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Dietary Antimicrobials in a Wean-to-Finish Facility

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Summary and Implications

The routine use of growth-promoting antimicrobial feed additives is under increasing pressure world-wide. In response to this pressure, it is important that producers and their advisors understand under what circumstances these additives are likely to be effective or ineffective, allowing for improved decisions regarding their use. An experiment was conducted to examine the routine use of antimicrobial feed additives in a wean-to-finish facility. The weaned pigs used in this experiment were purchased from a source where grow-finish pigs were positive for PRRSV, circovirus-2 and Mycoplasma hyopneumoniae and had a previous history of Actinobacillus pleuropneumoniae (APP) related problems. Experimental treatments were no growth-promoting antimicrobials after the pre-starter diet versus continuous antimicrobial additions from weaning to slaughter and day of weaning replicated in a 2 x 2 factorial. At the end of the nursery phase eight weeks after weaning, pigs fed diets containing antimicrobials were heavier ($P < 0.01$) with less variation in weight ($P < 0.01$). There was no effect of treatment on feed conversion efficiency for this eight- week period. Pigs fed diets containing antimicrobials also had less severe diarrhea ($P < 0.01$) at six weeks post-weaning. During the grow-finish phase, diets meant to contain antimicrobials often assayed for lower antimicrobial content than intended. However, there were no mixing errors such that pigs meant to receive diets with no antimicrobials were offered diets containing antimicrobials or vice versa. Pigs fed diets without antimicrobials grew faster ($P < 0.05$) with improved feed conversion ($P < 0.1$) during the grow-finish phase. Overall, there was no effect of dietary antimicrobial addition on pig performance, death loss, or carcass traits. In this experiment, while the weaned pigs were purchased from a source with known health challenges, the pigs remained very healthy, as evidenced by decreasing serum titers for APP and the lack of seroconversion for PRRSV. These results suggest that routine and continuous use of antimicrobial feed additives beyond the nursery stage in a wean-to-finish facility with high-health pigs should be evaluated on a case by case basis.

Introduction

Recently, the World Health Organization recommended that pork production systems world wide significantly reduce and eventually stop the use of growth-promoting antimicrobial feed additives. This follows the decision of the Danish government to ban their routine use, other than by veterinary prescription, and the recommendation of the European Union to ban growth-promoting antimicrobial use entirely. The basis for these recommendations is the belief that continuous additions of antimicrobials to swine diets contributes to the increasing public health problems associated with bacterial resistance to antimicrobials. In addition, many groups supporting a ban suggest that the response to growth-promoting antimicrobials in swine diets is much less than in previous years. Therefore, the financial impact to the swine industry and the impact on pig health and welfare will be minimal upon their removal from the diet. However, recent evidence suggests the expected benefits to the antimicrobial ban have not been fully realized, resulting in an increased incidence of pig scours and death loss in Denmark, even though therapeutic use of antimicrobials has increased.

Growth-promoting antimicrobials have been approved for use in swine diets since the mid 1950s. Traditionally, pigs fed diets containing these compounds have had increased daily gain, improved feed efficiency, decreased variation in performance and improved health. A limit to applying the traditional data to today's production systems is that the health status of the pigs was often never verified. Scientists and regulators cannot answer the question posed by producers, advisors and critics — under what conditions can we expect a response and when is it logical to expect little or no response to antimicrobials?

The following experiment was conducted to investigate the effect of routine additions of growth promoting antimicrobials to swine diets in a wean-to-finish facility when pigs were purchased from a source herd with known health challenges.

Methods

The experiment was conducted at the University of Nebraska's Haskell Ag Lab Swine Research Unit

Table 1. Experimental diets.

Ingredient	Pre-starter	1	2	3	4	5	6	7	8
Corn		875	1050	1205	1230	1312	1384	1527	1680
Soybean meal, 46.5% CP		435	550	645	665	585	520	410	260
Fat		40	50	50	60	60	60	30	30
Dicalcium PO_4, 18.5%					15	13	6	3	0
Limestone					17	17	17	17	17
L-lysine					2	2	2	2	2
Akey Vit/TM premix[a]					4	4	4	4	4
Salt					6	6	6	6	6
Natuphos 600G[b]					1	1	1	1	1
Akey 2000[a]	2000								
Akey Prestart 650[a]		650							
Akey Start 350[a]			350						
Akey Start 100[a]				100					
Weight range, lb	11.5-13	13-18	18-25	25-40	40-60	60-90	90-135	135-190	190-mkt
Feed budget, lb/pig	2.1	6.7	10.0	23.7					
Lysine,%	1.64	1.44	1.37	1.31	1.21	1.10	1.01	0.87	0.67

[a]Akey Inc, Lewisburg, OH
[b]BASF Inc, Mt. Olive, NJ.

Table 2. Dietary antimicrobial additions for DRUG treatment.

Weight range, lb	Antimicrobial	Dietary addition, g/t
11.5-13	chlortetracycline (CTC)	400
	tiamulin	35
13-25	bacitracin methylene disalicylate (BMD)	250
	roxarsone	34.5
25-60	CTC	100
	sulfamethazine	100
	penicillin	50
60-market	BMD	30
75 (for 10 days)	CTC	400 (10 mg/lb of body weight/day)
135 (for 10 days)	CTC	560 (10 mg/lb of body weight/day)

near Concord, Neb. Pigs were housed in a double curtain, naturally ventilated, fully slatted confinement facility with 16 pens and daily fresh water, under slat flushing for manure removal. Each 8 ft x 14 ft pen contained 15 pigs and contained one two-hole wean-to-finish feeder and one wean-to-finish cup drinker.

The experimental treatments were:

1) Continuous dietary additions of growth promoting antimicrobials (Drug) vs none (Control)
2) Date of weaning

Diets were corn-soybean meal based and formulated according to the recommendations of Akey, Inc. (Lewisburg, OH) from weaning to 40 pounds bodyweight and according to the University of Nebraska recommendations for high lean gain pigs thereafter (Table 1). The pre-starter diet contained 400 g/t of chlortetracycline and 35 g/t of tiamulin for all pigs. Both the pre-starter and Diet 1 contained 2,310 ppm zinc as zinc oxide. All remaining diets were in meal form with or without the appropriate growth-promoting feed additive (Table 2). From weaning until 40 lb body weight, pigs were fed according to the feed budget included in Table 1. From 40 lb body weight to slaughter, diets were switched on the week a pen achieved the target weight. Each delivery of feed was sampled and assayed for antimicrobial content by Alpharma Inc.

Two-hundred and forty newly weaned pigs (DK33 dam x Danbred NA sire; 15-21 days old) were purchased from a herd where grow-finish pigs were positive for PRRSV, circovirus-2 and *Mycoplasma hyopneumoniae*. The source herd also had a previous history of *Actinobacillus pleuropneumoniae (APP).*

On the day of weaning, pigs were transported to the research facility, eartagged, weighed and ranked within sex by weight. Every weight outcome group of eight pigs within sex was randomly assigned to pens. Pigs were weaned on Sept. 16 and Sept. 18, with 120 head delivered each day.

Approximately 2.5 weeks post-weaning, all pigs received a commercial electrolyte and citric acid in the water for five days as a preventative treatment for gut edema caused by beta-hemolytic *E. coli.* Pigs were vaccinated via the water for erysipelas at 8 weeks post-weaning.

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Table 3. Effect of experimental treatments on pig performance.

	Treatments						
	Dietary Drug		Wean Date			*P* Values	
Item	No	Yes	9/16/02	9/18/02	SE	Drug	Wean
No. pens	8	8	8	8			
Pig weight, lb							
Wean	11.4	11.4	11.8	10.9	<0.1	NS[a]	<0.01
Day 57[b]	63.9	69.4	70.8	62.4	0.8	<0.01	0.01
Final[c]	257.7	255.2	261.9	251.0	2.6	NS	0.05
Coefficient of variation of pig weight within a pen, %							
Wean	20.3	22.1	21.9	20.6	0.8	NS	NS
Day 57[b]	18.8	14.8	14.4	19.2	0.8	<0.01	<0.01
Final[c]	10.1	9.3	9.5	10.0	0.8	NS	NS
Average daily gain, lb							
Wean-day 57[a]	0.94	1.03	1.04	0.94	0.01	<0.01	<0.01
Day 57[b]- final	1.85	1.77	1.82	1.80	0.02	<0.05	NS
Overall	1.53	1.52	1.54	1.50	0.02	NS	<0.1
Average daily feed, lb							
Wean-day 57[b]	1.57	1.70	1.71	1.56	0.02	<0.01	<0.01
Day 57[b]-final	5.45	5.32	5.40	5.38	0.07	NS	NS
Overall	4.09	4.05	4.10	4.03	0.05	NS	NS
Feed:gain							
Wean-day 57[b]	1.67	1.65	1.66	1.67	0.02	NS	NS
Day 57[b]-final	2.96	3.01	2.97	2.99	0.02	<0.01	NS
Overall	2.67	2.67	2.66	2.69	0.02	NS	NS
IBP, Inc.							
Backfat, in.	0.80	0.83	0.81	0.83	0.02	NS	NS
Loin depth, in.	2.74	2.75	2.75	2.74	0.02	NS	NS
% lean	54.80	54.60	54.80	54.70	0.01	NS	NS
Carcass value, $/cwt	48.31	48.13	48.31	48.13	0.28	NS	NS
Hot carcass wt., lb	196.7	193.6	198.8	191.4	1.6	NS	<0.01

[a]NS = not significant (P > 0.1).
[b]Day 58 and day 56 for pigs weaned on 9/16 and 9/18, respectively.
[c]Day 163 and day 161 for pigs weaned on 9/16 and 9/18, respectively.

At weaning, one barrow and one gilt per pen were randomly selected, and these pigs were bled via vena puncture on week 0, 4, 8, 12, 16, 20 and before slaughter. Serum was harvested and frozen for subsequent serology profiling.

All pigs that died during the experiment were examined for cause of death by a consulting veterinarian. Pen size was not adjusted in the event of pig death. A record was maintained of any injectable antibiotic use for treatment of lameness, obvious respiratory distress, etc. No water-soluble antimicrobials were administered to either treatment group.

All pigs were slaughtered on the same day at IBP Inc at Madison, Neb. Pigs were identified with tattoo by sex within pen and carcass data was collected by IBP employees.

Results were analyzed as a complete random design using a 2 x 2 factorial arrangement of treatments using the GLM procedure of SAS with the pen of pigs as the experimental unit. The model included weaning date, use of feed additive and the interaction of these main effects.

Results and Discussion

On Oct. 30 (days 42 and 44 post-weaning), many pens of pigs were noted to have diarrhea. The pens were scored for severity of diarrhea, by a veterinarian without knowledge of the dietary treatment assignments, using a 1 to 3 scale with 1 being normal feces and 3 being severe diarrhea. The average scores were 1.25 for pens with diets containing feed additives (Drug) and 1.88 for Control pens (P < 0.01). No samples were collected for submission to a veterinary diagnostic laboratory and within two weeks there were no differences noted among the pens for diarrhea.

Three pigs died during the experiment. Death loss could was not related to either of the experimental treatments. Use of injectable and antimicrobials to treat individual pigs was minimal and also not related to the experimental treatments.

At the end of the experiment, frozen serum samples from the bleedings on weeks 0, 12 and just before slaughter were submitted to the University of Nebraska Veterinary Diagnostic Laboratory. All samples were negative for PRRSV other than three samples thought to be false positives. Several pigs were positive (complement fixation test) for APP at weaning. However, the titers declined over time, suggesting no active infection. Thus, the pigs maintained a relatively high health status during the experiment, in spite of the attempt to identify a source of pigs with health challenges often encountered in production systems.

Pig performance is presented in Table 3. There were no interactions between weaning day and dietary treatments ($P > 0.1$) except for coefficient of variation (CV) for pig weight within the pen on day 57. Day 57 in the table is day 58 for pigs weaned on Sept. 16 and day 56 for pigs weaned on Sept. 18. The interaction for CV on day 57 ($P < 0.05$) is due to the amount of the response to the experimental treatments, and not due to a difference in response. For pigs weaned on Sept. 16, the CV for within pen weight on day 57 was 14.8% and 14.0% and for pigs weaned on Sept. 18, the CV was 22.8% and 15.5%, for Control and Drug treatments, respectively.

For the first eight weeks post-weaning, pigs given diets that included growth promoting feed additives grew faster (1.03 vs 0.94 lb/d; $P < 0.01$) with no difference in feed conversion. Because they grew faster, pigs given diets that included growth promoting feed additives were 5.5 pounds heavier (69.4 vs 63.9 lb; $P < 0.01$) and had less weight variation within the pen (day 57 CV 14.8% vs 18.8%; $P < 0.01$) on day 57 of the trial..

However, during the period from day 57 to final, pigs given diets containing no growth promoting additives grew faster (1.85 vs 1.77 lb/d; $P < 0.05$) and were slightly more efficient (2.96 vs 3.01 lb/lb; $P < 0.1$). Much of this difference in performance occurred during the two-week period from day 57 to day 71. During this period, pigs given diets with no growth promoting feed additive grew faster (1.87 vs 1.74 lb/d; $P < 0.05$) and were more efficient (2.08 vs 2.25; $P < 0.05$). There was no effect of dietary antimicrobial treatment on any carcass parameter. The heavier hot carcass weight for pigs weaned on Sept. 16 vs Sept. 18 is a reflection of the heavier weaning weight ($P < 0.01$), faster overall daily gain ($P < .1$) and heavier final weight ($P < 0.05$). Date of weaning had no effect ($P > 0.1$) on any other carcass parameter.

Possibilities for why the improvement in performance during the nursery phase was not maintained during the grow-finish phase for pigs fed diets containing antimicrobials include the health status of the pigs and possible mixing errors at the feedmill. In spite of identifying a source of pigs from a herd with known health challenges in growing-finishing pigs, the pigs used in this experiment remained very healthy, possibly due to the smaller number of pigs in the facility. There were 240 pigs in the research facility, while in commercial facilities it is common to have 500-1,000 or more pigs per air space. The source herd often had this many pigs in various facilities.

The research diets were mixed at a commercial mill and every delivery was assayed for antimicrobial additions. All of the control diets were negative for antimicrobial additions. The U.S. Food and Drug Administration (FDA) allows assays for bacitracin methylene disalicylate (BMD) to vary +/- 30%, or feeds with 30 gm/ton additions to assay at 21 to 39 gm/ton and still be considered as meeting the label claim for 30 g/t additions. All assays were less than 30 g/t, with several less than 19 g/ton. Thus, the lack of response during the grow-finish phase may have been due in part to the lower than intended level of addition of BMD. Assays for the other antimicrobial additions to the diets were generally within US-FDA accepted ranges.

Conclusions

In this experiment, the use of antimicrobial growth promoting feed additives improved daily gain, reduced within pen weight variation for the first eight weeks post-weaning, and reduced the severity of diarrhea. However, during the grow-finish phase there was no overall effect of antimicrobials in the diet. These data suggest that the use of antimicrobial growth promoting feed additives remains an effective management tool during the nursery phase of production. However, there was no response during the grow-finish phase, possibly due to the very high health status of the pigs or lower than intended level of antimicrobial additions.

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