Kansas State University
College of Agriculture

SWINE DAY
2026

Effect of In-Feed Antibiotics on the Amount of Injectable Treatments and Total Antibiotic Usage in Finishing Pigs

Paige T. Soper, Joana Magoga[1], Katelyn N. Gaffield, Jordan T. Gebhardt[1], Robert D. Goodband, Mike D. Tokach, Jason C. Woodworth, and Joel M. DeRouchey

Summary

A total of 341 pigs (241 × 600 DNA; initially 77.8 ± 0.62 lb) were used to evaluate whether short-term dietary inclusion of chlortetracycline (CTC) + tiamulin during the first 14 d after placement into the finishing facility influenced the amount of injectable treatments, total antibiotic usage, and growth performance until marketing. Pigs were placed into 36 pens (8 to 10 pigs/pen) with 18 replicates per treatment. Pens were randomly assigned to either a non-medicated control diet or the control diet that was medicated with 400 g/ton CTC + 35 g/ton tiamulin for the first 14 d after placement. After d 14, all pens received a common diet. All injectable antibiotic treatments were administered according to the farm's standard operating procedure, with farm staff blinded to dietary treatments to prevent bias to individual treatment application. For treatment of lameness, an initial dose of dexamethasone (0.22 mg/kg) and lincomycin (11.1 mg/kg) were provided via intramuscular injection, followed by daily injections of lincomycin (11.1 mg/kg) for an additional 2 to 4 d until lameness was resolved. Injections were analyzed as number of treatment regimens initiated per 1,000 pig days and number of individual injections per 1,000 pig days. From d 0 to 14, pigs fed diets containing CTC + tiamulin tended to have fewer injection regimens initiated ($P = 0.081$) and had fewer individual injections ($P = 0.001$) than control pigs. Overall (d 0 to 99), there was no evidence of a difference in the number of treatment regimens initiated ($P = 0.371$) or number of individual injections ($P = 0.127$). Pigs fed CTC + tiamulin had increased ADG ($P = 0.001$) and improved F/G ($P = 0.001$) from d 0 to 14. However, over the entire 99-d study, no differences in ADG or F/G were observed. Still, the increased ADG in the early finishing phase led to a 2.6 lb heavier pig by d 99, although increased variation as pigs grew resulted in the difference not being statistically significant. Incorporating CTC + tiamulin into the diet increased total antibiotic usage by 12,611 mg/pig ($P < 0.0001$) and total cost per pig by $1.12 ($P < 0.0001$). In conclusion, incorporating CTC + tiamulin in the early finishing phase can help reduce the need for injectable antibiotics and the associated labor and improve growth performance during the medication feeding period. However, it also substantially increases overall antibiotic usage and total cost per pig, making the decision to use feed-grade antimicrobials situation-specific depending on the health status and production goals.

[1] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.

These data highlight the importance of data interpretation when making animal health decisions and should be used to guide judicious use of antimicrobials in swine production.

Introduction

The Kansas State University Swine Teaching and Research Center has historically experienced a high incidence of lameness in pigs after transfer from the nursery into the finishing barn due to changes in environment, flooring type, and aggression as pigs are mixed and social hierarchy is established. To respond to these clinical cases of lameness, individual injections to affected pigs are required, creating labor challenges for the farm. Feed-grade antimicrobials are available that can help prevent and manage bacterial diseases in swine that could cause respiratory distress or lameness. Chlortetracycline (CTC) and tiamulin are feed-grade antimicrobials that target a broad range of bacterial pathogens affecting swine. When used together, these compounds provide complementary activity against pathogens and may help reduce the incidence of disease requiring individual injection therapy. However, few data are available to understand the impact of feed-grade antimicrobials on overall amount of treatment injections, antibiotic use, and growth performance. Therefore, the objective of this study was to evaluate whether a short-term dietary inclusion of CTC and tiamulin influences the amount of injectable treatments and overall antibiotic use and growth performance until marketing in finishing pigs.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. This study was conducted in an enclosed, environmentally controlled finishing room at the Kansas State University Swine Teaching and Research Center in Manhattan, KS. Each pen provided 7.83 ft2 per pig and was equipped with a dry, two-hole feeder (Farmweld, Teutopolis, IL) and a one-cup waterer to provide ad libitum access to feed and water. Pens were located over a completely slatted, concrete floor with a 4-ft-deep pit underneath for manure storage. Daily feed additions to each pen were accomplished using a robotic feeding system (FeedPro, FeedLogic by ComDel Innovation, Wahpeton, ND) able to record feed deliveries for individual pens.

Animals and diets

A total of 341 pigs (241 × 600 DNA; initially 77.8 ± 0.62 lb) were housed in pens of 8 to 10 pigs, with 18 replications per treatment. All pens were mixed gender and were equipped with adjustable gates to allow space allowance per pig to be maintained if a pig died or was removed during the experiment. Pens were randomly assigned to either a non-medicated control diet or the control diet that was medicated with 400 g/ton CTC + 35 g/ton tiamulin for the first 14 d after placement. The CTC source used in this study was Aureomycin 100 manufactured by Phibro Animal Health (Teaneck, NJ), and the tiamulin source was provided as Denagard manufactured by Elanco Animal Health (Greenfield, IN). After d 14, all pigs received the control diet until reaching approximately 150 lb. Pigs were then fed a common finishing diet 2 from 150 to 200 lb and common finishing diet 3 from 200 lb to market, containing no in-feed antimicrobials. Diets were manufactured in meal form by O.H. Kruse Feed Technology and Innovation Center at Kansas State University (Table 1).

Pen weight, number of pigs per pen, and feed delivery were recorded biweekly to calculate ADG, ADFI, and F/G. All injectable antibiotic treatments were administered according to the farm's standard operating procedure, with farm staff blinded to dietary treatments to prevent bias to individual treatment application. Injectable treatments were provided for treatment of clinical lameness as deemed necessary by animal caretakers. This treatment regimen consisted of an initial dose of dexamethasone (0.22 mg/kg) and lincomycin (11.1 mg/kg), followed by daily injections of lincomycin (11.1 mg/kg) for an additional 2 to 4 d until lameness was resolved. Dexamethasone and Lincomycin 300 were used for injectable treatments and were sourced from Aspen Veterinary Resources (Liberty, MO). Tylosin was administered on one occasion during the experimental period to treat respiratory distress.

Statistical analysis

Experimental data were analyzed using linear models in SAS version 9.4 (SAS Institute, Inc., Cary, NC) with pen serving as the experimental unit. Growth performance was analyzed as repeated measures with dietary treatment, period, treatment × period, and weight block as the fixed effects. Therapeutic intervention was the response variable and was analyzed as number of treatment regimens initiated per 1,000 pig days and number of individual injections per 1,000 pig days with treatment as the fixed effect. Injection rate reflects the total number of injections administered, while the treatment regimen rate accounts for lameness events by grouping multiple injections given to the same pig for the same lameness incident. Results were considered significant with $P < 0.05$ and marginally significant at $0.05 < P \leq 0.10$.

Results and Discussion

From d 0 to 14, pigs fed CTC + tiamulin had an increased BW, ADG, and ADFI ($P \leq 0.038$) and improved F/G ($P = 0.001$). However, from d 14 to 28, when antimicrobials had been removed from the feed, there was an inverse effect on ADG (Table 2). Pigs formerly fed the antimicrobials in the diet had a reduced ADG ($P = 0.014$) compared with control fed pigs, with no differences in ADFI or feed efficiency. From d 28 to 99, there were no differences in ADG, ADFI, or feed efficiency. For the overall 99-d study, no differences in ADG, ADFI, or F/G were observed. However, the increased ADG in the early finishing phase led to a 2.6 lb heavier pig at d 99, although increased variation as pigs grew resulted in this difference not being statistically significant.

From d 0 to 14, pigs fed diets containing CTC + tiamulin tended to have fewer injection regimens initiated ($P = 0.081$) and had fewer individual injections ($P = 0.001$) than control pigs (Table 3). However, from d 14 to 99, there were no differences in injection regimens initiated or individual injections due to the addition of in-feed antibiotics. Overall (d 0 to 99), there was no evidence of a difference in the number of treatment regimens initiated ($P = 0.371$) or number of individual injections ($P = 0.127$).

Inclusion of CTC + tiamulin in the diet increased total antibiotic use by 12,611 mg/pig compared with the control group ($P < 0.0001$) representing approximately a 30-fold increase. However, there was no statistical difference in injectable antibiotic usage between treatments, highlighting that the observed increase in total antibiotic use was primarily driven by feed-grade antimicrobials. Additionally, inclusion of CTC + tiamulin increased cost by $1.12 per pig ($P < 0.0001$). In contrast, costs associated with injectable antibiotics alone were similar between treatments.

In conclusion, inclusion of CTC + tiamulin during the first 14 d after placement into the finishing barn improved growth performance, reduced the number of injectable treatments required, and tended to decrease the number of treatments initiated. However, it also significantly increased total antibiotic use and overall cost by $1.12 per pig. Based on these results, the decision to include in-feed antibiotics depends largely on the goals of the producer. Regardless, judicious use of antimicrobials will remain a high focus for swine producers and veterinarians moving forward.

Brand names appearing in this publication are for product identification purposes only. No endorsement is intended, nor is criticism implied of similar products not mentioned. Persons using such products assume responsibility for their use in accordance with current label directions of the manufacturer.

Table 1. Diet composition[1]

	Experimental diets		Common diets	
Ingredient, %	Control	CTC + tiamulin	Finishing diet 2	Finishing diet 3
Corn	73.25	72.84	80.36	84.64
Soybean meal, 47.7% CP	23.84	23.87	16.90	12.80
Soybean oil	0.50	0.50	0.50	0.50
Calcium carbonate	0.88	0.88	0.83	0.78
Monocalcium phosphate, 21.5% P	0.40	0.40	0.30	0.20
Sodium chloride	0.35	0.35	0.35	0.35
L-Lys-HCl	0.30	0.30	0.33	0.33
DL-Met	0.05	0.05	0.04	0.03
L-Thr	0.07	0.07	0.07	0.09
L-Trp	0.01	0.01	0.02	0.02
Trace mineral premix	0.15	0.15	0.13	0.10
Vitamin premix	0.15	0.15	0.13	0.10
Phytase[2]	0.06	0.06	0.06	0.06
Chlortetracycline[3]	---	0.20	---	---
Tiamulin[4]	---	0.18	---	---
Total	100	100	100	100
Calculated analysis				
SID AA, %				
Lys, %	1.00	1.00	0.85	0.75
Ile:Lys	62	62	60	58
Leu:Lys	137	137	142	149
Met:Lys	30	30	30	30
Met and Cys:Lys	55	55	56	57
Thr:Lys	60	60	60	63
Trp:Lys	18.3	18.3	18.2	18.3
Val:Lys	69	69	68	68
His:Lys	42	42	42	42
NE, kcal/lb	1,137	1,133	1,158	1,171
SID Lys:NE, g/Mcal	3.99	4.01	3.33	2.90
CP, %	17.8	17.8	15.1	13.5
Ca, %	0.56	0.56	0.49	0.43
STTD P, %	0.34	0.34	0.31	0.28
Ca:P	1.25	1.25	1.24	1.22

[1] Experimental diets, control or CTC + tiamulin diets, were fed for the first 14 d, after which all pigs received the control experimental diet until reaching approximately 150 lb. Pigs were then fed a common finishing diet 2 from 150 to 200 lb and common finishing diet 3 from 200 lb to market, containing no in-feed antimicrobials.

[2] HiPhorius 2,400 (Novonesis, Kongens Lyngby, Denmark) provided an estimated release of 0.12% STTD P with 1,500 FYT/kg.

[3] Aureomycin 100 (Phibro Animal Health Company, Teaneck, NJ).

[4] Denagard 10 (Elanco Animal Health, Greenfield, IN).

Table 2. Effect of chlortetracycline (CTC) and tiamulin on finishing pig growth performance[1]

Item	Control	CTC + tiamulin	SEM	*P* =
BW, lb				
d 0	77.8	77.7	0.62	0.955
d 14	107.7	110.5	0.93	0.038
d 28	139.7	141.4	0.87	0.191
d 42	171.4	172.8	1.08	0.371
d 64	228.3	230.0	1.26	0.343
d 85	280.6	282.1	1.64	0.505
d 99	316.8	319.4	1.81	0.330
d 0 to 14				
ADG, lb	2.14	2.34	0.038	0.001
ADFI, lb	3.97	4.16	0.054	0.019
F/G	1.86	1.78	0.015	0.001
d 14 to 28				
ADG, lb	2.29	2.20	0.023	0.014
ADFI, lb	4.64	4.54	0.045	0.106
F/G	2.03	2.06	0.017	0.229
d 28 to 42				
ADG, lb	2.27	2.24	0.033	0.484
ADFI, lb	5.17	5.11	0.062	0.561
F/G	2.28	2.29	0.034	0.870
d 42 to 64				
ADG, lb	2.58	2.58	0.026	0.988
ADFI, lb	6.50	6.50	0.061	0.933
F/G	2.53	2.52	0.025	0.921
d 64 to 85				
ADG, lb	2.60	2.57	0.029	0.452
ADFI, lb	7.71	7.67	0.078	0.742
F/G	2.97	2.99	0.029	0.634
d 85 to 99				
ADG, lb	2.59	2.66	0.036	0.187
ADFI, lb	8.18	8.18	0.078	0.979
F/G	3.16	3.08	0.038	0.139
d 0 to 99				
ADG, lb	2.44	2.45	0.017	0.593
ADFI, lb	6.15	6.13	0.053	0.779
F/G	2.53	2.51	0.012	0.244

[1] A total of 341 pigs (241 × 600 DNA; initially 77.8 ± 0.62 lb) were used in a 99-d growth study with 8 to 10 pigs per pen and 18 replications per treatment. Feed-grade antimicrobials were included at 400 g/ton (CTC) and 35 g/ton (tiamulin) and fed from d 0 to 14 for the CTC + tiamulin treatment after which all pigs were fed common diets.

Table 3. Effect of chlortetracycline (CTC) and tiamulin on amount of finishing pig injectable antimicrobial treatments, antimicrobial usage, and economics[1]

Item	Control	CTC + tiamulin	SEM	*P* =
Treatment regimen rate[2]				
d 0 to 14	5.95	2.48	1.591	0.081
d 14 to 99	1.00	1.13	0.282	0.748
d 0 to 99	1.72	1.33	0.324	0.371
Injection rate[3]				
d 0 to 14	21.26	8.26	3.006	0.001
d 14 to 99	3.22	3.95	0.528	0.317
d 0 to 99	5.82	4.58	0.597	0.127
Injectable medication usage, mg/pig placed				
Lincomycin	391.7	338.0	87.77	0.668
Tylosin	3.3	0.0	2.36	0.326
Total antimicrobial	395.1	338.0	88.55	0.652
Dexamethasone	1.4	1.2	0.29	0.573
Cost, $/pig placed	0.425	0.360	0.0937	0.630
Feed antimicrobial usage, mg/pig placed				
Chlortetracycline	0	11,649	99.6	< 0.0001
Tiamulin	0	1,019	8.7	< 0.0001
Total feed antimicrobial	0	12,668	108.3	< 0.0001
Cost, $/pig placed	0	1.185	0.0101	< 0.0001
Total antimicrobial usage, mg/pig placed	395	13,006	140.0	< 0.0001
Total antimicrobial cost, $/pig placed	0.425	1.546	0.0942	< 0.0001

[1] A total of 341 pigs (241 × 600 DNA; initially 77.8 ± 0.62 lb) were used in a 99-d growth study with 8 to 10 pigs per pen and 18 replications per treatment. Feed-grade antimicrobials were included at 400 g/ton (CTC) and 35 g/ton (tiamulin) and fed from d 0 to 14 for the CTC + tiamulin treatment after which all pigs were fed common diets.

[2] Number of treatment regimens initiated per 1,000 pig days.

[3] Number of individual injections per 1,000 pig days.