

## Determining the Impact of By-O-Reg+<sup>1</sup> in Diets with or without a Feed Grade Antibiotic on Growth Performance of Nursery Pigs<sup>2</sup>

*L. L. Thomas, J. C. Woodworth, R. D. Goodband, J. M. DeRouchey,  
M. D. Tokach, and S. S. Dritz*

### Summary

A total of 717 nursery pigs (PIC C-29 × 28 and PIC L3-1050 × 1040, initially 12.48 ± 0.10 lb) from two consecutive nursery groups were used in a 35-d growth study. The objective was to determine the impact of increasing levels of By-O-Reg+ in diets with or without 50 g/ton Carbadox. By-O-Reg+ is a unique mixture of essential oils primarily based on oregano. It utilizes encapsulation technology to stabilize the essential oils and is suggested to have antimicrobial-like properties. The present study evaluated growth performance of nursery pigs fed 1 of 6 dietary treatments that were arranged as a 2 × 3 factorial with main effects of antibiotic (none vs. 50 g/ton Carbadox) and By-O-Reg+ (0, 1, or 2 lb/ton). Experimental diets were fed for 21 d and then a common diet was fed for the final 14 d. Pens of pigs (5 barrows and 5 gilts) were balanced by initial BW and randomly allotted to treatments, with 12 replications (pens) per treatment. During the period when treatments were fed (d 0 to 21) no interactions were observed between By-O-Reg+ and Carbadox. Increasing By-O-Reg+ decreased, and then increased (quadratic  $P = 0.016$ ) F/G. Pigs fed diets with Carbadox had improved ( $P < 0.007$ ) ADG, ADFI, and F/G. From d 21 to 35, when a common diet was fed, pigs previously fed diets with Carbadox had increased ( $P = 0.007$ ) ADFI. However, an interaction (linear,  $P = 0.039$ ) was observed with pigs previously fed diets without Carbadox showing decreased ADFI as By-O-Reg+ increased; whereas when pigs were previously fed diets containing Carbadox, ADFI increased as the level of By-O-Reg+ increased. For the overall period (d 0 to 35), an interaction (linear,  $P = 0.031$ ) was observed for ADFI with pigs fed diets without Carbadox having decreased ADFI as By-O-Reg+ increased; whereas when pigs were fed diets containing Carbadox, ADFI increased with increasing By-O-Reg+. No main effects of By-O-Reg+ were observed for the overall data; however, adding Carbadox for 21 d after weaning improved ( $P < 0.015$ ) ADG, ADFI, and final BW and tended to improve ( $P < 0.087$ ) F/G. Overall, this study confirms

<sup>1</sup> By-O-Reg+ is a registered trademark of Advanced Ag Products, Hudson, SD, and appreciation is expressed to them for financial support of this experiment.

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the benefit of including a feed grade medication in nursery pig diets to improve growth performance. Increasing By-O-Reg+ in diets elicited few changes in performance, but during the test period the pigs fed 1 lb/ton of By-O-Reg+ had better F/G than those fed none or the 2 lb/ton of By-O-Reg+. More research is needed to confirm if 1 lb/ton inclusion of By-O-Reg+ is the appropriate dose to elicit the best response.

Key words: antibiotics, nursery pigs, oregano

## Introduction

Feed-grade antibiotics have been used for more than 50 years to enhance growth performance and prevent or treat disease in many livestock species. With growing concerns regarding antibiotic resistance, restrictions on antibiotic use in many countries has fueled interest in the use of alternative replacements. Alternative ingredients proposed to partly or fully replace antibiotics in swine diets include prebiotics, probiotics, and phytogetic feed additives such as herbs, spices, and essential oils. Oregano is a perennial herb grown in many countries and used commonly in human food products. It has a unique odor and taste attributable to the essential oil contained within. Oregano oil is suggested to have antimicrobial-like properties, thereby allowing for the potential to enhance growth performance in pigs. However, results do not consistently suggest that oregano can successfully replace antibiotics to maintain the same growth performance. A new oregano-based product has been introduced to the market. By-O-Reg+ is a unique source of oregano that utilizes encapsulation technology to protect the carvacrol (the primary beneficial phenolic compound found in oregano) from volatilization or binding to other components in the feed. This is suggested to protect and allow the essential oil to be released into the lower intestinal tract where it is most effective. While some studies have been conducted with poultry and aquaculture, the only swine-related studies have been conducted in sows, so the impact of By-O-Reg+ on growth performance of newly weaned pigs is unknown. The objective of this experiment is to determine the impact of By-O-Reg+ in diets with or without feed grade antibiotics on growth performance of weaned pigs.

## Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol for this experiment. The study was conducted at the Cooperative Research Farm's Swine Research Nursery (Sycamore, OH), which is owned and managed by Kalmbach Feeds, Inc.

A total of 717 pigs (PIC C-29 × 28 and PIC L3-1050 × 1040) from two consecutive nursery groups (group 1 initially  $12.8 \pm 0.10$  lb and group 2 initially  $12.2 \pm 0.06$  lb) were used in a 35-d growth study. Pens of pigs (5 barrows and 5 gilts) were balanced by initial BW and randomly allotted to treatments with 6 replications (pens) per treatment in each group for a total of 12 replications per treatment. Each pen had slatted metal floors and was equipped with a 4-hole stainless steel feeder and one nipple-cup waterer for ad libitum access to feed and water. To better reflect the increased challenge of rearing pigs in a commercial environment, rooms were not washed before the experiments to increase bacteria load. Group 1 had two previous sets of pigs; group 2 had 1 previous set of pigs. Dietary treatments were offered immediately after weaning and

were organized in a  $2 \times 3$  factorial with main effects of antibiotic (none vs. 50 g/ton of Carbadox) and By-O-Reg+ (0, 1, or 2 lb/ton). Treatment diets (Tables 1 and 2) were fed in pellet form in 2 phases with phase 1 fed from d 0 to 7 and phase 2 fed from d 7 to 21 with Carbadox and/or By-O-Reg+ added at the expense of corn. A common phase 3 diet (Table 3) that contained no Carbadox or By-O-Reg+ was fed in meal form d 21 to 35. Feed was manufactured at the Kalmbach Feeds feed mill. Multiple feed samples were collected at the feeder during each phase and analyzed for CP, ADF, NDF, crude fiber, ether extract, Ca, and P (Ward Laboratories, Inc., Kearney, NE, Table 4). Pig weight and feed disappearance were measured on d 0, 7, 14, 21, 28, and 35 to determine ADG, ADFI, and F/G.

Data were analyzed using the PROC MIXED procedures of SAS (SAS Institute Inc., Cary, NC) in a randomized design with pen serving as the experimental unit and experiment as the random blocking factor. The main effects of By-O-Reg+ and Carbadox, and their interactions, were tested using preplanned contrasts. Linear and quadratic contrasts were used to evaluate the effects of By-O-Reg+ on growth performance. Results were considered significant at  $P \leq 0.05$  and a trend at  $P \leq 0.10$ .

## Results and Discussion

Body weight, ADG, ADFI, and feed efficiency data are shown in Tables 3 (interactive means) and 4 (main effects). From d 0 to 21, no interactions were observed between pigs fed By-O-Reg+ or Carbadox. Feed efficiency of pigs fed By-O-Reg+ decreased, and then increased (quadratic,  $P = 0.016$ ), as By-O-Reg+ increased. Pigs fed diets with Carbadox had improved ( $P \leq 0.007$ ) ADG, ADFI, and F/G. From d 21 to 35, when a common diet was fed, pigs previously fed diets with Carbadox had improved ( $P = 0.007$ ) ADFI. An interaction (linear,  $P = 0.039$ ) was observed, with pigs previously fed diets without Carbadox showing decreased ADFI as By-O-Reg+ increased; whereas when pigs were previously fed diets containing antibiotics, the ADFI increased as the level of By-O-Reg+ increased. For the overall data (d 0 to 35), an interaction (linear,  $P = 0.031$ ) was observed for ADFI, with pigs fed diets without Carbadox exhibiting decreased ADFI as By-O-Reg+ increased; however, when pigs were fed diets containing Carbadox, ADFI increased as By-O-Reg+ increased. No main effects of By-O-Reg+ were observed for the overall study; however, adding Carbadox improved ( $P < 0.015$ ) ADG, ADFI, and final BW, and tended to improve ( $P < 0.087$ ) F/G.

In summary, this study confirms the benefit of including antibiotics to improve growth performance in nursery pig diets. Pigs consuming the feed with Carbadox had increased feed intake, resulting in increased ADG and final body weight. Increasing By-O-Reg+ in diets had minimal effects on growth performance, but during the period of supplementation (d 0 to 21) the pigs fed the low level of By-O-Reg+ had better F/G than those fed none or the high level of By-O-Reg+. More research is warranted to determine if the 1 lb/ton inclusion of By-O-Reg+ is the appropriate dose to elicit the best response. Additionally, increasing By-O-Reg+ from 1 to 2 lb/ton of complete feed was observed to stimulate ADFI in diets containing Carbadox. Additional research should be conducted to confirm if the greatest By-O-Reg+ benefit occurs when feed grade antibiotics are simultaneously present in the diet.

**Table 1. Diet composition (as-fed basis)**

Diets	Phase 1 <sup>1</sup>	Phase 2 <sup>2</sup>	Phase 3 <sup>3</sup>
Ingredient, %			
Corn	36.74	45.36	59.34
Soybean meal, 46.5% CP	23.75	31.02	33.59
Select fish meal	2.79	3.25	0.00
Spray dried whey	26.09	14.49	0.00
Spray dried plasma	4.00	---	0.00
Tallow	3.81	2.50	2.50
Limestone	0.96	0.93	1.33
Monocalcium phosphate	0.48	0.70	1.39
Zinc oxide, 72%	0.40	0.26	---
Ameribond 2x	---	0.40	0.40
Salt	0.25	0.25	0.50
L-lysine HCL	0.20	0.25	0.35
DL-methionine	0.13	0.13	0.12
Sulfate swine TM	0.09	0.09	0.09
Biotin 100mg/lb	0.08	0.08	0.08
L-threonine	0.06	0.12	0.14
K-vitamin E-20, 0	0.06	0.06	0.06
Vitamin premix	0.05	0.05	0.05
Choline chloride, 70%	0.05	0.05	0.05
Selenium .06%	0.02	0.02	0.02
Antibiotic <sup>4</sup>	---	---	---
By-O-Reg <sup>5</sup>	---	---	---
Total	100.0	100.0	100.0

*continued*

**Table 1. Diet composition (as-fed basis)**

Diets	Phase 1 <sup>1</sup>	Phase 2 <sup>2</sup>	Phase 3 <sup>3</sup>
Calculated analysis			
Standard ileal digestible (SID) amino acids, %			
Lysine	1.40	1.35	1.25
Met:lys	31	33	32
Thr:lys	63	63	63
Trpn:lys	18.7	18.2	18.3
ME, kcal/lb	1,565	1,532	1,529
Total lys, %	1.61	1.54	1.44
CP, %	22.6	22.6	21.2
Ca, %	0.90	0.90	0.90
P, %	0.72	0.70	0.70
Available P, %	0.48	0.41	0.37

<sup>1</sup>Phase 1 experimental diet fed from d 0 to 7.

<sup>2</sup>Phase 2 experiment diet fed from d 7 to 21.

<sup>3</sup>Phase 3 was a common diet that did not contain antibiotic or By-O-Reg+, fed from d 21 to 35.

<sup>4</sup>Mecadox 10 (Phibro Animal Health, Teaneck, NJ) containing Carbadox at 10 g/lb, was added to the antibiotic treatment groups at 5 lb/ton at the expense of corn in the control diet to form the antibiotic treatment in Phases 1 and 2.

<sup>5</sup>By-O-Reg+ (Advanced Ag Products, Hudson, SD) was included at 1 or 2 lb/ton at the expense of corn in the control diets to form the By-O-Reg+ treatments fed in phases 1 and 2.

**Table 2. Chemical analysis of diets (as-fed basis)<sup>1</sup>**

Item, % <sup>2</sup>	Phase 1	Phase 2	Phase 3
DM	91.18	89.99	89.39
CP	21.81	21.78	21.15
ADF	1.71	2.33	3.40
NDF	5.08	6.46	5.35
Crude fiber	1.86	2.03	2.95
Ca	0.90	0.90	1.03
P	0.80	0.67	0.73
Ash	6.66	6.21	5.80
Starch	22.93	28.39	35.90

<sup>1</sup>Phase 1, 2, and 3 diets were fed from d 0 to 7, 7 to 21, and 21 to 35, respectively.

<sup>2</sup>Values represent a subsample from a composite sample collected at the feeders in both groups.

**Table 3. Interactive effects of Carbadox and By-O-Reg+ on nursery pig growth performance<sup>1,2</sup>**

Added By-O-Reg+, lb/ton <sup>4</sup>	Carbadox <sup>3</sup> :						SEM	Probability, <i>P</i> <					
	-			+				By-O-Reg+		Carbadox	Interaction		
	0	1	2	0	1	2		Linear	Quadratic		Linear	Quadratic	
<b>d 0 to 21</b>													
ADG, lb	0.42	0.44	0.43	0.47	0.47	0.49	0.010	0.215	0.463	<0.0001	0.455	0.105	
ADFI, lb	0.57	0.56	0.55	0.59	0.58	0.61	0.013	0.984	0.353	0.007	0.186	0.564	
F/G	1.36	1.25	1.30	1.25	1.22	1.23	0.023	0.128	0.016	<0.0001	0.394	0.108	
<b>d 21 to 35</b>													
ADG, lb	1.07	1.04	1.04	1.04	1.09	1.09	0.026	0.767	0.882	0.247	0.161	0.468	
ADFI, lb	1.60	1.56	1.56	1.59	1.65	1.66	0.029	0.482	0.920	0.007	0.039	0.303	
F/G	1.51	1.51	1.51	1.53	1.52	1.52	0.027	0.951	0.905	0.424	0.876	0.938	
<b>d 0 to 35</b>													
ADG, lb	0.68	0.68	0.67	0.70	0.72	0.73	0.013	0.380	0.729	0.001	0.154	0.837	
ADFI, lb	0.98	0.96	0.96	0.99	1.00	1.03	0.013	0.529	0.517	0.001	0.031	0.733	
F/G	1.45	1.41	1.43	1.41	1.40	1.40	0.016	0.446	0.141	0.087	0.732	0.363	
<b>BW, lb</b>													
d 0	12.54	12.53	12.42	12.46	12.39	12.54	0.882	0.870	0.728	0.641	0.250	0.308	
d 21	21.38	21.86	21.29	22.13	22.09	22.86	2.529	0.225	0.782	<0.0001	0.123	0.042	
d 35	35.66	35.7	35.68	36.51	36.66	37.89	6.67	0.289	0.654	0.015	0.307	0.624	

<sup>1</sup> A total of 717 nursery pigs (PIC C-29 × 28 and PIC L3-1050 × 1040; group 1 initially 12.8 ± 0.10, group 2 initially 12.2 ± 0.06 lb) were used in two consecutive 35-d studies with 10 pigs per pen and 12 replications per treatment.

<sup>2</sup> Experimental diets were fed from d 0 to d 21, and a common diet was fed for the remainder of the study.

<sup>3</sup> Mecadox 10 (Phibro Animal Health, Teaneck, NJ) provided 50 g/ton Carbadox.

<sup>4</sup> By-O-Reg+ (Advanced Ag Products, Hudson, SD).

**Table 4. Main effects of Carbadox or By-O-Reg+ on nursery pig growth performance<sup>1,2</sup>**

Item	Carbadox <sup>3</sup>		SEM	By-O-Reg+ (lb/ton)			SEM	Probability, <i>P</i> <		
	-	+		0	1	2		By-O-Reg+		Carbadox
						Linear		Quadratic		
d 0 to 21										
ADG, lb	0.43	0.48	0.009	0.45	0.46	0.46	0.010	0.215	0.463	0.0001
ADFI, lb	0.56	0.59	0.045	0.58	0.57	0.58	0.046	0.984	0.353	0.007
F/G	1.30	1.23	0.077	1.30	1.24	1.27	0.078	0.128	0.016	0.0003
d 21 to 35										
ADG, lb	1.05	1.07	0.015	1.06	1.06	1.06	0.018	0.787	0.882	0.247
ADFI, lb	1.57	1.63	0.022	1.59	1.60	1.61	0.024	0.482	0.920	0.007
F/G	1.51	1.52	0.20	1.52	1.51	1.52	0.022	0.951	0.905	0.424
d 0 to 35										
ADG, lb	0.68	0.71	0.008	0.69	0.70	0.70	0.009	0.380	0.729	0.001
ADFI, lb	0.96	1.00	0.034	0.98	0.98	0.99	0.034	0.529	0.517	0.001
F/G	1.43	1.41	0.040	1.43	1.40	1.42	0.040	0.446	0.141	0.087
BW, lb										
d 0	12.50	12.46	2.818	12.50	12.46	12.48	2.841	0.870	0.728	0.641
d 21	21.51	22.36	4.589	21.76	21.98	22.07	4.701	0.225	0.782	0.001
d 35	35.68	37.02	3.792	36.08	36.18	36.78	4.644	0.290	0.654	0.015

<sup>1</sup> A total of 717 nursery pigs (PIC C-29 × 28 and PIC L3-1050 × 1040; group 1 initially 12.8 ± 0.10, group 2 initially 12.2 ± 0.06 lb) were used in two consecutive 35-d studies with 10 pigs per pen and 6 replications per treatment.

<sup>2</sup> Experimental treatment diets were fed from d 0 to d 21.

<sup>3</sup> Mecadox 10 (Phibro Animal Health, Teaneck, NJ) provided 50 g/ton Carbadox.

<sup>4</sup> By-O-Reg+ (Advanced Ag Products, Hudson, SD).