THE EFFECTS OF VOMITOXIN AND FEED INTAKE ON THE PERFORMANCE AND BLOOD CHARACTERISTICS OF YOUNG PIGS

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ABSTRACT

Thirty barrows (average weight 8.4 kg) were used in a 3-wk experiment to determine the effects of the ingestion of vomitoxin (deoxynivalenol)-contaminated feed on performance and blood chemistry. The barrows were assigned randomly to consume either: 1) a control diet (C), fed ad libitum, 2) a vomitoxin contaminated diet (V; 10.5 ppm), fed ad libitum, or 3) a vomitoxin contaminated pair-fed at levels equal to those consumed by V animals (PF). The V and PF pigs had similar daily gains (.19 vs .20 kg) and feed intakes (.40 and .39 kg), but both of these were lower (P<.01) than those for the C-fed pigs (.38 kg daily gain and .72 kg feed intake). The V-fed pigs had lower (P<.05) hematocrit, hemoglobin, serum glucose and serum phosphorus and tended to have lower serum calcium (P<.06) than C-fed pigs. The V-fed pigs had higher (P<.05) hemoglobin and tended to have higher (P<.08) serum phosphorus and lower (P<.07) serum calcium than PF animals. There was a high total- and free-bilirubin concentration in serum of C- and V-fed pigs in the last sampling period (3-wk), which may be due to fasting and not cholestasis. No differences among treatments were observed in any of the other blood parameters. These results suggest that the differences in animal performance and blood parameters observed between control and vomitoxin-fed pigs are mainly due to differences in feed intake.

(Key Words: Feed Intake, Vomitoxin, Performance, Blood, Pigs.)

Introduction

Vomitoxin (deoxynivalenol) is a trichothecene mycotoxin produced by Fusarium graminearum (Vesonder et al., 1976; Mirocha et al., 1979). Swine are particularly susceptible to this toxin. The ingestion of feeds contaminated with vomitoxin was observed to cause a depression of feed intake, feed refusal and emesis in pigs (Vesonder et al., 1976; Forsyth et al., 1977; Young et al., 1983). Poultry and cattle, on the other hand, appear to be more tolerant of this toxin (Hulan and Proudfoot, 1982; Moran et al., 1982; L. G. Young, unpublished data).

In a recent experiment, Young et al. (1983) fed young pigs diets contaminated with up to 43 ppm vomitoxin. They observed no pathological lesions in those animals, but were able to detect changes in several blood parameters as the level of dietary vomitoxin was increased. However, it was not clear from the data whether the changes in blood parameters were the direct result of the toxicity of the ingested toxin or were indirectly caused by the depression in feed intake by the animals. The purpose of the present investigation was to elucidate further the reason for these changes in blood parameters.

Materials and Methods

Vomitoxin-contaminated corn, containing about 400 ppm of vomitoxin, was produced in 1980 using the toothpick method (Young, 1943). The whole ears, including the cobs and husks, were ground and incorporated into the diet.

Thirty barrows (average weight 8.4 kg) were allotted randomly from outcome groups (replications) based on initial weight to three treatments (table 1): a) control diet (C), fed ad libitum; b) vomitoxin-contaminated diet (V, 10.5 ppm), fed ad libitum and c) control diet, pair-fed at a level equal to that consumed by V pairmate the previous day (PF). Each pig was
EFFECTS OF VOMITOxin ON PIG PERFORMANCE AND BLOOD CHARACTERISTICS

TABLE 1. COMPOSITION OF DIETS

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Diet</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground corn (IFN 4-02-992)</td>
<td>C</td>
<td>72.75</td>
</tr>
<tr>
<td>Moldy corn (1980)*</td>
<td>V</td>
<td>70.25</td>
</tr>
<tr>
<td>Soybean meal (IFN 5-04-612)</td>
<td>C</td>
<td>24.0</td>
</tr>
<tr>
<td>Lime stone (IFN 6-02-632)</td>
<td>V</td>
<td>24.0</td>
</tr>
<tr>
<td>Dicalcium phosphateb</td>
<td>C</td>
<td>.90</td>
</tr>
<tr>
<td>Saltc</td>
<td>V</td>
<td>.90</td>
</tr>
<tr>
<td>Vitamin premixd</td>
<td>C</td>
<td>1.5</td>
</tr>
<tr>
<td>Trace mineral premixe</td>
<td>V</td>
<td>1.5</td>
</tr>
<tr>
<td>Total</td>
<td>C</td>
<td>100.0</td>
</tr>
<tr>
<td></td>
<td>V</td>
<td>100.0</td>
</tr>
</tbody>
</table>

*aConsisted of ground kernels, cobs and husks.

*bCommercial product; contained 18.5% Ca and 20.5% P.

*cContained .01% Co and .015% I.

*dProvided per kg diet: vitamin A, 10,000 IU; vitamin D3, 1,500 IU; vitamin E, 30 IU; vitamin K, 2.2 mg; riboflavin, 4.0 mg; d-calcium-pantothenate, 16 mg; niacin, 25 mg; choline chloride, 300 mg; vitamin B12, .15/~g.

*eProvided per kg diet: Mn, 60 mg; Fe, 80 mg; Cu, 10 mg; Zn, 100 mg; Se, .10 mg.

housed individually in a steel cage (.95 x .44 m) equipped with slatted floor, self feeder and waterer. The temperature of the room was about 25 C throughout the experiment. The experiment lasted for 21 d. Weight gains and feed consumption were recorded weekly. At the end of each 7-d period, blood samples were obtained from the orbital sinus of the pigs in the early morning before feeding. The pigs were fed once daily in the morning. Most of the PF pigs were found to consume all their diet before evening. For this reason, at the end of the last feeding period, all feeders were removed 10 h after initiation of feeding, and the final weighing and bleeding of the animals was performed in the early morning of the next day.

Toxin Analysis. Zearalenone was analyzed by the method of James et al. (1982), as modified by Young et al. (1983). Vomitoxin was determined according to the procedure described by Pathre and Mirocha (1978). The feed samples were extracted with 40% aqueous methanol. Vomitoxin was then separated from the contaminants by solvent partition and thin-layer chromatography purification. The purified vomitoxin was derivatized with Trisil/TBT and quantitated in a gas-liquid chromatograph. A Varian 4600 gas chromatograph equipped with a flame-ionization detector and a 1.8-m glass column (20 mm id) packed with 3% OV-1 on 80/100 mesh chromosorb WHP was used for this analysis. The column temperature was programmed to change from 160 to 230 C at 5 C/min. The injector and detector temperature were held at 230 C and 270 C, respectively. Nitrogen was the carrier gas with a flow rate of 30 ml/min at room temperature. This method had a sensitivity limit of .2 ppm, with recoveries of 55%.

Hematology and Serum Chemistry Assays. Hematological assays were determined using a Coulter counter, Model S4. Serum preparation and assays were determined according to the procedures described by Young et al. (1983), using kit reagents5 and an American Monitor KDA analyzer5.

Statistical Analysis. The experimental design used was a split-plot with treatments and replicates as the main plots and periods as the subplots. The degrees of freedom for the treatments were partitioned into two single-degree-of-freedom contrasts: C vs V and V vs PF. When period x treatment interactions were detected, the parameters were also analyzed within periods.

4Coulter Electronics of Canada Ltd., Burlington, Ontario, Canada L7L 5J8.

5American Monitor Corp., Indianapolis, IN 46268.
Results

The vomitoxin-contaminated diet contained 10.5 ppm of vomitoxin and 1.1 ppm of zearalenone. No detectable amount of T-2, HT-2, diacetoxyscirpenol, nivalenol or fusarenone-X was present. The ingestion of the V diet resulted in a 45% reduction (P<.01) in feed intake and a 50% depression (P<.01) in daily gains as compared with the C-fed pigs (table 2). Feed efficiency was also lower (P<.07) in this group of pigs. No vomiting was observed during the experimental period. The V-fed pigs had daily gains similar to that of PF pigs.

Although the pigs were allotted randomly from within outcome groups based on initial weight, it was found that three blood parameters, the initial number of red blood cells (RBC), hematocrit (Hct) and hemoglobin (Hb) differed. Data for these parameters were adjusted by covariance.

White blood cell counts, mean corpuscular volume, mean corpuscular hemoglobin and mean corpuscular hemoglobin concentration were not significantly affected by treatments. There were no differences in RBC counts between pigs fed the C and V diets in any period (figure 1). The V-fed pigs had higher (P<.03) RBC counts than PF pigs in period 1 and 2, but not in period 3. The C-fed pigs had higher (P<.05) Hct values than the V-fed pigs throughout the experiment, but their Hb values were higher (P<.05) than those of the V-fed pigs only in period 2 and 3 (figure 2 and 3).

There were no significant differences in the following serum parameters: total protein, albumin, urea, cholesterol, creatinine, conjugated bilirubin, albumin to globulin ratio, glutamic-oxaloacetic transaminase, glutamic-pyruvic transaminase, alkaline phosphatase and creatine phosphokinase (CPK) among dietary treatments. Analyses for the overall experiment indicated that the C-fed pigs had higher (P<.06) serum calcium (figure 4) and higher (P<.05) serum phosphorus (figure 5) levels than V-fed pigs. The C-fed pigs had higher (P<.05) glucose levels than the V-fed pigs only in period 2 and 3 (figure 6). The total- and free-bilirubin levels (figure 7 and 8) were observed to be similar in the first two periods for pigs on all treatments. In the last period pigs fed C and V diets had higher (P<.01) total- and free-bilirubin than PF pigs (figures 7 and 8).

Discussion

A diet contaminated with approximately 10 ppm of vomitoxin was chosen in this study. Previous results (Young et al., 1983) indicated that pigs with similar body weight fed a 9 ppm vomitoxin-contaminated diet reduced feed intake by 50% and daily gain by 72%. Many

<table>
<thead>
<tr>
<th>Item</th>
<th>Treatment</th>
<th>SD</th>
<th>Contrast</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
<td>V</td>
<td>PF</td>
</tr>
<tr>
<td>No. of pigs</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Avg initial wt, kg</td>
<td>8.4</td>
<td>8.3</td>
<td>8.4</td>
</tr>
<tr>
<td>Avg daily gain, kg</td>
<td>.38</td>
<td>.19</td>
<td>.20</td>
</tr>
<tr>
<td>Avg daily feed consumption, kg</td>
<td>.72</td>
<td>.40</td>
<td>.39</td>
</tr>
<tr>
<td>Gain:feed ratio</td>
<td>.53</td>
<td>.48</td>
<td>.49</td>
</tr>
<tr>
<td>Diet assay</td>
<td>ND</td>
<td>1.10</td>
<td>ND</td>
</tr>
<tr>
<td>Zearalenone, ppm</td>
<td>ND</td>
<td>1.10</td>
<td>ND</td>
</tr>
<tr>
<td>Vomitoxin, ppm</td>
<td>ND</td>
<td>10.5</td>
<td>ND</td>
</tr>
</tbody>
</table>

**The experimental period was 21 d.
**NS = not significant.
**ND = none detected.
**P<.01.
blood parameters also differed as compared with the C animals. Levels of vomitoxin higher than this were found to cause complete feed refusal and loss of weight (Young et al., 1983). The better pig performance obtained in this experiment may be due to a longer experimental period (21 vs 11 d). It appeared that some pigs fed vomitoxin partially adapted to the V diet as
the experiment progressed, following the initial depression in feed intake. This adaptation was also observed by Friend et al. (1982).

Pigs fed the C diet had higher values of Hct, Hb and serum glucose than V and PF pigs. Although the V-fed pigs had higher values of

**HEMOGLOBIN**

Figure 3. Comparison of hemoglobin levels among treatments: control o—o, vomitoxin-contaminated o—o, pair-fed o—o. Overall SE = .31.

**CALCIUM**

Figure 4. Comparison of serum calcium levels among treatments: control o—o, vomitoxin-contaminated o—o, pair-fed o—o. Overall SE = .21.
PHOSPHORUS

Figure 5. Comparison of serum phosphorus levels among treatments: control ---, vomitoxin-contaminated ---, pair-fed - - - . Overall SE = .22.

Hb than the PF pigs, the Hct and serum glucose values were not significantly different between the two groups of animals.

Pigs fed the PF diet tended to have higher serum Ca and lower serum P than the V-fed pigs, suggesting that vomitoxin may influence mineral absorption and(or) metabolism.

A rapid decrease of serum glucose (figure 6) and a rapid increase of serum total- and free-bilirubin levels (figure 7 and figure 8) in both C-

GLUCOSE

Figure 6. Comparison of serum glucose levels among treatments: control ---, vomitoxin-contaminated ---, pair-fed - - - . Overall SE = 4.02.
and V-fed pigs, but not in the PF pigs in the last period, were observed. As all feeders were removed the previous evening before the termination of the experiment, the lower values observed in the PF pigs may be due to their longer fasting experience because most of these pigs consumed their feed within 10 h of feeding.

Hyperbilirubinemia in horse and man during fasting was reported by Bloomer et al. (1971) and Gronnall and Mia (1972).

In conclusion, the depression of pig performance and differences in the blood parameters between C- and V-fed pigs appeared to be mainly due to the depression of feed intake.
Mineral absorption and(or) metabolism, on the other hand, may be affected by consumption of a diet containing vomitoxin.

**Literature Cited**


Young, H. C., Jr. 1943. The toothpick method of inoculating corn for ear and stalk rots. Phytopathology 33:16 (Abstr.).