Effect of a commercial mycotoxin binder during mycotoxicosis in chickens

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Abstract

Two experiments were conducted to study the efficacy of a low inclusion commercial HSCAS in preventing the deleterious effects of aflatoxin (AF) in broiler chicks. Feed in both experiments was experimentally contaminated with synthetic aflatoxin. In Experiment 1, 75 1-d-old Arbor Acres straight-run broilers were randomly distributed into three dietary treatments with 25 replications each. T I was a corn-wheat-soybean meal (control diet), T II control + 1 ppm aflatoxin, and T III control + 1 ppm aflatoxin + 2.5 kg/mt binder. At 40 d of age, birds fed 1 ppm aflatoxin contaminated diet showed significant lower body weight, poorer feed conversion, smaller bursa and severe macroscopic oral lesions than chicks fed the control diet. The addition of binder significantly prevented the impaired performance, bursa damage and the severe oral lesions observed in chicks fed aflatoxin. In second Experiment, 32 5-d-old Ross male chicks were randomly divided into four dietary treatments with 8 replications each. T I was a sorghum-soybean meal control diet, T II control + 2.5kg/mt Binder, T III control + 1.25ppm aflatoxin and T IV control + 1.25ppm aflatoxin + 2.5kg/mt binder. Feeding aflatoxin contaminated diet plus binder resulted in statistically significant heavier and more efficient broilers, with substantially reduced gross oral lesions and microscopic organs lesions (tongue, gizzard, thymus, bursa, spleen, liver, and kidney) than those fed 1.25ppm aflatoxin at 38 d of age. The addition of 2.5 kg/mt of Binder to chick diets did not show any statistical difference in performance and bone ash compared to the control diet, demonstrating its lack of nutrients absorption. These results indicated that binder at 2.5 kg/mt was effective in preventing the toxic effects of aflatoxin in broilers chicks.

Keywords: Binder; aflatoxin; broilers


Introduction

Fungal contamination of agricultural products is often unavoidable and of worldwide concern, because the products frequently contain toxic metabolites that produce significant economic losses to the poultry industry. Mycotoxins cause a wide variety of adverse clinical signs, depending on the nature and concentration of toxins in the diets, animal species, age; and nutritional and health status at the time of exposure to contaminated feed (Unno, 1991). The presence of mycotoxins in poultry feeds is of concern because it has resulted in economic losses due to the reduced performance and health. T-2 toxin (T-2) is a naturally occurring mycotoxin from the group of the trichothecenes, which are produced by Fusarium spp. mainly before harvesting. Trichothecene toxins have been most often characterized by oral lesions and reduced growth in chickens, as well as the inhibition of protein synthesis, responsible for the negative effects on rapidly dividing cells such as those of the oral cavity, gastrointestinal tract, and lymphoid tissues (10, 15). In addition, Burditt et al. found that T-2 toxin produced a dose related feed refusal, suggesting that it may have been due to the irritative properties of trichothecenes. Practical methods to detoxify mycotoxins contaminated grain or feed on a large scale and in a cost-effective manner are not currently available. At present, one of

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the most practical approaches consist on using adsorbent materials in the diet to reduce the absorption of mycotoxins from the gastrointestinal tract. Hydrated sodium calcium aluminum silicate (HSCAS) represents an important group of products that have been used with success worldwide with this purpose. In the scientific literature, HSCAS has been reported to be effective against aflatoxin and ochratoxin, but not against T-2 (Bailey et al., 1998).

The objectives of this research were to determine the efficacy of Binder to ameliorate the toxic effects of aflatoxin present in broiler diets and to demonstrate that the addition of Binder would not negatively affect broiler performance.

Materials and Methods

Two experiments were conducted using chicks obtained from a commercial hatchery. The chicks were individually caged and reared under uniform management conditions in each experiment, with feed and water provided ad libitum. Feed in both experiments was experimentally contaminated with synthetic aflatoxin toxin. A commercial HSCAS, Binder was used in these experiments.

Experiment 1

In this experiment, a total of 75 day-old commercial broiler chicks were used for 40 days. Birds were fed a basal starter (1-21 days), grower (22-35 days) and finisher (36-40 days) corn-wheat-soybean meal mash diets that contained or exceeded the levels of nutrients recommended by the NRC, (1994) and were found to be below detection limits for T-2, diacetoxyxyscirpenol, HT-2 toxin, deoxynivalenol, aflatoxin B1, ochratoxin A, and zearalenone. The chicks were randomly distributed into three treatments with 25 replications each. Dietary treatments were as follows: 1) control diets; 2) control diets with the addition of 0.25% Binder; 3) control diets with the addition of 1.25 mg of aflatoxin/kg of feed; and 4) control diets with 1.25 mg aflatoxin/kg of feed plus 0.25% Binder. Chickens were weighed individually, total feed consumption recorded, and scored for oral lesions at 38 days of age. At the end of the experiment five birds from treatments 1, 3 and 4 were sacrificed to carry out histopathological analysis of bursa, thymus, spleen, liver, kidney, tongue and gizzard. Bone ash was measured in all broilers from treatment 1 and 2, following the A.O.A.C. (2000) method of analysis.

Oral lesion score consisted of a four point scoring system ranging from 0 to 3, including lesions detected at several sites within the mouth, mainly on the upper and lower mandibles, the corners of the mouth, and on the tongue. A lesion score 0 indicates no visible lesions; score 1 was seen as one mouth lesion; score 2 was seen as up to two lesions; and a lesion scored as 3 indicated more than two lesions.

Data were evaluated with ANOVA for a complete randomized design, using the general linear models procedure of SAS software; SAS Institute (1987). When the ANOVA showed significance, Duncan’s significant-difference test was applied. Statistical significance was accepted at P ≤ 0.05.

Results

Experiment 1

Results presented in Table 1 demonstrate the significant negative effect of feeding 1ppm aflatoxin on body weight and oral lesions of broilers at 21, 28 and 35 days of age; and on the relative bursa weight at 21 and 28 days of age. The relative weights of liver and spleen were not altered by the dietary inclusion of aflatoxin at 21 and 28 days of age (data not shown). The most severe oral lesions and the largest reduction of the bursa occurred at 21 and 28 days of age, respectively. Addition of 0.25% Binder to the aflatoxin contaminated diet significantly improved body weight, oral lesions and relative bursa weight that were not
The report from the histopathological analyses indicated that at 38 days of age 80% of the birds showed moderate microscopic damage of the bursa, gizzard, spleen, liver and kidney; and all of them presented severe lesions in thymus and tongue when fed a diet with 1.25 ppm aflatoxin. Addition of 0.25% Binder to the aflatoxin contaminated diet markedly reduced the degree and number of lesions in those organs, to a level comparable to the one reported for the control diet.

**Discussion**

The addition of 2.5 kg of Binder per metric ton of feed significantly diminished the adverse effects of aflatoxin in broiler chicks. This is the first report showing the *in vivo* effectiveness of an adsorbent against aflatoxin. All previous attempts to prevent the toxicity of aflatoxin in broilers using inorganic or organic adsorbents have failed (Bailey et al., 1998). The protective action of this HSCAS appears to involve sequestration of aflatoxin so that it is not available for gastrointestinal tract absorption by the chicks, as suggested by Phillips et al. (1990) for aflatoxin.

In spite of the effectiveness of Binder in preventing the decreased broiler performance and organs damage produced by the addition of aflatoxin, mild oral lesions were observed in some chickens fed the adsorbent. Probably, they are the results of the direct caustic effect of aflatoxin in the mouth (Hoerr, 2003), where the lack of appropriate conditions, especially high humidity and low pH, prevent the action of the adsorbent.

The results of Experiment 2 are in agreement with those previously obtained by Casarin et al. (2005), indicating that Binder does not interfere with the absorption of nutrients.

Results obtained in these experiments demonstrate that 1.0 or 1.25 mg of aflatoxin per kg of feed can produce, in general, the typical signs of an acute aflatoxicosis in broilers, similar to those reported in the literature (Chi et al., 1977) but using levels of aflatoxin greater than 2 mg/kg. According to Hoerr (2003), the severe ulcerative stomatitis produced by aflatoxin leads to decreased feed intake, reduced gain and decreased feed efficiency.

**Conclusions**

The addition of 2.5 kg of Binder per metric ton of feed was effective in preventing the deleterious effects of toxin aflatoxin in broiler chickens. The addition of 2.5 kg of Binder per metric ton of feed did not show any statistical difference in performance and bone ash.

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Table 1: Effects of 0.25% Binder on body weight (BW), oral lesion score, and bursa development of broiler chicks at different ages in Experiment 1

<table>
<thead>
<tr>
<th>Treatment</th>
<th>21 days</th>
<th></th>
<th></th>
<th>28 days</th>
<th></th>
<th></th>
<th>35 days</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>BW (g)</td>
<td>Oral lesion % BW</td>
<td>BW (g)</td>
<td>Oral lesion % BW</td>
<td>BW (g)</td>
<td>Oral lesion % BW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>538a</td>
<td>0a</td>
<td>0.30a</td>
<td>932a</td>
<td>0a</td>
<td>0.45a</td>
<td>1446a</td>
<td>0a</td>
</tr>
<tr>
<td>Control + 1 ppm AFLATOXIN</td>
<td>463b</td>
<td>1.84b</td>
<td>0.20b</td>
<td>788b</td>
<td>1.63b</td>
<td>0.20b</td>
<td>1148b</td>
<td>0.96b</td>
</tr>
<tr>
<td>Control + AFLATOXIN + Binder</td>
<td>543a</td>
<td>0.36a</td>
<td>0.28a</td>
<td>938a</td>
<td>0.21a</td>
<td>0.40a</td>
<td>1451a</td>
<td>0.04a</td>
</tr>
</tbody>
</table>

*Means within columns with no common superscripts differ significantly (P ≤ 0.05)*
Table 2: Effects of 0.25% binder on body weight, feed intake, feed conversion ratio (FCR), and organs development of broilers at 40 days of age in Experiment 1

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Body Weight (g)</th>
<th>Feed Intake (g)</th>
<th>FCR</th>
<th>Spleen %BW</th>
<th>Liver %BW</th>
<th>Heart %BW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>1791&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3690&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.06&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.12&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.6&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Control + 1 ppm AFLATOXIN</td>
<td>1381&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2928&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.12&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.09&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.6&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Control + AFLATOXIN + Binder</td>
<td>1840&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3717&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.02&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.12&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.6&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a,b</sup>Means within columns with no common superscripts differ significantly (P ≤ 0.05)

Table 3: Effects of binder on average daily gain (ADG), average daily intake (ADI), feed conversion ratio (FCR) and oral lesion score of 38 day-old broilers exposed to test diets for 33 days in Experiment 2

<table>
<thead>
<tr>
<th>Treatment</th>
<th>ADG (g)</th>
<th>ADI (g)</th>
<th>FCR</th>
<th>Oral lesion</th>
<th>Bone ash %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>54.8&lt;sup&gt;a&lt;/sup&gt;</td>
<td>105.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.92&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.25&lt;sup&gt;a&lt;/sup&gt;</td>
<td>45.95&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Control + 0.25% Binder</td>
<td>51.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>103.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.25&lt;sup&gt;a&lt;/sup&gt;</td>
<td>45.65&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Control + 1.25 ppm AFLATOXIN</td>
<td>44.9&lt;sup&gt;b&lt;/sup&gt;</td>
<td>98.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.19&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.75&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-</td>
</tr>
<tr>
<td>Control + 1.25 ppm AFLATOXIN + 0.25% Binder</td>
<td>53.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>101.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.90&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.75&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-</td>
</tr>
</tbody>
</table>

<sup>a,b,c</sup>Means within columns with no common superscripts differ significantly (P ≤ 0.05)

of broilers compared to those from the control diet, demonstrating its lack of nutrients absorption.

References


