Day of Age			
	n	Birth	7	14	21
Control	21	1.36	2.51	4.20	5.99
Oxytetracycline	21	1.41	2.54	4.02	5.61
Erythromycin	21	1.44	2.54	4.06	5.59
Penicillin G procaine	21	1.55	2.73	4.27	5.85
Tylosin	22	1.44	2.64	4.15	5.59
SE	—	0.07	0.16	0.28	0.39
P-value	—	0.49	0.84	0.96	0.90

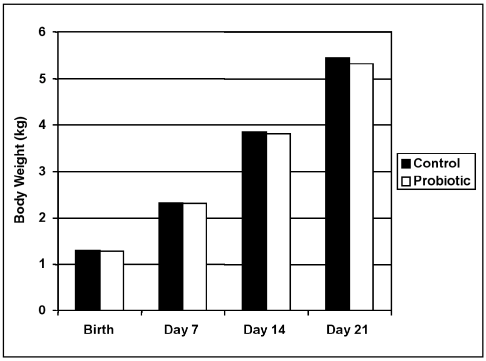

Figure 1. Body weights in pigs receiving 2 mL of an oral gavage of probiotic (5×10^6 lactobacillus and streptococcus colony forming units/mL) (n = 94) or vehicle (n = 87) within 24 hours after farrowing. There was no effect of treatment at any day and SE was 0.02 (birth), 0.04 (Day 7), 0.07 (Day 14), and 0.09 (Day 21).

In the current study, 4 commercially available, broad-spectrum antibiotics (oxytetracycline, erythromycin, penicillin G procaine, and tylosin) were evaluated for effects on pig body weights and survival during the pre-weaning period. There was no effect of treatment ($P = 0.83$) on the percentage of pigs that survived until weaning, which was 85.7% for controls, and 90.5% for oxytetracycline-, 90.5% for erythromycin-, 81.0% for penicillin G procaine-, and 81.8% for tylosin-treated animals. Moreover, pig body weights at birth ($P = 0.49$), and 7 ($P = 0.84$), 14 ($P = 0.96$), and 21 ($P = 0.90$) days of age were not different among groups (Table 1).

Based on these results, we suggest that the practice of routinely injecting pigs with an antibiotic during neonatal processing may need re-evaluation. Our results, however, do not preclude the possibility that other types of antibiotics not used in this experiment may have had a positive effect on pig growth and survival during the suckling period. Moreover, this experiment was conducted in an intensively managed university facility and it may not be appropriate to extrapolate the results to all swine farms. On commercial units that have been diagnosed to have present a specific disease or pathogen, administration at processing of a specific antibiotic to which the pathogen is sensitive may be warranted. For example, administration of oxytetracycline at birth, or at birth and a second treatment 5 to 7 days later, reduced the incidence of foot abscesses in suckling pigs by approximately 50% on a farm with a history of this ailment.[8] In another study, however, oxytetracycline decreased the foot abscess rate, but had no effect on mortality, diarrhea, or arthritis.[9] What seems apparent is that injection of nursing piglets with therapeutic antibiotics should be based on specific disease presence and not subjective routine practice.

Experiment 2

Probiotics generally refer to viable cultures of microbes that, when orally administered, purportedly increase the gastrointestinal population of beneficial microbes while competitively excluding bacteria that may depress health or growth performance. In the present study, however, there was no effect of treatment ($P = 0.65$) on the percentage of pigs that survived until weaning, which was 93.1% for controls and 94.7% for probiotic-treated animals. Pig body

Table 2. Effects of a Probiotic and Method of Grouping on Body Weights and Growth Performance in Nursery Pigs.

Item	Probiotic* Mixed†	Probiotic* Non-Mixed†	Vehicle Mixed†	Vehicle Non-Mixed†	SE
Pens (n)‡	4	4	4	4	–
Body weight (kg)					
Initial (Week 0)	7.58	7.88	7.63	7.82	0.35
Week 1	8.86	9.31	8.82	9.44	0.42
Week 2	11.65	11.66	11.23	11.94	0.48
Week 3	15.70	14.88	14.30	15.03	0.60
Average daily gain (kg/day) (Week 0-Week 3)§	0.39	0.33	0.32	0.34	0.02
Feed consumed (kg/head/day)‖	0.60	0.54	0.53	0.56	0.03
Feed:gain	1.59	1.64	1.71	1.64	0.13

*Probios Oral Suspension (Chr. Hansen Biosystems, Milwaukee, WI; 4 mL; 5×10^6 lactobacillus and streptococcus colony forming units/mL).

†Pigs were housed in pens containing pigs from different litters (MIXED) or littermates (NON-MIXED).

‡Four pigs per pen.

§For MIXED pens there was an effect ($P = 0.05$) of probiotic treatment.

‖For MIXED pens there was a tendency ($P = 0.08$) of probiotic treatment effect.

weights at birth ($P = 0.76$), and 7 ($P = 0.63$), 14 ($P = 0.55$), and 21 ($P = 0.24$) days of age were not different between groups (Figure 1).

In contrast, previous research has demonstrated positive effects of probiotics on neonatal piglet growth. For example, treatment with cultures of *Streptococcus faecium* suppressed *Escherichia coli*-induced diarrhea and improved growth in gnotobiotic pigs.[10] Growth rate of newborn piglets also was increased by a combination of bifidobacteria and lactic acid bacteria.[11]

The dichotomous results of the current experiment and previous research[10,11] could be due to different probiotics utilized. Similar to Experiment 1, caution also must be exercised in extrapolating the results generated in Experiment 2, which was conducted in a university facility, to those that may be obtained on other swine farms. In a review of the scientific literature, Turner et al.[12] noted that the specific production environment, including cleanliness of the facility, history of disease on the premises, and health status of treated pigs, greatly influences improvements in growth performance observed in response to performance-enhancing agents.

Experiment 3

In the current investigation, overall health of the pigs appeared good and no pigs died during the course of the experiment. There were no effects of treatment, grouping or treatment × grouping for pig body weights or feed conversion efficiency, and no effects of treatment or grouping for average daily gain or feed consumed (Table 2). There were tendencies for effects of treatment × grouping for average daily gain ($P = 0.11$) and feed consumed ($P = 0.12$). For MIXED pens, there was an effect of probiotic treatment on average daily gain ($P = 0.05$) and feed consumed ($P = 0.08$). These latter findings are consistent with a possible beneficial effect of probiotics in pigs that are subjected to various stressors (in this case, mixing of non-littermate pigs) at weaning. In this experiment, allocated floor space was generous and crowding was likely not a stressor.

Several studies have been conducted during which nursery pig growth performance was assessed following treatment with probiotics, and responses have been variable.[12] For example, Jasek et al.[13] reported that the supplementation of weanling pig diets with lactobacilli enhanced growth rate and feed conversion efficiency and decreased the shedding of *E. coli* in feces. In contrast, Harper et al.[14] found no difference in growth performance of nursery pigs fed an unmedicated control diet, a diet medicated with virginiamycin, or a diet supplemented with lactobacilli. In general, addition of streptococci to nursery pig diets has been reported to increase growth performance.[15–17]

As mentioned previously, the specific production environment probably influences improvements in growth performance observed in response to probiotics and other performance-enhancing agents. This could perhaps explain the equivocal results obtained in the current and previous[13–17] research.

CONCLUSIONS

In summary, our results suggest that there is little value to routinely administering antibiotics (oxytetracycline, erythromycin, penicillin G procaine, or tylosin) or a probiotic (lactobacillus and streptococcus) to neonatal pigs with regard to pre-weaning performance. However, on commercial units that have been diagnosed to have present a specific disease or pathogen, administration at processing of a particular antibiotic (perhaps one not evaluated herein) to which the pathogen is sensitive may be warranted. Finally, under the conditions of our nursery study, a probiotic (lactobacillus and streptococcus) tended to enhance average daily gain and feed consumption in pigs that were weaned into pens with non-littermates.

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