Evaluation of Beta-Glucan and Antibiotics on Growth Performance and Carcass Traits of Weanling and Finishing Pigs

R.P. Cueno, T.B. Morillo, S.D. Carter, M.S. Lachmann, J.S. Park and J.D. Schneider

Story in Brief

An experiment was conducted to determine the effect of β-glucan on growth performance of pigs during the nursery-to-finisher stage. In the nursery phase, a total of 144 pigs (average body weight = 11.86 lb) were weaned at approximately 20 days. Pigs were blocked by weight and randomly allotted to four dietary treatments (6 pens/trt) in a 2 x 2 factorial design with two levels of carbadox supplementation (0 vs .25%) and two levels of a product containing β-glucan (0 vs .20%). Pigs and feeders were weighed on d 0, 7, 14, 21, 28, 35 and 42 to determine average daily gain (ADG), average daily feed intake (ADFI), and feed to gain (F:G) ratio. The experiment was continued to growing-finishing stage and four pigs from each nursery pen were randomly chosen and allotted to pens. They were fed the same dietary treatments with the exception that chlortetracycline replaced carbadox as the antibiotic. Two pigs per pen were slaughtered and carcass traits were collected. The addition of antibiotic or β-glucan in the nursery phase tended to increase ADG, but had no effect on F:G. In the finishing phase, there were no effects of dietary treatments; however, pigs fed antibiotic or β-glucan had numerically greater ADG. For the entire period, ADG was improved by 4 to 5% with addition of antibiotic or β-glucan. There were only minimal effects of treatment on carcass traits. These results suggest that β-glucan may have potential to improve growth performance of weanling to finishing pigs.

Key Words: Pigs, β-glucan, Antibiotics

Introduction

There is a lot of debate on the issues surrounding the ban of growth-promoting antibiotics in animal feed. Despite major problems foreseen, such as economic losses (Mathews, 2001) and increased veterinary costs due to increased morbidity and mortality (Casewell et al., 2003), the clamor for a total worldwide ban continues. Yet there may be a need for a complete evaluation of the risks and benefits of antibiotics in animal feed vis a vis exploration of other options to improve health and growth performance of food animals.

β-glucan is a polysaccharide that is present in some plant (such as oat and barley), fungal (such as mushrooms), and yeast cell walls, and functions as an immunomodulator. It helps boost the immune system and stimulates a cascade of pathways that enhance both innate and adaptive immune responses. An active immune system may help the animal combat challenges from disease-causing organisms, help control clinical infection, and maintain growth processes. Thus, the use of β-glucan in pigs, from weaning to finishing, may be of benefit. Previous experiments have been done on weanling (Dritz et al., 1995; Decuypere et al., 1998; Hiss and Sauerwein, 2003; van Nevel et al., 2003) and finishing pigs (Fortin et al., 2003), using different β-glucan sources, with variable effects on growth and immune parameters. The source of dietary β-glucan used in animal nutrition may be an important factor that can influence its efficacy.

In a previous experiment from our lab (Morillo et al., 2004), the addition of .2% β-glucan product to antibiotic-free weanling pig diets resulted in a three-percentage point improvement in growth performance, which was approximately half the improvement observed with antibiotic inclusion. Mathews (2001) cited Doane's 1988 Agricultural Report which put weight gain improvement with low level antibiotic use at 10% and feed efficiency at 5% for swine, with higher responses in commercial farms compared to experimental set-ups. Thus, this product containing β-glucan seems to have potential in improving performance of weanling pigs fed antibiotic-free diets. There have been no reported benefits of the inclusion of β-glucan to antibiotic-free finisher rations. This study was performed to compare the effects of β-glucan in weanling and finishing pig diets containing 0 or .25 % antibiotic on weanling and finishing pig performance and carcass traits.

Materials and Methods

A total of 144 pigs (ave BW = 11.9 lb) was weaned at approximately 20 d for the nursery trial. Pigs were blocked by weight and randomly allotted to four dietary treatments (6 pens/trt) in a 2 x 2 factorial design with two levels of carbadox (Mecadox®, Pfizer Animal Health, USA) supplementation (0 vs .25%) and two levels of a product (Dong-Ahm BT, Seoul, South Korea) containing β-glucan (0 vs .20%). The composition of the diets is shown in Table 1. Pigs were fed in three dietary phases and in meal form. The Phase 1 diets were fed from d 0 to 14; Phase 2 diets from d 14 to 28; and Phase 3 diets from d 28 to 42. Pigs were housed (6 pigs/pen) in a temperature-controlled room and were allowed to have *ad libitum* access to feed and water throughout the experiment. Pigs and feeders were weighed on d 0, 7, 14, 21, 28, 35 and 42 to determine ADG, ADFI, and feed:gain (F:G) ratio.

Following the nursery phase, the experiment was continued to the growing-finishing phase. Pigs were fed for 1 wk with their respective diets before transferring to finisher room. Four pigs from each nursery pen were randomly chosen and allotted to pens and were fed the four dietary treatments (6 pens/trt) in a 2 x 2 factorial design. In the finisher phase, carbadox was replaced by .10% chlortetracycline (Aureomycin-50®, Alpharma, USA). Pigs were fed in three dietary phases. Pigs and feeders were weighed every 2 wk until the pigs reached approximately 230 lb. Two pigs per pen were transported to a commercial packing plant. Following 24 h in the chiller, the carcasses were ribbed and 10th rib fat depth and longissimus muscle area (LMA) were measured. Using these measures, the percentage of lean in the carcass was calculated.

Data were analyzed as a 2x2 factorial arrangement in a randomized complete block design using procedures described by Steel et al. (1997). The main effects of antibiotic, β-glucan, and their interaction were tested using orthogonal contrasts. The pen served as experimental unit.

Table 1. Composition of diets

	Nursery [ab]			Grower-Finisher[cd]		
	Phase 1	Phase 2	Phase 3	Phase 1	Phase 2	Phase 3
Ingredients						

Corn grain	28.17	48.74	56.53	65.18	70.86	76.49
Soybean meal, 48% CP	22.91	28.15	34.86	29.16	23.70	18.25
Whey dried	20.00	10.00				
Lactose	10.00	0				
Spray-dried animal plasma	6.00	0				
Blood cells, spray dried	0	2.50				
Fish menhaden meal	5.00	2.50				
Soybean oil	5.00	5.00	5.00	3.00	3.00	3.00
DL-methionine	.22	.06				
Dicalcium Phosphate	.60	1.12	1.33	.85	.89	.65
Limestone, ground	.87	.80	.90	.96	.70	.76
Sodium chloride	.35	.25	.50	.25	.25	.25
Trace Mineral Mix	.15	.15	.15	.15	.15	.15
Vitamin Mix	.25	.25	.25	.15	.15	.15
Ethoxyquin	.03	.03	.03			
Corn Starch[b]	.45	.45	.45	.30	.30	.30
Calculated analysis						
ME, kcal/kg	3,506	3,534	3,550	3,479	3,488	3,497
Lysine, %	1.6	1.4	1.2	1.05	.90	.75
Ca, %	.95	.85	.75	.65	.55	.50
P, %	.75	.70	.65	.55	.50	.45

[a] Nursery Phase 1: d 0-14 post weaning, Phase 2: d 15-28, Phase 3: d 29-42

[b]Within each nursery phase, cornstarch (CS) was replaced with either .20% β-glucan or .25% antibiotic to provide the dietary treatments: 1) .45 % CS, 2) .25 % carbadox + .20 % CS, 3) .20% β-glucan + .25 % CS, and 4) .20% β-glucan + .25 % carbadox

[c]Finsher Phase 1 was from the initial weight in the finisher to 110 lb; Phase 2 was from 110 to 170 lb; and Phase 3 was from 170 lb to market weight (`230 lb)

[d]Dietary treatments during the grower-finisher phase were similar to the nursery phase with the exception that chlortetracycline (.10%) was used in place of carbadox

Results and Discussion

There were no interactions between β-glucan or carbadox inclusion in the nursery phase. Inclusion of either a product containing β-glucan or carbadox increased (P<.06) ADG but had no effect on ADFI and F:G ratio of weanling pigs (Table 2). As in a previous experiment (Morillo et al., 2004), the numerical improvement in ADG with β-glucan inclusion was only about half of the improvement seen with carbadox inclusion. The final weights during the nursery phase were also increased (P<.04) with the inclusion of either β-glucan or carbadox. The pigs fed diets containing both β-glucan and carbadox were the heaviest and the improvement in ADG was numerically twice that seen with inclusion of carbadox alone. Dritz et al. (1995) and Hiss and Sauerwein (2003) have also investigated the effects of β-glucan additions to basal diets containing antibiotics for weanling pigs. Hiss and Sauerwein (2003) reported an increase in ADG and ADFI with β-glucan addition, but no effect on F:G ratio. Dritz et al. (1995) reported that .10 % β-glucan decreased growth performance of weanling pigs during the first 7 d post weaning but .025% or .05% β-glucan improved ADG and ADFI with no effect on F:G.

Table 2. Growth performance of pigs during the nursery phase[a]

Treatment	1	2	3	4				
β-glucan, %	0	0	.2	.2	SE	Antibiotic effect	β-glucan effect	Interaction
Antibiotic[b]	-	+	-	+				
Initial wt, lb	11.84	11.81	11.93	11.85				
Final wt, lb	42.35	43.85	43.18	45.29	.51	.01	.04	.55
ADG, lb	.76	.80	.78	.84	.01	.01	.06	.51
ADFI, lb	1.18	1.24	1.20	1.24	.02	.38	.55	.62
F:G	1.55	1.55	1.54	1.48	.02	.28	.13	.25

[a]Least squares means for 6 pens per treatment

[b]Provided 25 mg of carbadox per pound of complete feed

During the finisher phase, there were no interactions between β-glucan and carbadox (Table 3). The inclusion of either β-glucan or chlortetracycline had no effect on the ADG, ADFI, or F:G ratio. However, the inclusion of either antibiotic or β-glucan numerically improved ADG by 4 and 6%, respectively. These improvements in growth rate are similar to that reported by Morillo et al. (2004) for the nursery phase. The inclusion of β-glucan tended to improve (P<.09) the final weight during this phase while the inclusion of chlortetracycline had no effect on the final

weight. Also, during the finishing phase, and, unlike the nursery phase, the inclusion of β-glucan numerically improved ADG more so than the inclusion of antibiotic.

Table 3. Growth performance of pigs during the growing-finishing phase[a]

Treatment	1	2	3	4				
β-glucan, %	0	0	.2	.2	SE	Antibiotic effect	β-glucan effect	Interaction
Antibiotic[b]	-	+	-	+				
Initial wt, lb	48.69	52.13	50.58	54.00				
Final wt, lb	223.68	232.28	236.58	239.50	5.59	.32	.09	.62
ADG, lb	1.67	1.73	1.77	1.74	.05	.75	.23	.40
ADFI, lb	4.61	4.81	4.81	4.84	.14	.41	.41	.56
F:G	2.76	2.79	2.73	2.78	.04	.36	.64	85

[a]Least squares means for 6 pens (4 pigs/pen) per treatment

[b]Provided 25 mg of chlortetracycline per pound of complete feed

For the entire growing period (post-weaning to finishing), the inclusion of either β-glucan or antibiotic had no effect on the ADG, ADFI, or F:G ratio (Table 4). However, as seen in the nursery and finisher phases, there was a 4 to 5% improvement in ADG with the addition of antibiotic or β-glucan. It is well-established that the response to antibiotics is greater in a commercial setting than in a research setting (Cromwell, 1991). Whether the response to β-glucan would have been as great as that observed with antibiotics in a commercial setting is unknown. Information concerning the use of β-glucan in finisher diets is scarce.

For the carcass traits, the inclusion of antibiotic tended to improve (P<.06) the percentage of lean, although it numerically decreased the 10th rib fat depth increased longissimus muscle area. The inclusion of β-glucan (alone or in combination with antibiotic) did not affect (P>.10) carcass traits.

Table 4. Growth performance and carcass traits of pigs for the overall experiment[a]

Treatment	1	2	3	4				
β-glucan, %	0	0	.2	.2	SE	Antibiotic effect	β-glucan effect	Interaction
Antibiotic	-	+	-	+				
Overall								

Initial wt, lb	11.84	11.81	11.93	11.85				
Final wt, lb	223.68	232.28	236.58	239.50	5.59	.32	.09	.62
ADG, lb	1.42	1.47	1.49	1.49	.03	.49	.16	.47
ADFI, lb	3.65	3.81	3.81	3.85	.10	.35	.37	.55
F:G	2.58	2.60	2.56	2.58	.03	.53	.54	.92
Carcass								
10^{th} rib fat, in	.92	.88	.95	.84	.046	.12	.99	.44
Longissimus muscle area, in^2	6.70	6.80	6.76	6.85	.16	.62	.74	.97
Fat-free lean, %	50.99	52.07	50.12	52.35	.71	.05	.69	.45
[a]Least squares means for 6 pens per treatment								

Implications

The addition of antibiotic or a product containing β-glucan to the diets of weanling and finishing pigs tended to improve growth rate. The response to antibiotic was greater for weanling pigs compared to those fed diets with β-glucan; however, the response to β-glucan during the finishing phase was similar to that for pigs fed diets containing antibiotics. These results, although not significant, if coupled with previous results from our lab suggest that an approximately 5 to 6% improvement in growth performance was obtained with antibiotic, with a response to β-glucan of 3 to 4%. These results suggest a potential for β-glucan to possibly serve as an alternative, or in combination with antibiotics, to improve growth performance in pigs. However, more research, especially in a commercial setting, is warranted to better quantify the response to β-glucan.

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Authors

Cueno, R.P. - Graduate Student

Morillo, T.B. - Graduate Student

Carter, S.D. - Associate Professor

Lachmann, M.S. - Graduate Student

Park, J.S. - Graduate Student

Schneider, J.D. - Graduate Student