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Influence of antimicrobial sequence in the nursery on pig performance and economic return

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INFLUENCE OF ANTIMICROBIAL SEQUENCE IN THE NURSERY ON PIG PERFORMANCE AND ECONOMIC RETURN[1]

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Summary

A total of 1,008 pigs (11.9 lb and 19 d of age) were used in a 42-d experiment to determine the influence of antibiotic regimen on growth performance and economic return. From d 0 to 10, pigs were fed diets containing either no antibiotic or Denagard at 35 g/ton and chlortetracycline at 400 g/ton (Denagard/CTC). From d 10 to 21, diets contained no medication, Denagard/CTC, Mecadox at 25 g/ton and Oxytetracycline at 400 g/ton, or Mecadox at 50 g/ton. From d 21 to 42, diets contained either no medication or Denagard/CTC. Adding Denagard/CTC to the diet from d 0 to 10 improved ($P < 0.01$) ADG, F/G, and margin over feed cost (MOFC). Adding antibiotics to the diet from d 10 to 21 improved ($P < 0.01$) ADG, ADFI, F/G, and MOFC. There were no differences between pigs fed diets containing Mecadox at 25 g/ton in combination with Oxytetracycline and pigs fed diets containing Mecadox at 50 g/ton. Pigs fed diets containing Denagard CTC tended ($P < 0.09$) to have greater ADG than pigs fed either diet containing Mecadox and tended ($P < 0.07$) to have improved F/G and MOFC than pigs fed diets containing Mecadox at 50 g/ton. Adding Denagard/CTC to the diet from d 21 to 42 improved ($P < 0.05$) ADG, ADFI, and F/G. Denagard/CTC also improved ($P < 0.01$) MOFC when gain was valued at $1.00/lb of gain. For the overall trial, adding antibiotics to the diet during any phase improved ($P < 0.05$) ADG. Overall feed efficiency was improved when antibiotics were added to the diet from d 0 to 10 and 21 to 42. Overall feed cost per pig was increased ($P < 0.01$) by the addition of antibiotics to the diet; however, the improvement in ADG resulted in no change in overall feed cost per pound of gain ($P > 0.49$). Overall, MOFC was increased when antibiotics were added to the diet from d 0 to 10 and d 10 to 21 when gain was valued at $0.50 or $1.00/lb and tended to increase ($P < 0.06$) when Denagard/CTC was added to the diet from d 21 to 42 when the extra gain was valued at $1.00/lb. These results demonstrate that adding antibiotics to the nursery diet improved pig performance and economical return on this commercial farm.

Key words: antimicrobial, nursery pig

Introduction

Past research has continually demonstrated that including antibiotics in nursery pig diets improves pig growth performance. The greatest response is normally through an increase in feed intake, which increases daily gain. Although the benefit of including feed-grade

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antibiotics in the nursery stage is well documented, many production systems don't always include antibiotics in all of the nursery phases. The main reason for not including antibiotics in all the diets is to provide a period of time where oral vaccines can be administered. This trial was conducted to help determine the economic effect of removing the antibiotics from the diet.

A second purpose of this trial was to compare the growth and economic response of some of the antibiotic regimens that are commonly used in the commercial swine industry.

Procedures

A total of 1,008 pigs (19 d of age) were used in a 42-d experiment. Pigs were from a PRRSv positive, but stable, sow farm. Pigs were weaned into a 4-room nursery facility. Each room contained 12 pens (6 × 10 ft) with wire flooring and a single bowl waterer and 4-hole dry feeder. All pigs received the same 3-stage diets (d 1 to 10, 10 to 21, and 21 to 42); feed medication was the only difference between treatment groups (Table 1).

The research site had a finishing barn within 75 ft of the nursery building. Historical mortality was 2 to 10% with pigs seroconverting to PRRSv by wk 3 in the nursery. Pigs were vaccinated for *Mycoplasma hyopneumoniae* and received ½ dose circovirus vaccine at 2 and 4 wk postplacement.

All pigs were weaned on the same day and blocked by weight into each of the treatment groups. There were 8 treatment groups (126 pigs per treatment; 1,008 pigs total); each treatment group consisted of 6 pens with 21 pigs per pen. All pigs were monitored daily, and animals exhibiting severe clinical signs were humanely euthanized according to Novartis Animal Health animal welfare policy.

For the dietary antibiotic regimens, pigs were fed diets containing either no antibiotic or Denagard at 35 g/ton and chlortetracycline at 400 g/ton (Denagard/CTC) from d 0 to 10 (Table 2). From d 10 to 21, diets contained no medication, Denagard/CTC, Mecadox at 25 g/ton and Oxytetracycline at 400 g/ton, or Mecadox at 50 g/ton. From d 21 to 42, diets contained either no medication or Denagard/CTC.

Water and feed were available to all pigs ad libitum for the duration of the study. Feed samples were collected from the feed mill to confirm medication level for all diet phases and treatment groups. Feed samples also were collected from 1 feeder of each treatment group for all diet phases. All feed samples were analyzed for the appropriate medication and its concentration (Table 3). Carbadox levels in the diet were slightly lower than expected.

All pigs were weighed on d 0, 10, 21, and 42 to calculate ADG, ADFI, and F/G. Any pigs treated for health-related problems were recorded to calculate the number of treatments per pen. Actual feed cost at the time of the experiment was used to calculate feed cost per pig and feed cost per pound of gain. Margin over feed cost (MOFC) was calculated as pound of gain × the value of the gain minus feed cost per pig. Two different values of gain ($0.50 or $1.00/lb) were used to account for the impact of weight gained in the nursery on pig weight at market. The $0.50/lb assumes that weight gained in the nursery remains at market without becoming greater or smaller. The $1.00/lb assumes that each 1 lb gained in the nursery becomes 2 lb at market. Previous research has demonstrated that each 1 lb gained in the nursery is worth 1 to 4 lb at market depending on the research trial.

Data were analyzed by using the MIXED procedure of SAS with pen as the experimental unit for all response criteria. The statistical model included the fixed effect of treatment and random effect of nursery room. The data was derived from 6 replicate pens across 4

nursery rooms in a balanced incomplete block design. Single degree of freedom contrasts were used to determine the response to antibiotic inclusion in the diet during each phase and any differences between sources of antibiotic during phase 2.

Results

No adverse effects to inclusion of the antibiotics in the feed were noted during any phase of the study. Overall pig mortality during the study was similar to historical expected mortality. Laboratory analysis indicated that antibiotic levels in the feed were slightly lower than target levels for all antibiotic treatments (Table 3).

Adding Denagard/CTC to the diet from d 0 to 10 improved ($P < 0.01$) ADG, F/G and MOFC (Tables 4, 5, and 6). Feed cost per pig was increased ($P < 0.04$); however, the extra gain was great enough that feed cost per pound of gain was reduced ($P < 0.04$). Including Denagard/CTC in the diet from d 0 to 10 after weaning resulted in 0.83 lb more gain per pig and a net increase in MOFC of $0.22/pig when gain was valued at $0.50/lb and $0.62/pig when the value of gain was increased to $1.00/lb.

Adding antibiotics to the diet from d 10 to 21 improved ($P < 0.01$) ADG, ADFI, F/G, and MOFC. Similar to the results from d 0 to 10, adding antibiotics to the diets increased ($P < 0.01$) feed cost per pig, but the growth response was great enough to result in lower ($P < 0.01$) feed cost per pound of gain. Either treatment containing Mecadox improved ADG, ADFI, F/G, feed cost per pound of gain, and MOFC. There were no differences between pigs fed diets containing Mecadox at 25 g/ton in combination with Oxytetracycline and pigs fed diets containing Mecadox at 50 g/ton. Pigs fed diets containing Denagard/CTC tended ($P < 0.09$) to have greater ADG than pigs fed either diet containing Mecadox and tended ($P < 0.07$) to have improved F/G and MOFC compared with pigs fed diets containing Mecadox at 50 g/ton. On average, adding Denagard/CTC to the diet increased pig weight 2.1 lb and MOFC $0.64 and $1.69 with the value of gain at $0.50 and $1.00/lb, respectively, compared with the control. The two diets containing Mecadox had a similar MOFC advantage over the control at $0.38 to 0.43/pig when gain was valued at $0.50/lb and $1.03 to $1.15/pig when gain was valued at $1.00/lb.

Adding Denagard/CTC to the diet from d 21 to 42 improved ADG ($P < 0.01$), ADFI ($P < 0.03$), and F/G ($P < 0.05$). Feed cost per pig increased ($P < 0.01$) with the addition of Denagard/CTC to the diet. The response in MOFC depended on the value assigned to the extra gain (2.2 lb/pig) created by the Denagard/CTC. When gain was valued at $0.50/lb of gain (MOFC 1), margin was numerically ($0.26/pig) but not significantly influenced ($P = 0.16$) by Denagard/CTC inclusion in the diet. When gain was valued at $1.00/lb of gain, however, MOFC increased ($P < 0.01$; $1.32) when Denagard/CTC was added to the diet from d 21 to 42. Many production systems remove antibiotics from the feed during this time period to prevent interference with oral vaccines that are added to the drinking water. The negative impact of removing antibiotics from the diet on pig performance and margin over feed should be considered when evaluating vaccine strategies.

For the overall trial, adding antibiotics to the diet from d 0 to 10, 10 to 21, and 21 to 42 improved ($P < 0.05$) ADG. Overall feed efficiency was improved when antibiotics were added to the diet from d 0 to 10 and 21 to 42. Overall feed cost per pig was increased ($P < 0.01$) by the addition of antibiotics to the diet; however, the improvement in ADG resulted in no change in overall feed cost per pound of gain ($P > 0.49$). Overall MOFC was increased when antibiotics were added to the diet from d 0 to 10 and 10 to 21 regardless of the value assigned to the gain. Overall MOFC also tended to increase ($P < 0.06$) when Denagard/

CTC was added to the diet from d 21 to 42 when the extra gain was valued at $1.00/lb but was not increased (P = 0.21) when the gain was valued at $0.50/lb. These results demonstrate that adding antibiotics to the nursery diet improved pig performance and economical return on this commercial farm.

Table 1. Composition of control diets

Ingredient, %	Phase 1	Phase 2	Phase 3
Corn[1]	46.87	51.99	53.85
Soybean meal (46.5% CP)	20.00	27.50	26.89
Lactose replacement	23.33	10.00	---
Spray-dried animal plasma	3.67	---	---
Dried distillers grains with solubles	0.00	5.00	15.00
Fat, AV blend	1.45	1.50	1.48
Limestone	0.92	0.92	1.04
Monocalcium P, 21% P	1.04	1.00	0.43
Salt	.39	.39	.45
L-lysine HCl	0.766	0.582	0.400
DL-methionine	0.361	0.228	0.074
L-threonine	0.305	0.197	0.064
L-valine	0.166	0.071	---
Zinc oxide	0.350	0.250	---
Vitamin premix[2]	0.150	0.150	0.125
Trace mineral premix[3]	0.125	0.125	0.100
Copper sulfate	0.075	0.075	0.075
Phytase 2500	0.030	0.030	0.030
Total	100.00	100.00	100.00
SID lysine[4], %	1.45	1.34	1.25
Total lysine, %	1.576	1.464	1.41
SID amino acid ratios			
Met & Cys:lysine, %	58	58	57
Threonine:lysine, %	60	60	60
Tryptophan:lysine, %	13	15	17
Valine:lysine, %	58	59	66
ME, Kcal/lb	1518	1475	1488
Lactose, %	14	6	0
Salt, %	0.42	0.39	0.43
Phytase, units/kg	750	750	750
CP, %	17.6	19.5	21.8
Fat, %	5.4	5.0	5.3
Ca, %	0.74	0.75	0.7
P, %	0.66	0.69	0.64
Available P, %	0.45	0.42	0.35

[1] Antibiotics replaced corn in the control diets to form the experimental treatments.
[2] Provided following vitamins per pound of complete diet: vitamin A, 4,995 IU; vitamin D, 750 IU; vitamin E, 24 IU; vitamin K, 2.0 mg; vitamin B_{12}, 17.6 ug; niacin, 22.5 mg; pantothenic acid, 12.5 mg; and riboflavin, 3.8 mg.
[3] Contained following minerals: copper, 1.32%; iodine, 240 ppm; iron, 10%; manganese, 2.8%; selenium, 240 ppm; and zinc, 12%.
[4] Standardized ileal digestible.

Table 2. Dietary antibiotics in each phase

Treatment	d 0 to 10	d 10 to 21	d 21 to 42
1	No medication	No medication	No medication
2	Denagard/CTC[1]	Mecadox 25 g/OTC[2]	Denagard/CTC
3	Denagard/CTC	Mecadox 50 g	Denagard/CTC
4	Denagard/CTC	Mecadox 25 g/OTC	No medication
5	Denagard/CTC	Mecadox 50 g	No medication
6	Denagard/CTC	No medication	Denagard/CTC
7	Denagard/CTC	Denagard/CTC	Denagard/CTC
8	Denagard/CTC	Denagard/CTC	No medication

[1]Chlortetracycline, 400 g/ton.

[2]Oxytetracycline, 400 g/ton.

Table 3. Analyzed antibiotic levels in each phase, g/ton

Treatment	Carbadox	Oxytetracycline	Chlortetracycline	Tiamulin
Phase 1				
Control	< 1.14	< 5.68	< 1.82	< 2
Denagard/CTC[1]	---	---	298	24.0
Phase 2				
Control	< 1.14	11.9	2.62	< 2
Mecadox 25 g/OTC[2]	13.7	294	---	---
Mecadox 50 g	39.4	---	---	---
Denagard/CTC	---	---	251	22.7
Phase 3				
Control	< 1.14	< 5.68	< 1.82	< 2
Denagard/CTC	---	---	221	24.3

[1]Chlortetracycline, 400 g/ton.

[2]Oxytetracycline, 400 g/ton.

Table 4. Influence of antimicrobial additions to the diet on pig performance

	Treatment								
	1	2	3	4	5	6	7	8	
d 0 to 10	No med	Den/CTC[1]	Den/CTC	Den/CTC	Den/CTC	Den/CTC	Den/CTC	Den/CTC	
d 10 to 21	No med	Mec/OTC[2]	Mec 50 g	Mec/OTC	Mec 50 g	No med	Den/CTC	Den/CTC	
d 21 to 42	No med	Den/CTC	Den/CTC	No med	No med	Den/CTC	Den/CTC	No med	SEM
d 0 to 10									
ADG, lb	0.20	0.25	0.30	0.26	0.27	0.28	0.31	0.29	0.043
ADFI, lb	0.40	0.41	0.45	0.42	0.45	0.44	0.47	0.46	0.046
F/G	2.00	1.74	1.52	1.68	1.81	1.64	1.63	1.67	0.148
d 10 to 21									
ADG, lb	0.48	0.63	0.60	0.58	0.61	0.47	0.68	0.66	0.068
ADFI, lb	0.78	0.88	0.87	0.84	0.88	0.78	0.93	0.93	0.086
F/G	1.66	1.41	1.48	1.46	1.46	1.65	1.40	1.39	0.049
d 21 to 42									
ADG, lb	0.88	1.06	1.01	0.91	0.99	1.07	1.03	0.98	0.125
ADFI, lb	1.36	1.64	1.56	1.49	1.55	1.63	1.64	1.57	0.192
F/G	1.56	1.54	1.54	1.64	1.58	1.52	1.59	1.61	0.045
d 0 to 42									
ADG, lb	0.61	0.75	0.73	0.67	0.71	0.72	0.76	0.73	0.083
ADFI, lb	0.97	1.14	1.10	1.06	1.10	1.11	1.17	1.15	0.122
F/G	1.62	1.52	1.52	1.60	1.56	1.54	1.53	1.56	0.036
Weight, lb									
d 0	11.7	12.0	11.7	11.7	12.0	12.1	11.7	12.1	1.229
d 10	13.7	14.5	14.7	14.4	14.7	14.9	14.8	15.0	1.495
d 21	19.1	21.5	21.5	20.8	21.5	20.3	22.3	22.4	2.149
d 42	38.4	43.8	42.8	40.7	42.7	43.1	44.4	43.1	4.411
Mortality, %	8.7	3.6	2.7	5.1	5.2	6.4	4.7	0.8	0.029
Treatments, n	7.2	4.7	7.5	7.5	6.3	7.3	5.0	6.2	1.222

[1] Denagard, Chlortetracycline.

[2] Mecadox (Mec), Oxytetracycline (OTC).

Table 5. Influence of antimicrobial additions to the diet on feed economics[1]

	Treatment								
	1	2	3	4	5	6	7	8	
d 0 to 10	No med	Den/CTC[2]	Den/CTC	Den/CTC	Den/CTC	Den/CTC	Den/CTC	Den/CTC	
d 10 to 21	No med	Mec/OTC[3]	Mec 50 g	Mec/OTC	Mec 50 g	No med	Den/CTC	Den/CTC	
d 21 to 42	No med	Den/CTC	Den/CTC	No med	No med	Den/CTC	Den/CTC	No med	SEM
Feed cost, $/pig									
d 0 to 10	1.02	1.12	1.22	1.15	1.22	1.20	1.29	1.25	0.125
d 10 to 21	1.45	1.71	1.72	1.65	1.74	1.44	1.87	1.86	0.167
d 21 to 42	3.99	5.24	5.01	4.34	4.54	5.24	5.24	4.62	0.593
d 0 to 42	6.45	8.08	7.93	7.14	7.50	7.88	8.39	7.82	0.794
Feed cost, $/lb gain									
d 0 to 10	0.518	0.471	0.412	0.455	0.490	0.445	0.441	0.454	0.04
d 10 to 21	0.280	0.250	0.266	0.260	0.262	0.278	0.254	0.253	0.008
d 21 to 42	0.217	0.235	0.235	0.229	0.220	0.232	0.242	0.224	0.007
d 0 to 42	0.258	0.257	0.260	0.258	0.253	0.261	0.262	0.252	0.008
Margin over feed cost 1[4], $/pig									
d 0 to 10	-0.03	0.11	0.30	0.15	0.12	0.21	0.26	0.19	0.113
d 10 to 21	1.21	1.74	1.53	1.54	1.60	1.16	1.85	1.80	0.215
d 21 to 42	5.28	5.90	5.64	5.26	5.89	6.02	5.61	5.71	0.745
d 0 to 42	6.37	7.62	7.33	6.88	7.46	7.23	7.65	7.75	1.002
Margin over feed cost 2[4], $/pig									
d 0 to 10	0.96	1.33	1.81	1.45	1.46	1.61	1.80	1.63	0.322
d 10 to 21	3.87	5.20	4.77	4.73	4.93	3.77	5.56	5.46	0.587
d 21 to 42	14.56	17.04	16.28	14.85	16.31	17.27	16.45	16.04	2.048
d 0 to 42	19.19	23.31	22.60	20.90	22.42	22.35	23.68	23.33	2.748

[1] Base diet costs were $516.37/ton from d 0 to 10; $337.19/ton from d 10 to 21; and $278.90/ton from d 21 to 42. Medication costs per ton were $26.40 for Denagard/CTC, and $18.10 for Mecadox/OTC, and $21.86 for Mecadox.
[2] Denagard, Chlortetracycline.
[3] Mecadox (Mec), Oxytetracycline (OTC).
[4] Margin over feed cost 1 assumed a value of gain at $0.50/lb. Margin over feed cost 2 assumed a value of gain of $1.00/lb.

Table 6. Statistical differences for performance and economic data, (*P* <)

	Treat-ment	Contrasts[1]							
		1	2	3	4	5	6	7	8
d 0 to 10									
ADG, lb	0.07	0.004	0.06	0.02	0.17	0.19	0.07	0.62	0.08
ADFI, lb	0.66	0.15	0.29	0.13	0.54	0.29	0.13	0.63	0.57
F/G	0.10	0.01	0.10	0.11	0.15	0.67	0.58	0.90	0.04
d 10 to 21									
ADG, lb	0.003	0.005	.0001	.0001	0.001	0.96	0.09	0.08	0.70
ADFI, lb	0.23	0.09	0.010	0.004	0.04	0.77	0.16	0.27	0.91
F/G	.0001	.0001	.0001	.0001	.0001	0.37	0.34	0.07	0.77
d 21 to 42									
ADG, lb	0.04	0.01	0.53	0.48	0.63	0.71	0.63	0.91	0.002
ADFI, lb	0.23	0.01	0.25	0.19	0.39	0.93	0.59	0.53	0.03
F/G	0.28	0.77	0.15	0.12	0.26	0.40	0.85	0.31	0.05
d 0 to 42									
ADG, lb	0.06	0.003	0.03	0.02	0.09	0.67	0.23	0.43	0.02
ADFI, lb	0.33	0.02	0.10	0.05	0.23	0.96	0.32	0.36	0.14
F/G	0.12	0.02	0.14	0.17	0.19	0.43	0.50	0.91	0.01
Weight, lb									
d 0	1.00	0.85	0.94	0.98	0.93	0.96	0.98	0.95	0.97
d 10	0.99	0.35	0.65	0.56	0.76	0.80	0.65	0.84	0.67
d 21	0.69	0.10	0.07	0.05	0.16	0.82	0.39	0.52	0.64
d 42	0.58	0.06	0.22	0.17	0.35	0.83	0.50	0.64	0.13
Mortality, %	0.28	0.05	0.03	0.03	0.07	0.85	0.45	0.57	0.69
Treatments, n	0.56	0.54	0.30	0.18	0.48	0.50	0.68	0.28	0.45
Feed cost, $/pig									
d 0 to 10	0.40	0.04	0.14	0.06	0.32	0.30	0.11	0.57	0.43
d 10 to 21	0.02	0.01	0.00	0.00	0.00	0.64	0.07	0.18	0.89
d 21 to 42	0.00	0.002	0.28	0.21	0.43	0.95	0.58	0.53	<.0001
d 0 to 42	0.05	0.003	0.06	0.03	0.16	0.80	0.24	0.36	0.01
Feed cost, $/lb gain									
d 0 to 10	0.29	0.04	0.25	0.24	0.33	0.67	0.58	0.90	0.07
d 10 to 21	0.04	0.02	0.00	0.00	0.00	0.20	0.87	0.16	0.79
d 21 to 42	0.02	0.02	0.14	0.10	0.25	0.38	0.80	0.26	0.00
d 0 to 42	0.82	0.90	0.49	0.56	0.52	0.87	0.91	0.97	0.17
Margin over feed cost 1, $/pig[2]									
d 0 to 10	0.04	0.003	0.07	0.04	0.17	0.22	0.14	0.81	0.02
d 10 to 21	0.004	0.01	<.0001	<.0001	0.005	0.56	0.18	0.07	0.73
d 21 to 42	0.34	0.12	0.94	0.97	0.93	0.47	0.75	0.69	0.16
d 0 to 42	0.22	0.01	0.04	0.03	0.12	0.70	0.25	0.44	0.21
Margin over feed cost 2, $/pig[2]									
d 0 to 10	0.04	0.002	0.05	0.02	0.15	0.18	0.08	0.66	0.04
d 10 to 21	0.004	0.007	<.0001	<.0001	0.001	0.75	0.13	0.07	0.76
d 21 to 42	0.10	0.02	0.66	0.63	0.73	0.61	0.66	0.94	0.01
d 0 to 42	0.10	0.005	0.04	0.02	0.11	0.72	0.21	0.38	0.06

[1] Contrast 1 = Response to antibiotic in phase 1 (Treatment 1 vs. all others).
Contrast 2 = Response to antibiotic in phase 2 (Treatments 1 and 6 vs. all others).
Contrast 3 = Denagard/CTC vs. no medication in phase 2 (Treatments 1 and 6 vs. 7 and 8).
Contrast 4 = Mecadox vs. no medication in phase 2 (Treatments 1 and 6 vs. 2, 3, 4, and 5).
Contrast 5 = Mecadox 25 g/OTC vs. Mecadox 50 g in phase 2 (Treatments 2 and 4 vs. 3 and 5).
Contrast 6 = Mecadox 25 g/OTC vs. Denagard CTC in phase 2 (Treatments 2 and 4 vs. 7 and 8).
Contrast 7 Mecadox 50 g vs. Denagard CTC in phase 2 (Treatments 3 and 5 vs. 7 and 8).
Contrast 8 Denagard CTC vs. no medication in phase 3 (Treatments 1, 4, 5, and 8 vs. 2, 3, 6, and 7).
[2] Margin over feed cost 1 assumed a value of gain at $0.50/lb. Margin over feed cost 2 assumed a value of gain of $1.00/lb.