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Comparison of Different Antimicrobial Sequences on Nursery Pig Performance and Economic Return

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Summary

A total of 1,008 weanling pigs (12.0 lb and 19 d of age) were used in a 42-d experiment to compare different antibiotic regimens on growth performance and economic return. From d 0 to 11 and d 11 to 21, pigs were fed diets containing no antibiotic, a combination of Denagard (Novartis Animal Health, Greensboro, NC) at 35 g/ton and chlortetracycline at 400 g/ton (Denagard/CTC), or Pulmotil (Elanco, Greenfield, IN; 363 g/ton from d 0 to 11 and 181 g/ton from d 11 to 21). From d 21 to 42, pigs previously fed Denagard/CTC or Pulmotil were fed diets containing no medication, Denagard/CTC, or a combination of Mecadox (Philbro Animal Health Corp., Ridgefield Park, NJ) at 25 g/ton and oxytetracycline at 400 g per ton (Mecadox/OTC). Adding Denagard/CTC or Pulmotil to the diet from d 0 to 11 and d 11 to 21 improved ($P < 0.01$) ADG, ADFI, F/G, and income over feed cost (IOFC). There were no differences ($P > 0.21$) in ADG or ADFI between pigs fed Denagard/CTC and pigs fed Pulmotil; however, pigs fed Denagard/CTC tended to have better ($P < 0.09$) F/G from d 0 to 21. Feed cost was also lower ($P < 0.01$) and IOFC was greater ($P < 0.03$) from d 0 to 21 for pigs fed Denagard/CTC than for pigs fed Pulmotil. Adding Denagard/CTC or Mecadox/OTC to the diet from d 21 to 42 increased ($P < 0.05$) ADG, ADFI, and IOFC compared with feeding no antibiotic, but there were no differences ($P > 0.17$) in pig performance or IOFC between pigs fed Denagard/CTC and Mecadox/OTC. For the overall trial, adding antibiotics to the diet during any phase improved ($P < 0.05$) ADG, ADFI, F/G, and IOFC. These results demonstrate that adding antibiotics to the nursery diet improved pig performance and economical return on this commercial farm.

Key words: antimicrobial

Introduction

Past research has continually demonstrated that including antibiotics in nursery pig diets improves pig growth performance (Hays, 1978[4]; Zimmerman, 1986[5]; Cromwell,

[1] Swine Nutrition Services, Inc., Anchor, Il.
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[3] Department of Diagnostic Medicine/Pathobiology, Kansas State University.
[4] Hays, V. W. 1978. Effectiveness of feed additive usage of antibacterial agents in swine and poultry production. Report to the Office of Technology Assessment. U.S. Government Printing Office, Washington, DC.
[5] Zimmerman, D. R. 1986. Role of subtherapeutic levels of antimicrobials in pig production. J. Anim. Sci. 62(Suppl. 3):6-17.

2001[6]; Dritz et al., 2002[7]; Steidinger et al., 2008[8]). The greatest response is normally through an increase in feed intake, which increases daily gain. Although the benefit of including feed-grade antibiotics in the nursery stage is well documented, limited data are available comparing various antibiotic regimens for nursery pigs. In the 2008 Swine Day Report of Progress (Steidinger et al., 2008), we reported beneficial responses to antibiotics fed in nursery pig diets. In that study, we compared pigs fed different regimens and combinations including Denagard (Novartis Animal Health, Greensboro, NC) and chlortetracycline (Denagard/CTC) with pigs fed Mecadox (Philbro Animal Health Corp., Ridgefield Park, NJ) and oxytetracycline (Mecadox/OTC). Any of the antibiotic regimens tested improved growth performance and income over feed cost (IOFC) compared with pigs fed no antibiotic. In fact, removing antibiotics from the diet during any phase resulted in lower IOFC. Therefore, the purpose of this trial was to validate the response to antibiotics observed in our earlier study (Steidinger et al., 2008) and to compare the growth and economic response of some different antibiotic regimens that are commonly used in the commercial swine industry.

Procedures

A total of 1,008 pigs (12.0 lb and 19 d of age) were used in a 42-d experiment. Pigs were from a PRRSv positive, but stable, pig flow. The pig flow had a history of both enteric and respiratory challenge with a variety of organisms involved including *Pasteurella multocida*. Denagard/CTC was selected as one of the interventions based on the diagnostic history. 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; Phases 1, 2, and 3, respectively); 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 7 treatment groups (144 pigs per treatment; 1,008 pigs total); each treatment group consisted of 6 or 7 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.

Dietary treatments were arranged as a 2 × 3 factorial design plus a negative control (Table 2).The negative control did not contain antibiotics during any period. For the factorial, pigs received either Denagard/CTC or Pulmotil (Elanco, Greenfield, IN) from d 0 to 10 and d 10 to 21 and then 1 of 3 diets from d 21 to 42 (negative control, Denagard/CTC, or Mecadox/OTC. When Denagard/CTC was fed, Denagard was

[6] Cromwell, G. L. 2001. Antimicrobial and promicrobial agents. Pages 401-426 in Swine Nutrition. A. J. Lewis and L.L. Southern, eds. CRC Press, New York.

[7] Dritz, S. S., M. D. Tokach, R. D. Goodband, and J. L. Nelssen. 2002. Effects of administration of antimicrobials in feed on growth rate and feed efficiency of pigs in multisite production systems. J. Amer. Vet. Med. Assoc. 220:1690-1695.

[8] Steidinger et al., Swine Day 2008, Report of Progress 1001, pp. 74-81.

added at 35 g/ton and CTC at 400 g/ton. For Mecadox/OTC, Mecadox was included at 25 g/ton and OTC at 400 g/ton. When Pulmotil was fed during the first 2 phases, it was included in the diet at 363 g/ton during Phase 1 and 181 g/ton during Phase 2.

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).

All pigs were weighed on d 0, 11, 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. Income over feed cost was calculated as pound of gain × the value of the gain - feed cost per pig. Two different values of gain ($0.50/lb 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 (Tokach et al., 1995[9]; Steidinger et al., 2008).

Data were analyzed using the MIXED procedure of SAS (SAS Institute Inc., Cary, NC) 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 or 7 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 Denagard/CTC and Pulmotil during Phases 1 and 2 and between Denagard/CTC and Mecadox/OTC during Phase 3.

Results and Discussion

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 confirmed antibiotic inclusion in the test diets (Table 3). Analyzed levels in the feed were lower than targeted levels for CTC and Denagard but higher than target for OTC. The low levels of OTC in the control diets were unexpected. The reason may have been contamination during sampling. We don't believe the contamination occurred hrough feed mixing because feed batches without antibiotic were manufactured before batches with antibiotic to minimize any potential for carryover. The reason for the discrepancy in OTC and CTC levels in the Phase 3 diets is also unknown. The target level was 400 g/ton, but testing results revealed 803 g/ton for OTC and 279 g/ton for CTC.

[9] Tokach, M. D., J. E. Pettigrew, L. J. Johnston, M. Overland, J. W. Rust, and S. G. Cornelius. 1995. Effect of adding fat and(or) milk products to the weanling pig diet on performance in the nursery and subsequent grow-finish stages. J. Anim. Sci. 73:3358.

Adding Denagard/CTC or Pulmotil to the diet from d 0 to 11 and d 11 to 21 improved ($P < 0.01$) ADG, ADFI, F/G, and IOFC (Tables 4, 5, and 6). Adding Denagard/CTC to the diet also lowered ($P < 0.03$) feed cost per pound of gain during both phases, whereas feeding Pulmotil resulted in a similar ($P > 0.22$) feed cost per pound of gain compared with the control. Pigs fed Denagard/CTC had lower ($P < 0.01$) feed cost per pig and feed cost per pound of gain and higher ($P < 0.03$) IOFC than pigs fed Pulmotil from d 0 to 21 (Phases 1 and 2). Including Denagard/CTC in the diet from d 0 to 21 after weaning resulted in 4.1 lb more weight gain per pig and a net increase in IOFC of $1.35/pig when gain was valued at $0.50/lb and $3.46/pig when the value of gain was increased to $1.00/lb. Including Pulmotil in the diet from d 0 to 21 resulted in 3.5 lb more weight gain per pig than the control and a net increase in IOFC of $0.71/pig or $2.47/pig when valued at $0.50 and $1.00/lb, respectively. Thus, Denagard/CTC resulted in weight gain similar to that of Pulmotil, but with a greater IOFC ($0.64/pig to 0.99/pig depending on the value of gain).

Adding antibiotics to the diet from d 21 to 42 improved ADG ($P < 0.01$) and ADFI ($P = 0.02$) and tended to improve F/G ($P = 0.08$). There were no differences in performance ($P > 0.46$) between pigs fed Denagard/CTC and pigs fed Mecadox/OTC. Although adding antibiotics to the diet increased ($P < 0.01$) feed cost per pig and feed cost per pound of gain, the weight gain benefit resulted in increased ($P < 0.01$) IOFC when antibiotics were added to the diet. Pigs fed Mecadox/OTC had lower ($P = 0.03$) feed cost per pound of gain than pigs fed Denagard/CTC; however, there were no differences ($P > 0.17$) between the two antibiotics for IOFC. It is unknown whether the response in this phase may have been influenced by the higher tested OTC level in the Mecadox/OTC treatment relative to the CTC level in the Denagard/CTC treatment. The reason that we believe that the antibiotic level may have influenced the response is that pigs fed Denagard/CTC tended to grow faster than pigs fed Mecadox/OTC when compared with the same antibiotic combinations used during the Phase 2 period in our previous study (Steidinger et al., 2008).

For the overall trial, adding antibiotics to the diet from d 0 to 11, 11 to 21, and 21 to 42 improved ($P < 0.05$) ADG, ADFI, and F/G. Overall feed cost per pig was increased ($P < 0.01$) by the addition of antibiotics to the diet during any phase. Adding antibiotics to the diet also increased ($P < 0.04$) overall feed cost per pound of gain; however, overall IOFC was increased ($P < 0.04$) when antibiotics were added to the diet from d 0 to 21 and d 21 to 42. These results confirm the results of our first experiment (Steidinger et al., 2008) that adding antibiotics to the nursery diet improved pig performance and economic returns on this commercial farm.

Table 1. Composition of control diets

Item	Phase 1	Phase 2	Phase 3
Ingredient, %			
Corn[1]	42.62	41.21	40.37
Soybean meal (46.5% CP)	23.52	30.79	25.47
Whey permeate	20	7.5	- - -
Dried distillers grains with solubles	2.5	15	30
Spray-dried animal plasma	3.65	- - -	- - -
Menhaden fish meal	3.35	- - -	- - -
Fat, AV blend	1.501	2.077	1.425
Limestone	0.673	1.076	1.275
Monocalcium P, 21% P	0.424	0.702	0.052
Salt	0.25	0.25	0.4
L-lysine HCl	0.371	0.450	0.458
DL-methionine	0.205	0.154	0.072
L-threonine	0.127	0.114	0.089
Zinc oxide	0.375	0.25	- - -
Vitamin premix[2]	0.15	0.15	0.125
Trace mineral premix[3]	0.125	0.125	0.125
Copper sulfate	0.075	0.075	0.075
Sweetener	0.025	0.025	- - -
Phytase 1200	0.0625	0.0625	0.0625
Total	100.00	100.00	100.00
Calculated analysis			
SID lysine[4], %	1.45	1.36	1.25
Total lysine, %	1.58	1.52	1.41
SID amino acid ratios			
Met & Cys:lysine, %	59	60	57
Threonine:lysine, %	61	61	60
Tryptophan:lysine, %	17	17	17
Valine:lysine, %	63	67	66
ME, Kcal/lb	1,544	1,546	1,488
Lactose, %	16.0	6.0	---
Phytase, units/kg	680	680	680
CP, %	21.8	22.9	21.8
Fat, %	4.1	5.8	5.3
Ca, %	0.71	0.70	0.7
P, %	0.68	0.63	0.64
Available P, %	0.55	0.45	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 the 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 11	d 11 to 21	d 21 to 42
1	No medication	No medication	No medication
2	Denagard/CTC[1]	Denagard/CTC	Denagard/CTC
3	Pulmotil, 363 g	Pulmotil, 181 g	Denagard/CTC
4	Denagard/CTC	Denagard/CTC	No medication
5	Pulmotil, 363 g	Pulmotil, 181 g	No medication
6	Denagard/CTC	Denagard/CTC	Mecadox/OTC[2]
7	Pulmotil, 363 g	Pulmotil, 181 g	Mecadox/OTC

[1] Chlortetracycline, 400 g/ton.
[2] Oxytetracycline, 400 g/ton.

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

	Carbadox	Oxytetracycline	Chlortetracycline	Tiamulin	Pulmotil
Phase 1					
Control	1.53	8.49	<0.91	0	< 45.4
Denagard/CTC[1]	---	---	298	10.1	---
Pulmotil	---	---	---	---	295
Phase 2					
Control	2.25	5.28	<0.91	0	< 45.4
Denagard/CTC	---	---	379	20.3	---
Pulmotil	---	---	---	---	181
Phase 3					
Control	< 1.14	36.1	2.76	0	< 45.4
Mecadox 25g/OTC[2]	13.4	803	---	---	---
Denagard/CTC	---	---	279	17.5	---

[1] Chlortetracycline, 400 g/ton.
[2] Oxytetracycline, 400 g/ton.

Table 4. Influence of antimicrobial additions to the diet on pig performance[1]

	Treatment							
	1	2	3	4	5	6	7	
d 0 to 10:	No med	Den/CTC[2]	Pulmotil	Den/CTC	Pulmotil	Den/CTC	Pulmotil	
d 10 to 21:	No med	Den/CTC	Pulmotil	Den/CTC	Pulmotil	Den/CTC	Pulmotil	
d 21 to 42:	No med	Den/CTC	Den/CTC	No med	No med	Mec/OTC[3]	Mec/OTC	SEM
d 0 to 11								
ADG, lb	0.19	0.32	0.31	0.31	0.30	0.33	0.30	0.024
ADFI, lb	0.30	0.39	0.38	0.41	0.39	0.41	0.41	0.023
F/G	1.59	1.26	1.26	1.33	1.33	1.28	1.35	0.085
d 11 to 21								
ADG, lb	0.50	0.76	0.74	0.80	0.73	0.79	0.74	0.50
ADFI, lb	0.77	0.99	1.01	1.01	0.97	1.01	0.98	0.77
F/G	1.63	1.31	1.38	1.26	1.33	1.29	1.33	1.63
d 21 to 42								
ADG, lb	0.93	1.03	1.06	0.92	0.93	1.05	1.11	0.06
ADFI, lb	1.43	1.62	1.59	1.46	1.49	1.59	1.64	0.106
F/G	1.56	1.57	1.49	1.58	1.59	1.52	1.48	0.048
d 0 to 21								
ADG, lb	0.34	0.53	0.51	0.54	0.51	0.55	0.51	0.035
ADFI, lb	0.52	0.68	0.68	0.70	0.66	0.70	0.67	0.037
F/G	1.60	1.29	1.35	1.28	1.33	1.28	1.34	0.044
d 0 to 42								
ADG, lb	0.63	0.78	0.78	0.73	0.72	0.80	0.81	0.043
ADFI, lb	0.98	1.14	1.12	1.07	1.07	1.14	1.14	0.065
F/G	1.57	1.47	1.44	1.47	1.50	1.44	1.43	0.037
Weight, lb								
d 0	12.4	11.9	11.8	12.1	12.2	11.8	11.7	1.02
d 11	14.5	15.4	15.2	15.5	15.5	15.5	15.1	1.17
d 21	19.6	23.1	22.6	23.5	22.8	23.3	22.6	1.61
d 42	39.4	44.9	44.8	42.7	42.4	45.4	45.8	2.60
Survival, %	95.8%	96.3%	99.3%	100.0%	99.3%	99.3%	98.0%	1.3%

[1] Each mean represents 6 (treatment 1) or 7 pens with 21 pigs per pen for a total of 1,008 pigs.
[2] Denagard, chlortetracycline.
[3] Mecadox, oxytetracycline.

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

	Treatment							
	1	2	3	4	5	6	7	
d 0 to 10:	No med	Den/CTC[2]	Pulmotil	Den/CTC	Pulmotil	Den/CTC	Pulmotil	
d 10 to 21:	No med	Den/CTC	Pulmotil	Den/CTC	Pulmotil	Den/CTC	Pulmotil	
d 21 to 42:	No med	Den/CTC	Den/CTC	No med	No med	Mec/OTC[3]	Mec/OTC	SEM
Feed cost, $/pig								
d 0 to 11	0.73	1.02	1.19	1.06	1.22	1.06	1.26	0.068
d 11 to 21	0.98	1.39	1.58	1.41	1.52	1.42	1.53	0.086
d 21 to 42	2.95	3.81	3.74	3.01	3.07	3.60	3.70	0.234
d 0 to 21	1.70	2.41	2.76	2.47	2.73	2.48	2.78	0.141
d 0 to 42	4.68	6.21	6.42	5.47	5.78	6.07	6.46	0.329
Feed cost, $/lb gain								
d 0 to 11	0.351	0.296	0.358	0.313	0.377	0.302	0.38	0.021
d 11 to 21	0.205	0.183	0.216	0.177	0.209	0.181	0.209	0.007
d 21 to 42	0.153	0.176	0.167	0.155	0.156	0.163	0.159	0.005
d 0 to 21	0.250	0.219	0.261	0.217	0.259	0.218	0.265	0.009
d 0 to 42	0.179	0.191	0.198	0.179	0.192	0.182	0.192	0.004
Income over feed cost 1, $/pig[4]								
d 0 to 11	0.33	0.73	0.48	0.66	0.46	0.75	0.41	0.099
d 11 to 21	1.53	2.42	2.10	2.58	2.13	2.51	2.15	0.179
d 21 to 42	6.78	7.00	7.40	6.61	6.74	7.42	7.91	0.43
d 0 to 21	1.84	3.13	2.55	3.25	2.59	3.26	2.51	0.251
d 0 to 42	8.57	10.07	9.84	9.85	9.30	10.65	10.35	0.604
Income over feed cost 2, $/pig[4]								
d 0 to 11	1.39	2.48	2.14	2.38	2.12	2.57	2.07	0.226
d 11 to 21	4.04	6.22	5.77	6.58	5.77	6.44	5.84	0.435
d 21 to 42	16.51	17.80	18.55	16.24	16.55	18.44	19.52	1.054
d 0 to 21	5.38	8.69	7.83	8.96	7.88	8.99	7.77	0.612
d 0 to 42	21.83	26.35	26.10	25.16	24.38	27.38	27.16	1.494

[1] Base diet costs were $442.60/ton from d 0 to 11; $252.31/ton from d 11 to 21; and $196.63/ton from d 21 to 42. Medication costs per ton were $27.85 for Denagard/CTC (Den/CTC), $18.65 for Mecadox/OTC (Mec/OTC), and $122.54 for 363 g of Pulmotil ($61.77 for 181 g of Pulmotil).
[2] Denagard, chlortetracycline.
[3] Mecadox, oxytetracycline.
[4] Income over feed cost 1 assumed a value of gain at $0.50/lb. Income over feed cost 2 assumed a value of gain of $1.00/lb.

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

	Contrasts[1]							
	1	2	3	4	5	6	7	8
d 0 to 11								
ADG, lb	<0.01	<0.01	<0.01	0.32	0.01	0.04	0.03	0.90
ADFI, lb	<0.01	<0.01	<0.01	0.55	0.07	0.29	0.04	0.36
F/G	<0.01	<0.01	<0.01	0.67	0.02	0.02	0.10	0.45
d 11 to 21								
ADG, lb	<0.01	<0.01	<0.01	0.21	0.04	0.10	0.05	0.77
ADFI, lb	<0.01	<0.01	<0.01	0.66	0.05	0.09	0.10	0.96
F/G	<0.01	<0.01	<0.01	0.16	0.05	0.16	0.05	0.57
d 21 to 42								
ADG, lb	0.09	0.19	0.05	0.32	<0.01	0.01	<0.01	0.46
ADFI, lb	0.15	0.20	0.15	0.80	0.02	0.05	0.03	0.86
F/G	0.66	0.94	0.45	0.30	0.08	0.27	0.07	0.48
d 0 to 21								
ADG, lb	<0.01	<0.01	<0.01	0.21	0.02	0.06	0.03	0.82
ADFI, lb	<0.01	<0.01	<0.01	0.48	0.05	0.13	0.08	0.82
F/G	<0.01	<0.01	<0.01	0.09	0.01	0.04	0.03	0.89
d 0 to 42								
ADG, lb	<0.01	<0.01	<0.01	0.92	<0.01	0.01	<0.01	0.55
ADFI, lb	0.03	0.04	0.05	0.86	0.03	0.09	0.05	0.81
F/G	0.01	0.01	0.01	0.96	0.02	0.09	0.02	0.55
Weight, lb								
d 0	0.54	0.57	0.55	0.96	0.43	0.53	0.49	0.95
d 11	0.40	0.37	0.49	0.74	0.87	0.88	0.89	0.99
d 21	0.02	0.02	0.05	0.52	0.34	0.46	0.38	0.91
d 42	0.05	0.06	0.06	0.99	0.02	0.08	0.04	0.73
Survival, %	0.03	0.06	0.04	0.74	0.89	0.61	0.79	0.48

continued

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

	Contrasts[1]							
	1	2	3	4	5	6	7	8
Feed cost, $/pig								
d 0 to 11	<0.01	<0.01	<0.01	<0.01	0.01	0.09	0.01	0.37
d 11 to 21	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.02	0.93
d 21 to 42	0.01	0.02	0.01	0.80	<0.01	<0.01	<0.01	0.47
d 0 to 21	<0.01	<0.01	<0.01	0.01	0.01	0.03	0.01	0.72
d 0 to 42	<0.01	<0.01	<0.01	0.22	<0.01	<0.01	<0.01	0.87
Feed cost, $/lb gain								
d 0 to 11	0.50	0.03	0.33	<0.01	0.32	0.21	0.70	0.42
d 11 to 21	0.24	<0.01	0.47	<0.01	0.99	0.74	0.72	0.53
d 21 to 42	0.08	0.05	0.19	0.28	<0.01	<0.01	0.14	0.03
d 0 to 21	0.27	<0.01	0.22	<0.01	0.85	0.80	0.94	0.88
d 0 to 42	0.04	0.34	<0.01	<0.01	0.02	0.01	0.34	0.08
Income over feed cost 1, $/pig[2]								
d 0 to 11	0.01	<0.01	0.24	<0.01	0.10	0.13	0.20	0.82
d 11 to 21	<0.01	<0.01	0.01	0.01	0.10	0.25	0.10	0.65
d 21 to 42	0.31	0.59	0.17	0.21	0.01	0.12	<0.01	0.17
d 0 to 21	<0.01	<0.01	0.01	<0.01	0.09	0.18	0.12	0.86
d 0 to 42	0.02	0.02	0.06	0.41	0.02	0.15	0.01	0.31
Income over feed cost 2, $/pig[2]								
d 0 to 11	<0.01	<0.01	0.01	0.04	0.03	0.08	0.07	0.96
d 11 to 21	<0.01	<0.01	<0.01	0.06	0.05	0.15	0.07	0.72
d 21 to 42	0.15	0.32	0.09	0.27	<0.01	0.02	<0.01	0.31
d 0 to 21	<0.01	<0.01	<0.01	0.03	0.04	0.11	0.07	0.83
d 0 to 42	0.01	0.01	0.02	0.70	0.01	0.05	0.01	0.44

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