The Effects of Biomin Product A and Vomitoxin on Growth Performance of Nursery Pigs[1,2]

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Summary

A total of 340 barrows (PIC 1050, initially 25.7 lb ± 0.2 lb BW and 35 d of age) were used in a 28-d growth trial examining the effects on nursery pig growth performance of adding Biomin Product A (Biomin; Herzogenburg, Austria) to diets contaminated with deoxynivalenol (DON), or vomitoxin on nursery pig growth performance. Also, 5% water was added in a diet with Biomin Product A as a means of potentially enhancing the activity of the product. Pigs were allotted to pens by weight, and pens were assigned to 1 of 8 treatments in a randomized complete block design with location in the barn serving as the blocking factor. There were 9 replications per treatment (pens) and 4 to 5 pigs per pen. Initial mycotoxin analyses were conducted on the primary ingredients at Romer Labs[5] and served as the basis of diet formulation. Eight dietary treatments were formulated to contain: (1) no vomitoxin or Biomin Product A, (2) 1.5 ppm vomitoxin and no Biomin Product A, (3) 1.5 ppm vomitoxin and 0.15% Biomin Product A (3 lb/ton), (4) 1.5 ppm vomitoxin and 0.30% Biomin Product A (6 lb/ton), (5) 3.0 ppm vomitoxin and no Biomin Product A, (6) 3.0 ppm vomitoxin and 0.30% Biomin Product A (6 lb/ton), (7) 3.0 ppm and 0.45% Biomin Product A (9 lb/ton), and (8) 3.0 ppm vomitoxin and 0.45% Biomin Product A with 5% water added to the diet. Dried distillers grains with solubles containing vomitoxin were used to increase concentrations in the treatment diets. After feed manufacturing, ingredients and diets were analyzed at Romer Labs and NDSU[6]. DON levels for the low- (1.5 ppm) and high- (3.0 ppm) vomitoxin diets were determined to average 2.5 and 5.2 ppm, respectively. Experimental diets were fed in meal form from d 0 to 21, and a common diet was fed from d 21 to 28 to evaluate performance immediately after removing vomitoxin from the diet. Overall (d 0 to 21), pigs fed high-vomitoxin diets had decreased ($P < 0.01$) ADG and ADFI compared to pigs fed diets lower in DON concentration. Adding Biomin Product A to diets containing vomitoxin had no effect ($P > 0.24$) on ADG; however, adding Biomin Product A to low-vomitoxin diets increased (quadratic, $P < 0.01$) ADFI, resulting in poorer (quadratic, $P < 0.01$) F/G. Furthermore, there were no differences ($P > 0.39$) in performance or feed efficiency when 5% water was added to the diet containing Biomin Product A. In conclusion, adding Biomin Product A to the diet did not improve nursery pig performance during the 3-week period during which diets containing low or high concentrations of vomitoxin were fed.

Key words: nursery pig, vomitoxin,

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2 Appreciation is expressed to Hubbard Feeds (Mankato, MN) and New Fashion Pork (Jackson, MN) for supplying the DDGS used in the study.

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Introduction

High concentrations of mycotoxins, especially vomitoxin, were present in the 2009 corn crop. Vomitoxin, also known as deoxynivalenol (DON), develops when moisture is overabundant during the flowering period of corn. Deoxynivalenol is directly associated with the plant pathogens *Fusarium graminearum (Gibberella zeae)* and *F. culmorum*, the causative agents for *Fusarium* head blight in wheat and *Gibberella* ear rot in corn. Among livestock species, pigs are particularly susceptible to deoxynivalenol consumption, which can cause reductions in performance, sub-clinical immune suppression and, in high concentrations, vomiting and feed refusal. However, swine producers are interested in finding ways to utilize vomitoxin-contaminated corn as a feedstuff. Dried distiller's grains with solubles (DDGS), a by-product of the ethanol industry, also presents significant problems for swine producers because mycotoxin levels are 2 to 3 times more concentrated than in the original corn source.

Although no FDA-approved mycotoxin inhibitors exist, some available products have shown promise in the presence of vomitoxin. Biomin Product A (Biomin, Herzogenburg Austria) is one product that might reduce the effects of DON. However, a recent study at Kansas State University by Barnes et al (2010)[7] incorporated Biofix Plus into nursery pig diets containing 4 ppm DON at 0.15% of the diet with no effect on performance. The goal of this study was to determine whether lower levels of vomitoxin or higher inclusion rates of Biomin Product A would result in improved performance when feeding DON-contaminated diets to young pigs. In addition, it was hypothesized that adding water to the diet might improve the efficacy of Biomin Product A product in diets highly contaminated with DON. That hypothesis was also tested in this trial.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. The study was conducted at the Kansas State University Segregated Early Weaning Research Facility in Manhattan, KS.

A total of 340 barrows (PIC 1050, initially 25.7 lb ± 0.2 lb BW and 35 d of age) were used in a 28-d growth trial. Pigs were allotted to pens by weight, and pens were assigned to 1 of 8 treatments in a randomized complete block design, with location in the barn serving as the blocking factor. There were 9 replications per treatment (pens) with 4 to 5 pigs per pen. Each pen (4 × 4 ft) contained a 4-hole dry self-feeder and 1 cup waterer to provide ad libitum access to feed and water.

To naturally incorporate vomitoxin at desired concentrations, both a clean and contaminated source of DDGS were supplied by Hubbard Feeds (Mankato, MN) to incorporate DDGS into the test diets at equivalent levels. Base corn, soybean meal, and the two sources of DDGS were tested for mycotoxin content at Romer Labs, Inc (Table 1). before diet manufacturing. These results were used in diet formulation. After diets were manufactured, each was sampled and tested again at Romer Labs and at North Dakota State University.

Initially, all pigs were fed a commercial SEW diet with a budget of 2 lb/pig followed by a commercial transition diet with a budget of 5 lb/pig for the first 7 d postweaning. At

[7] Barnes et al. Swine Day 2010. Report of Progress 1038, pp 79-85.

d 7 postweaning, Phase 2 diets were fed for 7 days. On d 14 (d 0 of the experiment), Phase 3 diets comprising the 8 experimental treatments (Table 2) were fed to the pigs. Apart from vomitoxin and Biomin Product A content, diets were formulated to be identical in nutrient composition, and all diets contained a total of 20% DDGS. Based on the initial mycotoxin analysis of base ingredients, the 8 experimental diets were formulated to contain: (1) no vomitoxin or Biomin Product A, (2) 1.5 ppm vomitoxin and no Biomin Product A, (3) 1.5 ppm vomitoxin and 0.15% Biomin Product A (3 lb/ton), (4) 1.5 ppm vomitoxin and 0.30% Biomin Product A (6 lb/ton), (5) 3.0 ppm vomitoxin and no Biomin Product A, (6) 3.0 ppm vomitoxin and 0.30% Biomin Product A (6 lb/ton), (7) 3.0 ppm vomitoxin and 0.45% Biomin Product A (9 lb/ton), and (8) 3.0 ppm vomitoxin, 0.45% Biomin Product A and 5% water added to the diet. Experimental diets were presented in meal form and were fed from d 0 to 21. A common meal diet (<0.5 ppm DON) was fed from d 21 to 28 to evaluate the change in performance immediately after removing vomitoxin from the diet. All diets were manufactured at the Kansas State University Animal Science Feed Mill. Average daily gain, ADFI, and F/G were determined by weighing pigs and measuring feed disappearance on d 4, 7, 14, 21, and 28 of the trial.

Data were analyzed as a randomized complete block design with pen as the experimental unit. Analysis of variance used the MIXED procedure of SAS (SAS Institute, Inc., Cary, NC) with treatment as a fixed effect. Treatment means were separated using the LSMEANS statement and CONTRAST statements in SAS. Means were considered significant at $P < 0.05$ and trends at $P < 0.10$.

Results and Discussion

After diet sampling, the analyzed DON concentrations from Romer Labs were higher and more variable between diets than expected. Therefore the samples at Romer Labs were tested a second time. Romer Labs indicated that their analysis procedures are less accurate for vomitoxin concentrations over 5 ppm (such as with the high-vomitoxin DDGS used in the diets). A separate set of ingredient and diet samples were sent to the North Dakota State University Veterinary Diagnostic Laboratory (NDSU) for comparative analysis. The NDSU results for the contaminated DDGS were approximately 50% higher (15.8 ppm) than the results reported by Romer Labs (10.1, 12.1 ppm), which explains why the test diets formulated to be 1.5 ppm (low-DON) and 3.0 ppm (high-DON) actually averaged approximately 2.5 and 5.2 ppm, respectively. Based on variability between labs and analyses, a composite level of DON for each diet was generated as an average of the 3 separate analyses (Table 1).

From d 0 to 4, pigs fed high concentrations of vomitoxin had reduced ($P < 0.01$) ADG, ADFI, and poorer ($P < 0.01$) F/G than those fed low concentrations. From d 4 to 7, pigs fed high-DON diets had decreased ($P < 0.01$) ADFI and tended to have lower ($P < 0.06$) ADG than pigs fed low-DON diets. From d 7 to 14, pigs fed high concentrations of DON had decreased ($P < 0.01$) ADFI compared to those fed low-vomitoxin diets. Pigs fed high-DON diets had decreased ($P < 0.01$) ADG and ADFI during d 14 to 21 when compared to pigs fed diets containing lower concentrations. For the overall test period (d 0 to 21), pigs fed diets containing high levels (3.0 ppm) of DON had reduced ($P < 0.01$) ADG and ADFI compared to pigs fed diets containing low concentrations. In the common diet period (d 21 to 28), there were no differences ($P > 0.25$)

in ADFI or F/G between high- and low-vomitoxin diets; however, pigs previously fed high vomitoxin concentrations tended to have improved ($P < 0.09$) ADG vs. pigs than pigs fed low concentrations. For the overall trial period (d 0 to 28), pigs fed high-DON diets from d 0 to 21 had reduced ($P < 0.01$) ADG and ADFI, although they did have improved ($P < 0.05$) F/G when compared with pigs fed low concentrations. On days 4, 7, 14, 21, and 28, pigs fed high concentrations of vomitoxin weighed less ($P < 0.01$) than pigs fed low concentrations. Overall, pigs fed diets low in vomitoxin had similar performance to the positive control diet, which contained less than 0.65 ppm DON.

During d 0 to 4, pigs fed high concentrations of vomitoxin had poorer ($P < 0.02$) F/G as Biomin Product A increased in the diet. There was a Biomin Product A response from d 7 to 14, where increasing Biomin Product A resulted in quadratic response (quadratic, $P < 0.03$) in ADG in pigs fed diets containing high concentrations of vomitoxin because pigs fed 0.3% Biomin Product A had lower ADG than pigs fed 0 or 0.45% Biomin Product A. Also, F/G worsened (quadratic, $P < 0.04$) with increasing Biomin Product A. For ADFI, pigs fed high and low vomitoxin concentrations had improved (quadratic, $P < 0.05$) ADFI from d 7 to 21 with increasing Biomin Product A. This within-phase response translated into an overall increase (quadratic, $P < 0.08$) in ADFI for both high- and low-DON diets with increasing Biomin Product A. Overall (d 0 to 21), adding Biomin Product A to diets containing low or high concentrations of vomitoxin had no effect ($P > 0.24$) on ADG. In addition, pigs fed diets with the low concentration of vomitoxin had poorer (quadratic, $P < 0.01$) F/G as Biomin Product A increased in the diet. Adding Biomin Product A to the diet from d 0 to 21 did not influence ($P > 0.06$) ADG, ADFI, or F/G during the common period (d 21 to 28). Similar to the data from d 0 to 21, pigs fed low-vomitoxin diets had increased ($P < 0.01$) ADFI but poorer ($P < 0.04$) F/G as the dietary level of Biomin Product A increased.

Adding water to diets containing the high vomitoxin and Biomin Product A from d 0 to 4 improved ($P < 0.02$) F/G and tended to improve ($P < 0.07$) ADG. However, overall (d 0 to 21), adding 5% water to the high-vomitoxin diet containing 0.45% Biomin Product A did not influence ($P > 0.39$) ADG, ADFI, or F/G. However, it is important to note that significant feed quality issues were associated with the diet containing 5% added water. As the trial progressed, the diet containing added water had bridging problems in the feeders and began to spoil, as evidenced by a stale, musty odor. However, no visual mold growth was observed. As a result of these observations, samples of the water-added diet were sent to NDSU for additional mycotoxin analysis. Samples were sent from d 0, 7, 14, and 21, and a numeric increase in DON levels was observed (Table 1). The practical issues of adding water to a dry feed mix, as well as a lack of response in performance, suggest that adding water does not improve the efficacy of the Biomin Product A in highly contaminated DON diets fed to young pigs.

In conclusion, the addition of Biomin Product A to nursery pig diets containing 2 to 6 ppm of DON did not improve growth performance and seemed to have a negative effect on feed efficiency during the 3-week experimental period. The addition of water at the time of mixing feed did not affect performance and resulted in apparent feed spoilage and problems with bridging in feeders.

Table 1. Analyzed vomitoxin (DON) content (ppm) in diet samples (as-fed basis)[1]

	Romer Labs[2]		NDSU[3]	
Item	Analysis 1	Analysis 2	Analysis 3	Avg value
Basal ingredients, ppm				
Corn	<0.5	<0.5	- - -[4]	
Soybean meal	<0.5	<0.5	- - -	
Control DDGS	0.9	- - -	0.7	
Contaminated DDGS	10.1	12.7	15.8	
Test diets[5], ppm				
Positive Control	0.6	- - -	0.7	0.65
Low-vomitoxin negative control	2.1	2.1	2.7	2.30
1.5 ppm DON, 0.15% Biomin Product A	3.0	3.0	3.0	3.00
1.5 ppm DON, 0.30% Biomin Product A	1.9	3.0	2.7	2.53
High-vomitoxin negative control	5.5	6.1	5.0	5.53
3.0 ppm DON, 0.30% Biomin Product A	4.2	6.0	5.9	5.37
3.0 ppm DON, 0.45% Biomin Product A	4.9	4.9	5.0	4.93
3.0 ppm DON, 0.45% Biomin Product A with 5% water	5.6	4.0	4.4[6]	4.80

[1] Reported vomitoxin levels as a combination of DON and 15-acetyl DON levels.
[2] Romer Labs, Union, MO. Samples were analyzed using a combination of liquid chromatography and mass spectrometry.
[3] NDSU Veterinary Diagnostic Laboratory, Fargo, ND. Samples were analyzed using a variety of mass spectrometry, ELISA, and high-pressure liquid chromatography.
[4] (- - -) indicates sample was not analyzed at this time.
[5] Test diet labels denote formulated DON levels.
[6] Additional samples were collected at d 0, 7, 14, and 21 and sent to NDSU for DON analysis. Results: d 0 (3.0 ppm), d 7 (3.4 ppm), d 14 (3.8 ppm) and d 21 (3.8ppm).

Table 2. Diet composition for the Biomin Product A and control vomitoxin (DON) treatments (as-fed basis)[1]

		Phase 3 diets[2]							
			Low DON (1.5 ppm)[3]			High DON (3.0 ppm)[3]			5% Water[4]
Item	Common diet	Positive control	Low Neg. control	0.15% Biomin Product A	0.30% Biomin Product A	High Neg. control	0.30% Biomin Product A	0.45% Biomin Product A	0.45% Biomin Product A
Ingredient, %									
Corn	57.06	49.06	49.06	48.89	48.73	49.06	48.73	48.57	46.16
Soybean meal, 46.5%	25.90	27.63	27.63	27.65	27.66	27.63	27.66	27.67	26.27
Control DDGS 29% CP	- - -	20.00	10.00	10.00	10.00	- - -	- - -	- - -	- - -
Contaminated DDGS 28.5% CP	- - -	- - -	10.00	10.00	10.00	20.00	20.00	20.00	19.00
Select menhaden fish meal	4.50	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Spray dried whey	10.00	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Monocalcium P, 21% P	0.38	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.57
Limestone	0.58	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.19
Salt	0.30	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.33
Zinc oxide	0.25	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Copper sulfate	- - -	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Vitamin premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.24
Trace mineral premix	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.14
L-lysine HCl	0.25	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.39
DL-methionine	0.13	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
L-threonine	0.11	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.07
Phytase[5]	0.17	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.12
Biomin Product A[6]	- - -	- - -	- - -	0.15	0.30	- - -	0.30	0.45	0.43
Water	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	5.00
Total	100.0	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

continued

Table 2. Diet composition for the Biomin Product A and control vomitoxin (DON) treatments (as-fed basis)[1]

		Phase 3 diets[2]							
			Low DON (1.5 ppm)[3]			High DON (3.0 ppm)[3]			5% Water[4]
Item	Common diet	Positive control	Low Neg. control	0.15% Biomin Product A	0.30% Biomin Product A	High Neg. control	0.30% Biomin Product A	0.45% Biomin Product A	0.45% Biomin Product A
Calculated composition, %									
SID[7] amino acids, %									
Lysine	1.30	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.21
Isoleucine:lysine	61	63	63	63	63	63	63	63	63
Leucine:lysine	127	148	148	148	148	148	148	147	147
Methionine:lysine	35	30	30	30	30	30	30	30	30
Met & cys:lysine	59	58	58	58	58	58	58	58	58
Threonine:lysine	63	62	62	62	62	62	62	62	62
Tryptophan:lysine	17.0	17	17	17	17	17	17	17	17
Valine:lysine	68	72	72	72	72	72	72	72	72
CP, (N × 6.25)	21.3	22.9	22.9	22.9	22.9	22.9	22.9	22.9	21.8
Total lysine	1.43	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.37
ME, kcal/lb	1,505	1,506	1,506	1,503	1,501	1,506	1,501	1,499	1,424
SID Lysine:ME, g/Mcal	3.92	3.83	3.83	3.83	3.84	3.83	3.84	3.84	3.84
Ca	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.67
P	0.63	0.60	0.60	0.60	0.60	0.60	0.60	0.59	0.57
Available P	0.47	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.40

[1] A total of 340 pigs (Initial BW 25.7 lb ± 0.2 lb) were used with 4 to 5 pigs per pen and 9 replicates per treatment.
[2] Diets were fed for 21 d with day 14 postweaning as d 0 of the experiment. A common diet was fed from d 21 to 28 across all treatments. Diets were fed in mash form.
[3] The analyzed average DON content for the low- and high-vomitoxin diets were 2.6 and 5.3 ppm, respectively.
[4] The 5% water treatment is a duplicate of the high-vomitoxin, 0.45% Biomin Product A treatment diluted with 5% water (2.85ppm DON, 0.427% Biomin Product A).
[5] Phyzyme 600 (Danisco Animal Nutrition, St. Louis, MO).
[6] Biomin Product A (Biomin USA, San Antonio, TX).
[7] Standardized ileal digestible.

Table 3. Effects of Biomin Product A and vomitoxin (DON) on nursery pig growth performance[1]

		Low DON (1.5 ppm)[2]			High DON (3.0 ppm)[2]					Probability, P <					
										Vomitoxin	Biomin Product A low-DON diets		Biomin Product A high-DON diets		
Item	Positive control	Low Neg. control	0.15% Biomin Product A	0.30% Biomin Product A	High Neg. control	0.30% Biomin Product A	0.45% Biomin Product A	5% Water[3] 0.45% Biomin Product A	SEM	Low vs high	Linear	Quad	Linear	Quad	5% Water
d 0 to 4															
ADG, lb	0.83	0.83	0.84	0.77	0.63	0.55	0.57	0.70	0.06	0.01	0.39	0.47	0.29	0.56	0.07
ADFI, lb	1.44	1.45	1.55	1.41	1.21	1.15	1.22	1.35	0.06	0.01	0.61	0.10	0.98	0.39	0.14
F/G	1.74	1.78	1.91	1.87	1.98	2.16	2.51	2.00	0.17	0.01	0.67	0.65	0.02	0.36	0.02
d 4 to 7															
ADG, lb	0.98	1.06	1.04	1.05	0.95	0.95	0.95	1.00	0.06	0.06	0.89	0.84	0.99	0.99	0.57
ADFI, lb	1.54	1.57	1.62	1.51	1.41	1.34	1.43	1.46	0.07	<0.01	0.44	0.25	0.98	0.26	0.75
F/G	1.59	1.53	1.60	1.46	1.51	1.42	1.52	1.46	0.06	0.37	0.45	0.17	0.92	0.24	0.52
d 7 to 14															
ADG, lb	1.25	1.37	1.32	1.27	1.32	1.20	1.30	1.27	0.04	0.13	0.06	0.99	0.36	0.03	0.65
ADFI, lb	2.07	2.06	2.16	2.02	2.01	1.90	2.00	2.04	0.04	0.01	0.44	0.02	0.56	0.04	0.48
F/G	1.66	1.51	1.65	1.60	1.53	1.59	1.55	1.61	0.04	0.35	0.06	0.04	0.52	0.31	0.27
d 14 to 21															
ADG, lb	1.56	1.43	1.55	1.53	1.42	1.42	1.41	1.32	0.05	0.01	0.08	0.17	0.85	0.94	0.12
ADFI, lb	2.48	2.36	2.53	2.45	2.33	2.25	2.34	2.27	0.05	0.01	0.11	0.01	0.84	0.05	0.17
F/G	1.60	1.65	1.63	1.61	1.65	1.59	1.67	1.72	0.04	0.88	0.36	1.00	0.98	0.11	0.30
d 0 to 21															
ADG, lb	1.23	1.24	1.27	1.23	1.17	1.12	1.14	1.14	0.03	0.01	0.70	0.32	0.32	0.24	0.95
ADFI, lb	2.01	1.98	2.09	1.97	1.87	1.79	1.88	1.90	0.04	0.01	0.94	0.01	0.79	0.08	0.69
F/G[a]	1.63	1.59	1.65	1.60	1.60	1.61	1.65	1.67	0.02	0.76	0.55	0.01	0.11	0.21	0.39
d 21 to 28[4]															
ADG, lb	1.80	1.85	1.90	1.83	1.93	1.93	1.89	1.98	0.04	0.09	0.85	0.28	0.63	0.59	0.13
ADFI, lb	3.50	3.59	3.73	3.55	3.72	3.67	3.66	3.78	0.07	0.25	0.70	0.06	0.49	0.87	0.22
F/G	1.96	1.95	1.97	1.95	1.94	1.91	1.94	1.91	0.05	0.48	0.96	0.68	0.96	0.55	0.58
d 0 to 28															
ADG, lb	1.37	1.39	1.42	1.38	1.36	1.32	1.33	1.34	0.02	0.01	0.70	0.20	0.33	0.54	0.63
ADFI, lb	1.70	1.69	1.79	1.68	1.62	1.56	1.62	1.65	0.03	0.01	0.71	0.01	0.61	0.09	0.32
F/G[a]	1.24	1.21	1.26	1.21	1.20	1.18	1.22	1.23	0.02	0.05	0.97	0.04	0.56	0.15	0.62

continued

Table 3. Effects of Biomin Product A and vomitoxin (DON) on nursery pig growth performance[1]

		Low DON (1.5 ppm)[2]			High DON (3.0 ppm)[2]					Probability, P <					
										Vomitoxin	Biomin Product A low-DON diets		Biomin Product A high-DON diets		
Item	Positive control	Low Neg. control	0.15% Biomin Product A	0.30% Biomin Product A	High Neg. control	0.30% Biomin Product A	0.45% Biomin Product A	5% Water[3] 0.45% Biomin Product A	SEM	Low vs high	Linear	Quad	Linear	Quad	5% Water
Weights, lb															
d 0	25.87	25.63	25.82	25.65	25.64	25.50	25.64	25.54	0.17	0.31	0.93	0.28	0.84	0.39	0.60
d 4	29.19	28.95	29.20	28.73	28.18	27.72	27.91	28.34	0.31	0.01	0.52	0.25	0.35	0.37	0.23
d 7	32.12	32.12	32.30	31.86	31.04	30.58	30.77	31.35	0.39	0.01	0.55	0.42	0.45	0.47	0.20
d 14	40.87	41.72	41.53	40.74	40.41	38.99	40.02	40.25	0.45	0.01	0.12	0.57	0.29	0.04	0.70
d 21	51.78	51.74	52.40	51.48	50.37	48.92	49.89	49.84	0.56	0.01	0.71	0.18	0.29	0.07	0.94
d 28	64.35	64.65	65.67	64.32	64.12	62.44	63.14	63.93	0.63	0.01	0.69	0.11	0.15	0.17	0.35

[1] A total of 340 pigs (PIC 1050, initial BW 25.7 lb ± 0.2 lb) were used in a 28-d study to determine the effects of vomitoxin and Biomin Product A on nursery pig performance.
[2] The analyzed average DON content for the low- and high-vomitoxin diets were 2.6 and 5.3 ppm, respectively.
[3] The 5% water treatment is a duplicate of the high-vomitoxin, 0.45% Biomin Product A treatment diluted with 5% water (2.85ppm DON, 0.427% Biomin Product A).
[4] A common diet (<0.5 ppm DON) was fed across all treatments from d 21 to d 28.