COMPARISON OF WATER-BASED AND IN-FEED ANTIMICROBIALS FOR GROWTH PERFORMANCE ENHANCEMENT OF WEANLING PIGS

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Summary

A total of 350 weanling pigs (initially 13.0 lb and 14 ± 3 d of age, PIC) were used to determine the effects of water-based antimicrobial on nursery pig growth performance. Pigs were given one of 5 experimental treatments: negative control (no antibiotics in the feed or water), positive control diet containing Neo-Terramycin® (140 g/ton Neomycin sulfate, 140 g/ton Oxytetracycline HCl), Neomycin sulfate in the water (24.2 mg of Neomycin sulfate per L), Oxytetracycline in the water (24.2 mg of Oxytetracycline per L), and Neomycin sulfate and Oxytetracycline (Neo/oxy) in the water. Overall (d 0 to 28 after weaning), pigs provided a water antimicrobial had greater ADG ($P<0.01$) and ADFI ($P<0.02$) than did pigs provided non-medicated water and feed. But pigs fed diets containing Neo-Terramycin® had greater ADG and ADFI ($P<0.01$) than did pigs provided a water antimicrobial. Pigs provided water containing Neomycin sulfate or Neo/oxy had greater ADG and ADFI ($P<0.05$) than did pigs provided non-medicated feed and water, and ADG and ADFI of pigs provided water containing Oxytetracycline were intermediate. There were no differences in growth performance between water antimicrobials and no differences in F/G for all treatments.

(Key Words: Nursery Pig, Antibiotics, Water, Growth.)

Introduction

The use of in-feed antimicrobials in nursery pig diets has long been recognized as a method to improve growth performance and health. But the use of these feed additives poses several challenges to swine production systems. First, changing the type of antimicrobial can be difficult due to feed-processing limitations. Second, handling multiple antibiotics in the mill leads to multiple runs of feed and concerns with cross-contamination with non-medicated feed. Third, pulsing antibiotics can be very difficult with feed application due to the difficulty of timing the delivery of the feed. Replacing in-feed with water-based antimicrobials would simplify feed processing and reduce the risk of feed being contaminated with an inappropriate antimicrobial or antimicrobial residue. Therefore, we conducted this trial to evaluate the effectiveness of water-based antimicrobials as a potential replacement for typical feed delivery of antimicrobials for improving nursery growth performance.

Procedures

A total of 350 weanling pigs (initially 13.0 lb and 14 ± 3 d of age, PIC) were blocked by

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initial weight and randomly allotted to one of five dietary treatments. Two adjacent pens used the same water line and served as one experimental unit. There were 5 pigs per pen and 7 experimental units (14 pens) per treatment. Pigs remained on the same treatments for 28 d after weaning. The five experimental treatments were: negative control (no antibiotics in the feed or water, positive control diet containing Neo-Terramycin® (140 g/ton Neomycin sulfate, 140 g/ton Oxytetracycline HCl), Neomycin sulfate in the water, Oxytetracycline in the water, or Neomycin sulfate and Oxytetracycline in the water (Neo/Oxy). When used, 12.5 ml of Neomycin liquid (200 mg/ml Neomycin sulfate) was provided per L of water and was then diluted to a concentrate:water ratio of 1:100. This provided 24.2 mg of Neomycin sulfate per L of drinking water. Oxytetracycline powder was provided at 45.35 g (55.1 mg of oxytetracycline per g) per L, and was then diluted to a concentrate:water ratio of 1:100, equivalent to 24.2 mg of Oxytetracycline per L of drinking water. For the Neo/Oxy treatment, the water contained 24.2 mg of Neomycin sulfate and 24.2 mg of Oxytetracycline per L. Pigs that received water-based antibiotics were fed the negative control diet that did not contain an antibiotic.

Water-based antimicrobials were administered through SelectDoser™ peristaltic pumps (Genesis Instruments; Elmwood, WI). This type of doser is powered by electricity, and siphons a concentrated, pre-mixed stock solution through a tube and doses the antimicrobial into the existing water supply. Concentrated stock solutions were made once every two days throughout the experiment. Each solution consisted of 4 L of water and either 50 ml Neomycin (12.5 ml/L), 181.4 g Oxytetracycline (45.35 g/L), or a combination of 50 ml Neomycin and 181.4 g Oxytetracycline. These concentrated stock solutions were dosed into the existing water line at a ratio of 1:100 to achieve the desired amount of antimicrobial.

Dietary treatments were fed in meal form (Table 1). Phase 1 (d 0 to 14 after weaning) diets were formulated to contain 1.41% true ileal digestible (TID) lysine, 0.90% Ca, and 0.52% available phosphorus. Phase 2 (d 14 to 28 after weaning) diets were formulated to contain 1.31% TID lysine, 0.85% Ca, and 0.42% available phosphorus. The trial was conducted in an environmentally controlled segregated early-weaning nursery facility at Kansas State University. Each pen was 5 × 5 ft and contained one self-feeder and one nipple waterer to provide *ad libitum* access to feed and water. Average daily gain, ADFI, and F/G were determined by weighing pigs and feeders on d 0, 7, 14, and 28 after weaning. In addition, water disappearance was measured. Growth performance data were analyzed as a randomized complete-block design, with pair of pens as the experimental unit. Analysis of variance was performed by using the MIXED procedure of SAS.

Results and Discussion

From d 0 to 14, pigs provided a water antimicrobial had greater ADG ($P<0.02$) and improved F/G ($P<0.03$), and tended to have increased ADFI ($P<0.08$), compared with those of pigs fed non-medicated feed or water. But pigs fed diets containing Neo-Terramycin® had greater ADG and ADFI ($P<0.01$) than did pigs provided a water antimicrobial. Pigs provided water containing Neomycin sulfate or Neo/oxy had greater ADG and ADFI ($P<0.05$) than those of pigs provided non-medicated water and feed, and those of pigs provided water containing Oxytetracycline were intermediate. Pigs fed diets containing Neo-Terramycin® had greater ADG and ADFI ($P<0.05$) than did pigs provided water containing Oxytetracycline provided or non-medicated feed and water. Pigs provided water containing Neo/oxy or diets containing Neo-Terramycin® had improved F/G ($P<0.05$), compared with F/G of pigs provided non-medicated feed and water; results of all other treatments were intermediate.

From d 14 to 28, pigs provided a water antimicrobial had greater ADFI ($P<0.02$) and tended to have greater ADG ($P<0.11$) than did pigs provided non-medicated feed and water, but pigs fed diets containing Neo-Terramycin® had greater ADFI ($P<0.01$) and ADG ($P<0.03$) than did pigs provided a water antimicrobial. Pigs fed diets containing Neo-Terramycin® had greater ADG ($P<0.05$) than did pigs provided water containing Neo/oxy or provided non-medicated feed and water; ADG of pigs provided water containing Neomycin sulfate or Oxytetracycline was intermediate. Pigs provided water containing Neomycin sulfate had greater ADFI ($P<0.05$) than did pigs provided non-medicated feed and water; ADFI of pigs provided water containing Oxytetracycline or Neo/oxy was intermediate. Pigs provided water containing Oxytetracycline had improved F/G ($P<0.05$), compared with that of pigs fed diets containing Neo-Terramycin® or those provided water containing Neo/oxy; F/G of pigs provided water containing Neomycin sulfate or provided non-medicated feed and water was intermediate.

Overall (d 0 to 28 after weaning), pigs provided a water antimicrobial had greater ADG ($P<0.01$) and ADFI ($P<0.02$) than did pigs provided non-medicated water and feed, but pigs fed diets containing Neo-Terramycin® had greater ADG and ADFI ($P<0.01$) than did pigs provided a water antimicrobial. Pigs provided water containing Neomycin sulfate or Neo/oxy had greater ADG and ADFI ($P<0.05$) than did pigs provided non-medicated feed and water; results of pigs provided water containing Oxytetracycline were intermediate. There were no differences in growth performance between water antimicrobials and no differences in F/G for all treatments.

Water disappearance was variable, but much greater than expected. In typical commercial nurseries using bowl waterers, expected water disappearance is around 20% of pig body weight (BW). In our experiment, water disappearance was approximately 36.4% of BW during the first week of the trial, and gradually declined to 22.8% by d 28. Nipple waterers (without guards) were used in our experiment. As a result, the increased water usage is most likely due to accidental pressure on the nipple during non-drinking activities, causing wastage. In addition, it was observed that a considerable amount of water was wasted during the normal drinking process.

Water antimicrobial concentrations were based on predicted water consumption, without accounting for wastage. As a result of increased wastage, pigs provided water antimicrobials most likely did not receive the desired amount of antimicrobial per pound of body weight. Furthermore, pigs provided an antimicrobial through the water received an overall lower dosage than did pigs provided antimicrobial through the feed because of the unexpected wastage. In more recent experiments in the same facility, in which bowl waterers and various rates of water antimicrobials were used, there was no significant difference in growth performance between pigs provided an antimicrobial through the water or the feed. In those experiments there was decreased wastage at the waterer and, thus, an increase in the actual amount of antimicrobial to the pig.

The use of a water-based antimicrobial resulted in improved growth performance, compared with that of pigs fed feed and water without antimicrobials. Water disappearance by all pigs was greater than expected and may have resulted in decreased antimicrobial consumption, compared with that of pigs provided feed antimicrobial. For example, if actual water consumption was assumed to be 10% of BW, those pigs provided a water-based antimicrobial consumed 65.8 mg/pig/d, compared with 207.2 mg/pig/day from the feed-based antimicrobial, for the overall treatment period. Further research is needed to determine if the same rate of growth performance can be obtained when water-based or feed-based antimicrobials are provided at the same dosages.

Table 1. Diet Composition (As-fed Basis)

	Phase 1[a]		Phase 2[b]	
Ingredient, %	Negative Control	Positive Control	Negative Control	Positive Control
Corn	48.42	48.42	60.32	60.32
Soybean meal (46.5% CP)	28.98	28.98	34.98	34.98
Spray dried whey	15.00	15.00	---	---
Select menhaden fish meal	3.75	3.75	---	---
Monocalcium P (21% P)	1.15	1.15	1.60	1.60
Limestone	0.70	0.70	1.10	1.10
Salt	0.33	0.33	0.33	0.33
Vitamin premix	0.25	0.25	0.25	0.25
Trace mineral premix	0.15	0.15	0.15	0.15
L-threonine	0.13	0.13	0.13	0.13
DL-methionine	0.15	0.15	0.15	0.15
Lysine HCl	0.30	0.30	0.30	0.30
Test ingredient[c]	0.70	0.70	1.00	1.00
Total	100.00	100.00	100.00	100.00
Calculated analysis				
Total lysine, %	1.55	1.55	1.45	1.45
True digestible amino acids				
Lysine	1.41	1.41	1.31	1.31
Isoleucine:lysine ratio, %	60	60	63	63
Leucine:lysine ratio, %	120	120	129	129
Methionine:lysine ratio, %	34	34	33	33
Met & cys:lysine ratio, %	57	57	57	57
Threonine:lysine ratio, %	62	62	63	63
Tryptophan:lysine ratio, %	17	17	18	18
Valine:lysine ratio, %	65	65	69	69
ME, kcal/lb	1,494	1,481	1,497	1,484
CP, %	21.8	21.8	21.4	21.4
Ca, %	0.90	0.90	0.85	0.85
P, %	0.80	0.80	0.75	0.75
Available P, %	0.52	0.52	0.42	0.42

[a]Fed from d 0 to 14 after weaning.
[b]Fed from d 14 to 28 after weaning.
[c]Corn starch or Neo-Terramycin® (140 g/ton Neomycin sulfate, 140 g/ton Oxytetracycline HCl).

Table 2. Growth Performance of Early-weaned Nursery Pigs Provided Water-based Antimicrobials[a]

Item	Neg Control	Neo/Oxy Feed[f]	Water Antimicrobial Neo[g]	Oxy[h]	Neo/Oxy[i]	Probability, P< Trt	Neg. Control vs. Water Antimicrobials	Neo/Oxy Feed vs. Water Antimicrobials	SE
d 0 to 14									
ADG, lb	0.63[b]	0.77[d]	0.70[bcd]	0.65[bc]	0.73[cd]	0.01	0.02	0.01	0.030
ADFI, lb	0.83[b]	0.95[d]	0.89[cd]	0.84[bc]	0.89[cd]	0.01	0.08	0.01	0.030
F/G	1.32[b]	1.23[cd]	1.27[bcd]	1.29[bc]	1.22[d]	0.02	0.03	0.19	0.031
d 14 to 28									
ADG, lb	1.29[b]	1.40[c]	1.35[bc]	1.35[bc]	1.31[b]	0.03	0.11	0.03	0.031
ADFI, lb	1.81[b]	2.00[d]	1.91[c]	1.87[bc]	1.88[bc]	0.01	0.02	0.01	0.036
F/G	1.40[bc]	1.43[c]	1.41[bc]	1.38[b]	1.43[c]	0.17	0.62	0.24	0.023
d 0 to 28									
ADG, lb	0.96[b]	1.08[d]	1.02[c]	1.00[bc]	1.02[c]	0.01	0.01	0.01	0.022
ADFI, lb	1.32[b]	1.48[d]	1.40[c]	1.35[bc]	1.39[c]	0.01	0.02	0.01	0.028
F/G	1.37	1.36	1.36	1.35	1.36	0.81	0.30	0.92	0.019

[a]A total of 350 weanling pigs, initially 13.0 lb (PIC); Each mean consists of 7 experiment units (pair of pens served by the same water line).
[bcde]Means in the same row with different superscripts differ.
[f]Neo/Oxy (Neo-Terramycin® providing 140 g/ton Neomycin sulfate, 140 g/ton Oxytetracycline HCl).
[g]Neomycin sulfate (24.2 mg/L).
[h]Oxytetracycline (24.2 mg/L).
[i]Neo/Oxy combination (24.2 mg/L Neomycin sulfate, 24.2 mg/L Oxytetracycline HCl).

Table 3. Water Disappearance of Early-weaned Pigs Provided Water-based Antimicrobials (% BW)[a]

Item	Neg. Control	Neo/Oxy Feed[b]	Water Antimicrobial			Overall Mean
			Neo[c]	Oxy[d]	Neo/Oxy[e]	
d 0 to 7	34.9	33.5	35.4	39.3	38.9	36.4
d 7 to 14	30.3	27.4	26.9	37.0	35.7	31.5
d 14 to 21	22.0	20.3	25.9	26.9	28.8	24.8
d 21 to 28	21.4	19.7	24.9	23.9	24.3	22.8
d 0 to 28	27.2	25.2	28.3	31.8	31.9	28.9

[a]A total of 350 weanling pigs, initially 13.0 lb (PIC); Each mean consists of 7 experiment units (pairs of pens served by the same water line).
[b] Neo/Oxy (Neo-Terramycin® providing 140 g/ton Neomycin sulfate, 140 g/ton Oxytetracycline HCl).
[c]Neomycin sulfate (24.2 mg/L).
[d]Oxytetracycline (24.2 mg/L).
[e]Neo/Oxy combination (24.2 mg/L Neomycin sulfate, 24.2 mg/L Oxytetracycline HCl).