Long-Term Feeding of Graded Levels of Deoxynivalenol in Grower-Finisher Pigs

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Summary

Mycotoxin-contaminated grains are commonly downgraded for use in livestock feed and, while the best strategy for livestock producers is to avoid feeding mycotoxin-contaminated grain altogether, with the increased incidence and level of contamination this is no longer a viable option. Therefore, strategies that allow the use of mycotoxin-contaminated grains in livestock feed are necessary.

Based on the preliminary results of this study, feeding 3 or 5 ppm DON resulted in reduced body weight and growth performance, however, evidence suggests pigs can adapt to DON-contaminated diets. In addition, DON may have less of an impact on younger animals. While older animals also have an ability to adapt to DON, the shorter time-period available for recovery may be insufficient. Results also indicate that the effects of DON-contamination on growth performance largely relates to a reduction in feed intake, as feed efficiency remained relatively constant across dietary treatments.

Introduction

The mycotoxin, deoxynivalanol (DON, also known as vomitoxin), is of significant importance to agriculture since it commonly contaminates corn, wheat, oats and barley and is one of the most prevalent mycotoxins in Canada. In the World Mycotoxin Survey conducted by BIOMIN, DON was reported to be the most prevalent mycotoxin in many ingredients of importance in swine, occurring in 77, 70, 46, and 48% of corn, barley, wheat and soybean samples tested, respectively. In North America, 58% of all grain samples analyzed contained DON, representing a ‘severe risk’ (Biomin, 2016). Data for wheat in Saskatchewan shows an increase in the incidence of fusarium, with 80-90% of wheat (CWRS and Durum) downgraded due to DON contamination.

Contaminated grains are commonly downgraded for use in livestock feed and, while the best strategy for livestock producers is to avoid feeding mycotoxin-contaminated grain altogether, with the increased incidence and level of contamination this is no longer a viable option. Therefore, many strategies typically include the elimination or reduction of the negative effect of mycotoxins in animal feeds. Most of these strategies focus on the deactivation of mycotoxins through binding of the mycotoxin using adsorbents, such as silicate clays and activated carbon, which can be included in feed as non-nutrient additives. In general, however, current feed additives are relatively ineffective in mitigating the negative effects of mycotoxins

Given the increasing incidence of DON-contamination there is an obvious economic impact of mycotoxin contamination for both the grain and pork sectors. Further information is required on long-term DON exposure in grower-finisher pigs that can be used to develop feeding programs which maximize inclusion of DON-contaminated grains while minimizing the impact on growth performance and profitability of both pork and grain producers.

Experimental Procedures

A total of 240 grower pigs (initial body weight of 35.9±1.1 kg) were housed in groups of six pigs/pen and randomly assigned to one of four dietary treatments over two blocks (n=10/trt). Dietary treatments (Tables 1) consisted of a control diet with no DON contamination (CON), or one of three DON-contaminated diets containing 1, 3, or 5 ppm DON (DON1, DON3, DON5). DON diets consisted of replacing clean wheat with naturally contaminated wheat and wheat screenings. Diets were isonitrogenous and isocaloric in order to meet or exceed nutrient requirements according to NRC (2012). Pigs were fed ad libitum for a total of 11 weeks (six weeks grower, five weeks finisher). Blood samples were obtained at 0, 2, 6, 8, and 11 weeks for liver and kidney blood chemistry panel (Prairie Diagnostic Services, Saskatoon, SK) as indicators liver and kidney function.

Results and Discussion

There was a significant decrease in body weight of DON3 and DON5 compared to CON-fed pigs by day 35, with no effect of DON1 (Table 2) to the end of the study. DON3 and DON5 reduced average daily gain in the grower phase and overall compared to CON-fed pigs. There was no DON effect on average daily gain in the finisher phase. There was a reduction in average daily feed intake during the first week of the study in DON3 and DON5-fed pigs compared to CON, with no effect of treatment in grower phase overall. Compared to CON, DON-fed pigs experienced a reduction in feed intake throughout the finisher phase and over the entire study, with no effects on feed efficiency.

Feed intake of DON-fed pigs was reduced compared to control fed pigs, while feed efficiency was only reduced in week one, suggesting that the capacity for growth is not affected in these pigs but feed intake is insufficient to support maximum growth. Based on these preliminary results, while feeding 3 or 5 ppm DON resulted in reduced body weight and growth performance, there is evidence that pigs can adapt to DON-contaminated diets. There was no impact of dietary treatment on any measures of kidney and liver health (data not shown).

Implications

Overall, it may be possible to feed diets containing higher levels of DON than currently recommended, however, adjustments would be needed in housing or feeding or in feed costs to account for reduced market weight.

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Table 1. Experimental diets used to determine effects of long-term mycotoxin exposure in finisher pigs

	CON	DON1	DON3	DON5
Ingredient (%, as-fed)				
Wheat (clean)	30.0	33.3	20.0	6.7
Wheat (8 ppm DON)[1]	-	4.9	14.8	24.7
Wheat screenings (35 ppm DON)[1]	-	1.7	5.2	8.6
Barley	39.2	39.2	39.2	39.2
Canola oil	3.7	3.7	3.7	3.7
Soybean meal	14.0	14.0	14.0	14.0
L-Lysine	0.463	0.463	0.463	0.463
DL-Methionine	0.075	0.075	0.075	0.075
L-Threonine	0.144	0.144	0.144	0.144
Limestone	1.00	1.00	1.00	1.00
Dicalcium phosphate	0.80	0.80	0.80	0.80
Salt	0.50	0.50	0.50	0.50
Vitamin/mineral premix[2]	0.20	0.20	0.20	0.20
Calculated nutrient content[3]				
DM (%)	86.4	86.4	86.4	86.5
ME (kcal/kg)	3291	3291	3291	3291
CP (%)	17.5	17.5	17.5	17.5
Lysine (%, SID)	0.98	0.98	0.98	0.98
DON (ppm)	0	1	3	5
Analyzed nutrient content[4]				
DM (%)	89.2	88.4	82.9	89.4
CP (%)	15.4	17.4	16.4	16.4
DON (ppm)	0.28	0.73	3.4	4.36

1 DON content of contaminated wheat and wheat screenings determined at Central Testing Laboratory (Winnipeg, MB)

2 Provided per kg of complete diet: vitamin A, 8000 IU; vitamin D, 1500 IU; vitamin E, 30 IU; menadione, 2.5 mg; vitamin B12, 0.025 mg; thiamine, 1.00 mg; biotin, 0.10 mg; niacin, 20 mg; riboflavin, 4 mg; pantothenate; 12 mg; folic acid, 0.50 mg; pyridoxine, 2.0 mg; Fe, 100 mg; Zn, 100 mg; Mg, 40 mg; Cu, 15 mg; Se, 0.30 mg; and I, 1mg

3 Nutrient content of diets calculated based on published nutrient requirements of ingredients according to NRC (2012) and INRA (2002)

4 DON content analyzed by Biomin.

Table 2. Growth performance of finisher pigs fed diets containing graded levels of DON for 6 weeks

	CON	DON1	DON3	DON5	SEM	P-value
Body weight (kg)						
Day 0	36	35.59	35.66	36.38	0.34	NS
Day 7	42.45	41.61	40.71	41.67	0.44	NS
Day 14	50.06^{a}	49.81^{a}	47.83^{b}	49.20^{ab}	0.49	0.01
Day 21	58.03^{a}	57.70^{a}	55.70^{ab}	56.66^{b}	0.60	0.04
Day 28	68.07	67.60	65.39	65.76	0.84	NS
Day 35	75.91^{a}	74.47^{ab}	72.73^{b}	72.70^{b}	0.86	0.03
Day 42	85.14^{a}	83.73^{ab}	81.98^{b}	81.62^{b}	0.91	0.005
Day 49	94.72^{a}	93.09^{ab}	90.94^{bc}	89.83^{c}	0.96	0.005
Day 56	102.66^{a}	100.86^{ab}	98.26^{bc}	97.71^{c}	1.00	0.004
Day 63	110.55^{a}	108.64^{ab}	106.32^{bc}	105.02^{c}	0.91	<0.001
Day 70	118.44^{a}	116.22^{ab}	114.59^{bc}	112.92^{c}	0.91	0.001
Day 77	124.92^{a}	123.40^{ab}	120.98^{bc}	119.92^{c}	0.91	0.002
Average daily gain (kg/d)						
Week 1	0.92^{a}	0.86^{a}	0.72^{b}	0.76^{b}	0.04	0.001
Week 2	1.09	1.17	1.02	1.08	0.04	NS
Week 3	1.14	1.13	1.12	1.06	0.03	NS
Week 4	1.44	1.42	1.38	1.3	0.06	NS
Week 5	1.15	1.12	1.14	1.11	0.04	NS
Week 6	1.32	1.32	1.32	1.27	0.04	NS
Grower Phase	1.17^{a}	1.15^{ab}	1.10^{bc}	1.08^{c}	0.02	<0.01
Week 7	1.37^{a}	1.34^{a}	1.28^{a}	1.17^{b}	0.04	<0.01
Week 8	1.13	1.11	1.05	1.13	0.06	NS
Week 9	1.13	1.11	1.15	1.04	0.05	NS
Week 10	1.13	1.08	1.18	1.13	0.04	NS
Week 11	0.93	1.03	0.91	1.00	0.06	NS
Finisher Phase	1.14	1.13	1.11	1.10	0.01	NS
Overall	1.15^{a}	1.14^{a}	1.11^{b}	1.09^{b}	0.01	<0.001
Average daily feed intake (kg/d)						
Week 1	1.59^{a}	1.55^{a}	1.40^{b}	1.42^{b}	0.04	0.002
Week 2	1.90	1.98	1.78	1.81	0.07	NS
Week 3	2.03	1.95	1.93	1.95	0.06	NS
Week 4	2.37^{b}	2.58^{a}	2.49^{a}	2.49^{a}	0.03	0.002
Week 5	2.79	2.77	2.67	2.60	0.05	NS
Week 6	3.17	3.07	3.09	2.95	0.08	NS
Grower Phase	2.29	2.27	2.20	2.18	0.03	NS
Week 7	3.17^{a}	2.95^{a}	2.96^{a}	2.71^{b}	0.08	0.004
Week 8	3.19^{a}	3.06^{ab}	2.99^{b}	2.94^{b}	0.06	0.01
Week 9	3.02	2.80	2.89	2.88	0.09	NS
Week 10	3.19	3.05	3.06	2.97	0.05	NS
Week 11	3.05	2.99	2.94	2.91	0.07	NS
Finisher Phase	3.12^{a}	2.97^{b}	2.96^{b}	2.88^{b}	0.05	<0.001
Overall	2.62^{a}	2.55ab	2.47^{b}	2.47^{b}	0.03	0.003

^{a,b,c} Means within a row without a common superscript differ significantly ($P < 0.05$)