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J A. Barnes

Joel M. DeRouchey

Michael D. Tokach

See next page for additional authors

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Effects of vomitoxin concentration in nursery pig diets and the effectiveness of commercial products to mitigate its effects

Authors

J A. Barnes, Joel M. DeRouchey, Michael D. Tokach, Robert D. Goodband, Jim L. Nelssen, and Steven S. Dritz

Effects of Vomitoxin Concentration in Nursery Pig Diets and the Effectiveness of Commercial Products to Mitigate its Effects[1]

J.A. Barnes, J.M. DeRouchey, M.D. Tokach, R.D. Goodband, S.S. Dritz[2], and J.L. Nelssen

Summary
A total of 180 pigs (PIC TR4 × 1050, initially 22.8 lb and 34 d of age) were used in a 21-d trial to evaluate the effects of vomitoxin concentration in nursery pig diets and the effectiveness of commercial products to mitigate vomitoxin's negative effects on performance. Pens of pigs were balanced by initial weight and were randomly allotted to 1 of 5 dietary treatments with 6 replications per treatment. Dietary treatments included a control diet consisting of corn-soybean meal and regular dried distillers grains with solubles (DDGS; low vomitoxin), a negative control diet containing 4 ppm dietary vomitoxin (from contaminated DDGS), and the negative control diet with Biofix Plus, Cel-can with bentonite clay, or Defusion Plus. All diets were fed in meal form.

From d 0 to 10, pigs fed either the negative control or diets containing Biofix Plus, Cel-can with bentonite clay, or Defusion Plus had decreased ($P < 0.05$) ADG and ADFI than pigs fed the positive control diet. Pigs fed the positive control diet had improved F/G ($P < 0.05$) compared to pigs fed the negative control diet and diets containing Biofix Plus or Cel-can with bentonite clay, with pigs fed diets containing Defusion Plus intermediate.

From d 10 to 21, pigs fed the positive control or diet containing Defusion Plus had greater ($P < 0.05$) ADG than the negative control, Biofix Plus, and Cel-can with bentonite clay diets. Additionally, pigs fed the positive control diet had a greater ($P < 0.05$) ADFI than pigs fed the negative control and diets containing Biofix Plus and Cel-can with bentonite clay, with pigs fed Defusion Plus intermediate.

Overall (d 0-21), pigs fed the positive control diet had greater ($P < 0.05$) ADG compared to pigs fed any of the vomitoxin-contaminated diets. In addition, pigs fed diets containing Defusion Plus had greater ADG ($P < 0.05$) than pigs fed the negative control diet and diets containing Biofix Plus or Cel-can with bentonite clay. Pigs fed the positive control diet had greater ADFI ($P < 0.05$) than pigs fed any other dietary treatment. Pigs fed the positive control diet had improved F/G ($P < 0.05$) compared to the negative control and diets containing Biofix Plus or Cel-can with bentonite clay. Also, pigs fed Defusion Plus had improved F/G ($P < 0.05$) compared to pigs fed the negative control. Thus, nursery pigs fed diets containing 4 ppm vomitoxin had reduced growth performance. Including Defusion Plus in the diet improved performance but not to that of pigs fed a low-vomitoxin diet.

[1] Appreciation is expressed to New Fashion Pork, Jackson, MN, and Hubbard Feeds, Mankato, MN, for supplying the contaminated DDGS.
[2] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.

Key words: Biofix Plus, Cel-can with bentonite clay, Defusion Plus, vomitoxin

Introduction

Mycotoxins are toxic secondary metabolites produced by fungi that can be found in many varieties of grain and forage produced for feed. Worldwide, approximately 25% of crops are contaminated by mycotoxins annually (CAST, 1989[3]). Mycotoxin contamination has been found to reduce yield and quality of grains, to reduce the health and productivity of animals, and to represent a hazard to consumers.

Deoxynivalenol (DON), often referred to as vomitoxin, is a particularly abundant mycotoxin and is one of the most common contaminants of wheat, corn, and barley worldwide. With high levels of vomitoxin found in the 2009 corn crop, understanding its impact on swine performance is pertinent to industry productivity and animal health. To further confound the problem in swine diets, DDGS contains approximately 3 times the vomitoxin level found in the corn where it originated because vomitoxin is unaltered in the fermentation process. Thus, both corn and DDGS must be monitored for vomitoxin levels. Currently, several commercial products are marketed to help alleviate the effects of vomitoxin in swine diets. However, sparse data are available on the effectiveness of these commercial products.

Biofix Plus is a direct-fed fermented product that provides a source of yeast to potentially absorb the mycotoxins as well as break down vomitoxin by enzymatic degradation. Cel-can is a mixture of yeast components that provides a supply of fermentation metabolites in combination with clay to bind and absorb mycotoxins. Defusion Plus is a blend of antioxidants, amino acids, direct-fed microbials, and preservatives thought to absorb or break down vomitoxin in feed over a period of time.

The objectives of this trial were to determine the effect of vomitoxin in nursery pig diets and to evaluate the effectiveness of three commercial products (Biofix Plus, Cel-can, and Defusion Plus) in vomitoxin-contaminated diets for nursery pigs.

Procedures

The Kansas State University (K-State) Institutional Animal Care and Use Committee approved the protocol used in this experiment. The study was conducted at the K-State Swine Teaching and Research Farm in Manhattan, KS.

A total of 180 pigs (TR4 × 1050, initially 22.8 lb and 34 d of age) were used in a 21-d growth trial to compare the effects of vomitoxin concentration in nursery pig diets and the effectiveness of commercial products to mitigate associated negative performance. Pigs were allotted to pens by initial BW, and pens were assigned to treatments in a random block design, with both weight and location in the nursery serving as blocking factors. Dietary treatments included a control diet consisting of corn-soybean meal and regular DDGS (low vomitoxin), a negative control diet containing 4 ppm dietary vomitoxin (from contaminated DDGS), the negative control diet with Biofix Plus (ADM Alliance Nutrition; Quincy, IL), Cel-can (Value-Added Science & Technologies; Mason City, IA) with bentonite clay, or Defusion Plus (North American Nutri-

[3] CAST, Council for Agricultural Science and Technology. 1989. Mycotoxins: Economic and health risks. Task Force Report No. 116.

tion Co., Inc.; Brookville, OH) (Table 1). Diets were fed in meal form. A source of DDGS containing 12 ppm vomitoxin was included at 17% of the total ration to make the vomitoxin-contaminated diets.

Each pen contained a 4-hole, dry self-feeder and a nipple waterer to provide ad libitum access to feed and water. Pens had wire-mesh floors and allowed approximately 3 ft^2 per pig. Pig weight and feed disappearance were measured on d 0, 3, 7, 10, and 21 of the trial to determine ADG, ADFI, and F/G.

Diet samples were collected from feeders between each weigh day and submitted for a complete mycotoxin analysis at the Veterinary Diagnostic Laboratory at North Dakota State University, Fargo. End-of-trial samples were also collected from the Defusion Plus and negative control treatment (Table 2) to determine if vomitoxin breakdown occurred. Samples were sent for analysis after the trial concluded.

Data were analyzed as a randomized complete block design using the GLIMMIX procedure of SAS (SAS Institute, Inc., Cary, NC) with pen as the experimental unit. Differences between treatments were determined by using least squares means ($P < 0.05$). Pair-wise comparison was also used to test the difference between the negative control and vomitoxin mitigation treatments.

Results and Discussion

The analyzed dietary vomitoxin concentration for the positive control diet was 0.8 ppm. In addition, analyzed dietary vomitoxin concentration for the negative control, Biofix Plus, Cel-can with bentonite clay, and Defusion Plus were 4.6, 4.4, 4.3, and 5.1 ppm respectively. Also, other DON metabolites, (3-Acetyl DON and 15-Acetyl DON) were analyzed and found in small concentrations in the diets. If vomitoxin contamination is suspected, it is important to complete a full mycotoxin screening that will test for both vomitoxin and DON metabolites because these metabolites may have an additive affect. Fumonisin B1 and Zearelenone levels were tested and found in diets at or below cautionary dietary limits. Day 21 samples were collected from the negative control and Defusion Plus treatments to test for enzymatic degradation and reduction of dietary vomitoxin. Only a small reduction in dietary vomitoxin level was observed.

From d 0 to 3 and d 3 to 7, pigs fed the control diet had greater ($P < 0.05$) ADG and ADFI compared to pigs fed diets containing vomitoxin-contaminated DDGS (Table 3). There were no differences for growth criteria between the negative control and mitigation treatments for these periods. From d 7 to 10, pigs fed the positive control had greater ($P < 0.05$) ADG than pigs fed the negative control, Biofix Plus, or Cel-can with bentonite clay, while the pigs fed Defusion Plus were intermediate.

From d 0 to 10, pigs fed either the negative control or diets containing Biofix Plus, Cel-can with bentonite clay, or Defusion Plus had decreased ($P < 0.05$) BW, ADG, and ADFI compared with pigs fed the positive control diet. Pigs fed the positive control diet had improved ($P < 0.05$) F/G compared to pigs fed the negative control diet and diets containing Biofix Plus or Cel-can with bentonite clay, with pigs fed diets containing Defusion Plus intermediate.

From d 10 to 21, pigs fed the positive control diet or the diet containing Defusion Plus had greater ($P < 0.05$) ADG than the negative control, Biofix Plus, and Cel-can with bentonite clay diets. Additionally, pigs fed the positive control diet had a greater ($P < 0.05$) ADFI than pigs fed the negative control diets containing Biofix Plus and Cel-can with bentonite clay. Pigs fed Defusion Plus were intermediate.

Overall (d 0 to 21), pigs fed the positive control diet had greater ($P < 0.05$) final BW and ADG compared to pigs fed any of the vomitoxin-contaminated diets. In addition, pigs fed diets containing Defusion Plus had greater ($P < 0.05$) ADG than pigs fed the negative control diet or diets containing Biofix Plus or Cel-can with bentonite clay. Pigs fed the positive control diet had greater ($P < 0.05$) ADFI than pigs fed any other dietary treatment. Pigs fed the positive control diet had improved F/G ($P < 0.05$) compared to the negative control and diets containing Biofix Plus or Cel-can and bentonite clay. Also, pigs fed Defusion Plus had improved F/G ($P < 0.05$) compared to pigs fed the negative control. It should be noted the pigs used in this study had good health status during the entire course of the experiment and only 1 pig was taken off test on d 9 (from the Defusion Plus treatment) due to chronic poor performance.

In summary, nursery pigs fed diets containing 4 ppm vomitoxin clearly had reduced growth performance. Including Defusion Plus improved performance but not to the level of a positive control, low-vomitoxin diet. Therefore, Defusion Plus appears to have potential for mitigating some of the negative impacts of vomitoxin on growth performance.

Results for this study found that feeding nursery diets contaminated with 4 ppm vomitoxin resulted in reduced final BW by 7.6 lb over the 21-d period. Pigs fed the Defusion Plus (5 lb per ton) were the only vomitoxin-contaminated diet group to have improved gains, which resulted in intermediate growth performance between the positive and negative control.

Table 1. Composition of diets (as-fed basis)[1]

		Vomitoxin, 4 ppm			
Item	Positive control	Negative control	Biofix Plus	Cel-can with bentonite clay	Defusion Plus
Ingredient, %					
Corn	51.36	51.36	51.26	50.66	51.09
Soybean meal, 46.5% CP	28.29	28.29	28.29	28.34	28.31
DDGS	17.00	---	---	---	---
Vomitoxin DDGS[2]	---	17.00	17.00	17.00	17.00
Monocalcium P, 21% P	0.65	0.65	0.65	0.65	0.65
Limestone	1.20	1.20	1.20	1.20	1.20
Salt	0.35	0.35	0.35	0.35	0.35
Copper sulfate	0.05	0.05	0.05	0.05	0.05
Vitamin premix	0.25	0.25	0.25	0.25	0.25
Trace mineral premix	0.15	0.15	0.15	0.15	0.15
L-lysine HCl	0.40	0.40	0.40	0.40	0.40
DL-methionine	0.08	0.08	0.08	0.08	0.08
L-threonine	0.10	0.10	0.10	0.10	0.10
Phytase[3]	0.13	0.13	0.13	0.13	0.13
Cel-can	---	---	---	0.15	---
Defusion Plus	---	---	---	---	0.25
Biofix Plus	---	---	0.10	---	---
Bentonite clay	---	---	---	0.50	---
TOTAL	100.00	100.00	100.00	100.00	100.00
Calculated analysis					
Standardized ileal digestible amino acids, %					
Lysine	1.27	1.27	1.27	1.27	1.27
Isoleucine:lysine	63	63	623	63	63
Methionine:lysine	32	32	32	32	32
Met & cys:lysine	59	59	59	59	59
Threonine:lysine	63	63	63	63	63
Tryptophan:lysine	17	17	17	17	17
Valine:lysine	72	72	72	72	72
Total lysine, %	1.43	1.43	1.43	1.43	1.43
ME, kcal/lb	1,506	1,506	1,504	1,496	1,502
SID Lysine:ME, g/Mcal	3.83	3.83	3.83	3.85	3.84
CP, %	22.64	22.64	22.64	22.61	22.63
Ca, %	0.69	0.69	0.69	0.69	0.69
P, %	0.60	0.60	0.60	0.59	0.60
Available P, %	0.42	0.42	0.42	0.42	0.42

[1] Diets were fed from approximately 22.8 to 44.2 lb in meal form.
[2] Analyzed Deoynivalenol concentration in DDGS was 23.5 ppm.
[3] Phyzyme 600 (Danisco Animal Nutrition, St Louis, MO.) Provided per pound of diet: 340.5 FTU/lb and 0.13% available P released.

Table 2. Mycotoxin analysis of diets

	Composite[1]					d 21[2]	
Items, ppm	Positive control	Negative control	Biofix Plus	Cel-can with bentonite clay	Defusion Plus	Negative Control	Defusion Plus
Deoxynivalenol (DON)	0.8	4.6	4.4	4.3	5.1	6.1	4.6
3-Acetyl DON	<0.5	<0.5	<0.5	< 0.5	<0.5	<0.5	<0.5
15-Acetyl DON	<0.5	1.0	1.0	1.0	1.1	1.3	1.0
Total DON	0.8	5.6	5.4	5.3	6.2	7.4	5.6
Fumonisin B1	2.0	2.0	2.0	1.0	<2.0	2.0	1.0
Zearelenone	<0.5	0.5	0.5	0.5	0.5	0.6	0.5

[1] Values are a mean of 6 samples collected on d 2, 5, 8, 12, 14, and 19 that were blended before being analyzed at the end of the experiment.
[2] Collected at conclusion of the study and analyzed in a separate run from other samples.

Table 3. Effect of vomitoxin level and commercial products on nursery pig growth performance[1]

		Vomitoxin, 4ppm				
Item	Positive control	Negative control	Biofix Plus	Cel-can + bentonite clay	Defusion Plus	SEM
BW, lb						
d 0	22.7	22.8	22.9	22.9	22.8	0.42
d 3	25.3	23.6	23.7	23.7	23.7	0.44
d 7	29.7[a]	27.0[b]	26.8[b]	27.0[b]	26.8[b]	0.48
d 10	38.2[a]	33.6[b]	33.5[b]	34.3[b]	35.5[b]	0.71
d 21	49.8[a]	42.2[c]	41.8[c]	42.2[c]	44.9[b]	0.88
d 0 to 3						
ADG, lb	0.85[a]	0.28[b]	0.27[b]	0.27[b]	0.31[b]	0.056
ADFI, lb	1.30[a]	0.85[b]	0.92[b]	0.87[b]	0.83[b]	0.051
F/G	1.55[a]	3.92[b]	4.41[b]	3.35[b]	3.09[b]	0.711
d 3 to 7						
ADG, lb	1.11[a]	0.83[b]	0.76[b]	0.83[b]	0.78[b]	0.042
ADFI, lb	1.55[a]	1.15[b]	1.09[b]	1.12[b]	1.05[b]	0.052
F/G	1.40	1.40	1.44	1.36	1.37	0.057
d 7 to 10						
ADG, lb	1.24[a]	0.92[b]	0.96[b]	0.95[b]	1.04[ab]	0.078
ADFI, lb	1.86[a]	1.45[b]	1.40[b]	1.44[b]	1.46[b]	0.085
F/G	1.50	1.59	1.49	1.54	1.44	0.079
d 0 to 10						
ADG, lb	1.07[a]	0.69[b]	0.67[b]	0.70[b]	0.71[b]	0.039
ADFI, lb	1.56[a]	1.15[b]	1.13[b]	1.14[b]	1.11[b]	0.052
F/G	1.46[a]	1.67[b]	1.69[b]	1.65[b]	1.56[ab]	0.050
d 10 to 21						
ADG, lb	1.42[a]	1.10[b]	1.08[b]	1.12[b]	1.34[a]	0.050
ADFI, lb	2.26[a]	1.90[b]	1.80[b]	1.85[b]	2.05[ab]	0.089
F/G	1.62	1.72	1.69	1.67	1.55	0.066
d 0 to 21						
ADG, lb	1.29[a]	0.92[c]	0.90[c]	0.92[c]	1.03[b]	0.032
ADFI, lb	1.97[a]	1.59[b]	1.51[b]	1.54[b]	1.63[b]	0.065
F/G	1.53[a]	1.71[c]	1.68[bc]	1.67[bc]	1.57[ab]	0.044

[abc] Within a row, means without a common superscript differ ($P < 0.05$).

[1] A total of 180 pigs (TR4 × 1050, initially 22.8 lb and 34 d of age) were used in a 21-d trial with 6 pigs per pen and 6 pens per treatment.