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Alleviation of the effect of dietary aflatoxin in turkey poults using bentonite-montmorillonite or yeast binder

[1]Oyegunwa, A. S.,[2]Ewuola, E. O.,[2]Agboola, A. F. and [2]Iyayi,E. A.
[1]*Department of Agricultural Science, Tai Solarin University of Education, Ijagun Ijebu Ode Nigeria.*
[2]*Department of Animal Science, University of Ibadan, Ibadan Nigeria*
Corresponding author: oyegunwaas@tsued.edu.ng*; 234-8066484845*

Abstract

In a 28-day feeding trial, the alleviation of the effect of dietary aflatoxin in turkey poultsusing 2 inclusion levels of yeast or bentonite-montmorillonite binders (BB) was investigated. One hundred and ninety-two, 21-day-old turkey poults were randomly allotted to six experimental diets in a completely randomized design as follows: D1 (control diet without aflatoxin), D2 (diet with 0.15mg/kg of aflatoxin), D3 (0.15mg/kg aflatoxin + 3g/kg BB), D4 (0.15mg/kg + 6g/kg BB), D5 (0.15mg/kg + 1.5g yeast/kg diet), D6 (0.15mg/kg + 3.0g yeast/kg diet).Feed intake, bodyweight gain, feed conversion ratio and mortalities were measured using standard methods to determine the positive effect of the BB or yeast and the negative effect of aflatoxin on the turkeypoults. Blood samples (5ml) were also collected from the turkey poults via jugular venopuncture and used for analysis to determine the haematology of turkey poults. Addition of BB or yeast significantly improved the feed intake (1,432.94g, 1,360.63g, 1,334.38g and 1,359g) for D3, D4, D5 & D6 respectively compared to 1,139.09g in D2. Body weight gain was also improved in diets supplemented with BB or yeast thus: D3 (571g), D4 (580,50g), D5 (588.25g) and D6 (522.50g) compared with body weight gain of 409.75g in D2. Feed conversion ratio also showed significant improvement in turkeys fed with (D1), D3, D4, D5 and D6 when compared with D2. Mortality figures in the D2 was highest (56%) when compared with D3 (0%), D4 (0%), D5 (12%) and D6 (0%) that were supplemented with BB and yeast as binders.Higher values of packed cell volume, haemoglobin and red blood cells obtained from our findings were indication of improved performance in turkeys that were fed with diets supplemented with BB or yeast. Overall, the supplementation of turkey diets with BB or yeast was shown to improve the overall performance of turkey poultsthat were intoxicated with aflatoxin at levels above

Keywords: Aflatoxin, alleviation, turkey poults, yeast, bentonite-montmorillonite

Atténuation de l'effet des aflatoxines alimentaires chez les dindonneaux à l'aide de bentonite-montmorillonite ou de liant de levure

Résumé

Dans un essai d'alimentation de 28 jours, l'atténuation de l'effet de l'aflatoxine alimentaire chez les dindonneaux à l'aide de 2 niveaux d'inclusion de levure ou de liants bentonite-montmorillonite (BB) a été étudiée. Cent quatre-vingt-douze dindonneaux âgés de 21 jours ont été répartis au hasard dans six régimes expérimentaux selon un plan complètement randomisé comme suit : D1 (régime témoin sans aflatoxine), D2 (régime avec 0,15 mg/kg d'aflatoxine), D3 (0.15mg/kg aflatoxine + 3g/kg BB), D4 (0.15mg/kg + 6g/kg BB), D5 (0.15mg/kg + 1.5g levure/kg diète), D6 (0.15mg/kg + 3.0g levure/kg de ration). La prise alimentaire, le gain de poids corporel, le taux de conversion alimentaire et les mortalités ont été mesurés à l'aide de méthodes standard pour déterminer l'effet positif du BB ou de la levure et l'effet négatif de l'aflatoxine sur les dindonneaux. Des échantillons de sang (5 ml) ont

également été prélevés sur les dindonneaux par ponction veineuse jugulaire et utilisés pour l'analyse afin de déterminer l'hématologie des dindonneaux. L'ajout de BB ou de levure a significativement amélioré la prise alimentaire (1 432,94 g, 1 360,63 g, 1 334,38 g et 1 359 g) pour D3, D4, D5 et D6 respectivement par rapport à 1 139,09 g en D2. La prise de poids corporel a également été améliorée dans les régimes supplémentés en BB ou en levure ainsi : J3 (571g), J4 (580,50g), J5 (588,25g) et J6 (522,50g) par rapport à une prise de poids corporel de 409,75g en J2. Le taux de conversion alimentaire a également montré une amélioration significative chez les dindes nourries avec (D1), D3, D4, D5 et D6 par rapport à D2. Les chiffres de mortalité dans le D2 étaient les plus élevés (56 %) par rapport à D3 (0 %), D4 (0 %), D5 (12 %) et D6 (0 %) qui étaient supplémentés de BB et de levure comme liants. Des valeurs plus élevées d'hématocrite, d'hémoglobine et de globules rouges obtenues à partir de nos résultats étaient une indication d'une amélioration des performances chez les dindes nourries avec des régimes supplémentés en BB ou en levure. Dans l'ensemble, il a été démontré que la supplémentation des régimes de dinde avec du BB ou de la levure améliorait la performance globale des dindonneaux intoxiqués par l'aflatoxine à des niveaux supérieurs à

Mots clés : Aflatoxine, atténuation, dindonneaux, levure, bentonite-montmorillonite

Introduction

Aflatoxin, is a class of mycotoxin produced by 2 fungal species *Aspergillus flavus* and *Aspergillus parasiticus*. Aflatoxin is known to interact with the basic metabolic pathways of the cell disrupting key enzymatic processes including carbohydrate, lipid metabolism and protein synthesis (Cheeke and Shull, 1985). By virtue of the multiplicity of actions of aflatoxin on the liver and other cells containing mixed function oxidase systems, the effects of this toxin on animals are profound and far reaching. At the present time, there appears to be no absolutely safe way of preventing or ameliorating the scourge of aflatoxicosis other than avoiding conditions conducive to the formation of aflatoxin in feedstuffs and avoiding feed with preformed aflatoxin. But because of the nature of feed distribution system in the poultry industry, this avoidance is difficult. A more economical solution is the incorporation of a dietary additive such as, mycotoxin (aflatoxin) binder (Smith and Hamilton, 1970). Extensive research has been conducted to prevent mycotoxicosis that mainly include- physical, chemical, nutritional or biological approaches.The use of mycotoxin binders, which can trap the mycotoxin molecule by means of ion exchange and thereby hindering their absorption into the gastrointestinal tract, has gained much attention in prevention of mycotoxicosis. The efficacy of clay minerals depends on the geographical source and surface characteristics of the clay, with products having a larger surface area being more effective (Phillips *et al*., 1988). Performance of broiler chicken fed 15 or 30g/kg bentonite in the diet was studied by Katouli *et al*. (2010). The authors reported that 30g/kg bentonite improved weight gain, feed intake and growth rate. Pasha *et al*. (2007) tested the influence of bentonite at 5 and 10g/kg and acetic acid in the diet of broilers and found that weight gain, feed consumption, protein efficiency ratio and protein digestibility increased significantly. Modified yeast cell wall has also been used to sequester aflatoxin and its effectiveness varies across species of animals (Diaz *et al*., 2004; Kutz *et al*., 2009). Yiannikouris*et al*. (2004) proposed that the glucan portion of the yeast cell wall interacts with the mycotoxin molecule which is the active component of the yeast cell wall.The effects of aflatoxin

on domestic turkeys is well researched. For example, extensive mortality was produced in young domestic turkeys that were given 0.4mg/kg aflatoxin or more of dietary aflatoxin (Giambrone *et al*., 1985). However, information on the alleviation of the effect of aflatoxin on turkey poults are still needed in view of the extreme susceptibility of turkey to aflatoxin. Hence this study was conducted.

Materials and methods

Birds and experimental design

A total of 192 twenty-one-day old turkey poults were used for this study. They were weighed at the third week with average initial weights of 168.75±8.14g, 162.50±6.95g, 157.75±6.13g, 159.00±10.80g, 159.50±10.91g, 163.25±5.74g for D1 to D6 respectively. The turkey poults were then randomly allotted to six dietary treatments as follows: D1 (Diet with no aflatoxin), D2 (Diet with 0.15mg/kgaflatoxin), D3 (0.15mg/kg aflatoxin + 3g/kg BB), D4 (0.15mg/kg aflatoxin + 6g/kgBB), D5 (0.15mg/kg aflatoxin + 1.5g/kg yeast) and D6 (0.15mg/kg aflatoxin + 3.0g/kg yeast). Each dietary treatment was divided into 4 replicates with each replicate having 8 poults in a completely randomized design. The birds were reared in a well ventilated standard poultry house of the Teaching and Research Farm, University of Ibadan following all standard protocols of the institution for animal experimentation. The feeding trial lasted for 28 days with routine management practices adhered to.

Production of aflatoxin and quantification

A pure culture of *Aspergillus flavus* (N3228 strain) was obtained from International Institute of Tropical Agriculture (IITA), Ibadan. The ten plates were subcultured at the pathology unit of Animal Care Services Konsult Ltd., Ogere Remo. The purpose of sub-culturing is to produce more *Aspergillus flavus for* high aflatoxin production.According to method described by Shotwell*et al*. (1966), pure culture of *Aspergillus flavus* was prepared at IITA in 50mls of V8 juice as the nutrient medium. V8 juice contains 20gms of agar-agar, 950mls of distilled water which was autoclaved for 20 minutes at 121^0C and allowed to cool o 45^0C. The resulting liquid is then poured into containers and allowed to gel. The inoculum was incubated for 11 days and this medium is specific for *Aspergillus flavus*. Sub-culturing of the fungi was done at Animal Care Services Konsult, Ogere Remo using the Sabroid Dextrose Agar as against the V8 juice used in IITA. Other reagents that were used in the laboratory include tween 20, tween 80, ethanol and jik bleach.Pure maize was purchased from Bodija market in Ibadan. The maize grains were soaked for six hours in a big plastic bowl. After soaking, the grains were autoclaved at 121^0C for 20minutes. The purpose of autoclaving was to ensure that the maize was free from any microbes before being used for the intended purpose. 1ml of tween 20 was added to 1000ml of distil water for the purpose of sticking the spores of the fungi to the maize grains firmly. The tween 20 mixture is then poured gently into each plate containing the fungi while the substrate is stirred gently with a spreader and poured back into the 1000ml jar and mixed vigorously. Five plates of the fungi are poured into 1000ml jar. Spore count was done using a micropipette to charge haemocytometer with spore solution and covered with cover slip, and counted under compound microscope with objective lens X 40 magnification. Spore load obtained per ml was obtained by multiplying the average count by a factor of 50000.

Aflatoxin in the maize grains was produced by inoculating the autoclaved maize with the fungus strain, *Aspergillus flavus* isolate (N3228 strain). 100ml of spore solution was poured into each 1kg bag of maize and

shook vigorously until no visible water is seen in nylon. Samples of maize were then kept for two weeks to allow for high production of aflatoxin in the maize samples. After two weeks samples of maize showed high contamination characterized by dark greenish to black colouration which is due to high levels of toxin produced from fungus activities on the maize grains. The mouldy maize grains were washed with tween 80 in order to kill the spores prior to drying of the maize grains.

Aflatoxin quantification

Portions of the dried grains were collected homogenized and ground into powder with size less than 2mm with test portion sizes of 200g. A 20g sub-sample from a bulk sample of 200g was ground and extracted with 100ml of 70% methanol using a high-speed blender (Waring Commercial, Springfield, MO) for 3 minutes. The mixture was then passed through Whatman paper No 1, and the extract collected in a 250ml separating funnel and 100ml of distilled water was added to ease separation. The solution was extracted twice with 25ml methylene chloride. Following separation, the methylene chloride layer was filtered through 40g of anhydrous sodium sulphate to remove residual water. The extract was collected in a polypropylene cup and evaporated to dryness in a fume hood. The residue was dissolved in 200ul of methylene chloride and either diluted or concentrated to allow accurate densitometry. Extracts and Aflatoxin standards were separated on thin-layer chromatography (TLC) plates (silica gel 60, 250 um) by development with diethyl ether-methanol-water (96:3:1), visualized under ultra violet light, and scored visually for presence or absence of Aflatoxin with a 2mg limit of detection. Aflatoxins were quantified using scanning densitometer, CAMAG TLC Scanner 3 with win-CATS 1.4.2 software (Camag AG, Muttenz, Switzerland) as described previously.

Determination of mixing proportion of aflatoxin

A simple method for determining the quantity of Aflatoxin-contaminated maize to be added to the finished feed to give the required concentration in the feed was formulated by Oyegunwa*et al*.(2015) as follows:

$$\text{Required amount of contaminated maize (kg)} = \frac{\text{Qty of finished feed (kg) X conc. Required in finished feed (mg/kg)}}{\text{Conc. of Aflatoxin in maize carrier (mg/kg)}}$$

Sources of yeast and bentonite-montmorillonite and mixing method

Yeast powder was purchased from Bodija market in Ibadan while bentonite-motmorillonite was imported from Germany and manufactured by Fusion Biosystems Company. Appropriately measure quantities of the binders were first mixed with maize and then incorporated into the finished feed by hand mixing.

Feed preparation

The corn-based diets used in this study was formulated based on the nutritional requirements recommended by the NRC (1994) with CP adjusted to 28.44% and ME at 3021.37kcal/kg. The culture material with 1.01mg/kg of total aflatoxin was added to each ration to reach the desired aflatoxin concentration in the diet (Table 1). Feed and water were provided *ad libitum.*

Table 1: Gross composition (%) of turkey poults starter diets

Ingredients	D1	D2	D3	D4	D5	D6
Pure maize	52.00	37.00	37.00	37.00	37.00	37.00
Contd. Maize	-	15.00	15.00	15.00	15.00	15.00
Soybeanmeal	40.00	40.00	40.00	40.00	40.00	40.00
Fish meal (72%)	5.00	5.00	5.00	5.00	5.00	5.00
Dicalcium phosphate	1.00	1.00	1.00	1.00	1.00	1.00
Limestone	1.00	1.00	1.00	1.00	1.00	1.00
Methionine	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25	0.25
Common salt	0.25	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated Nutrient						
Crude protein	28.44	28.44	28.44	28.44	28.44	28.44
ME (kcal/kg)	3021.37	3021.37	3021.37	3021.37	3021.37	3021.37
Crude fibre (%)	3.90	3.90	3.90	3.90	3.90	3.90
Calcium (%)	0.92	0.92	0.92	0.92	0.92	0.92
Phosphorus (avl)	0.55	0.55	0.55	0.55	0.55	0.55

[1]D1 (control diet without aflatoxin), D2 (diet with 0.15mg/kg of aflatoxin), D3 (0.15mg/kg aflatoxin + 3g/kg BB), D4 (0.15mg/kg + 6g/kg BB), D5 (0.15mg/kg + 1.5g yeast/kg diet), D6 (0.15mg/kg + 3.0g yeast/kg diet)
[2]1kg premix contains: Vitamin A – 13340 I.U; Vitamin D3 – 2680 I.U; Vitamin E – 10 I.U.; Vitamin K – 2.68mg; Calcium pantothenate – 10.68mg; Vitamin B12 – 0.022mg; Folic acid – 0.668mg; Choline chloride – 400mg; Chlorotetracycline – 26.68mg; Manganese – 13mg; Iron – 66.68mg; Zinc – 53.34mg; Copper – 3.2mg; Iodine – 1.86mg; Cobalt – 0.268mg; Selenium – 0.108mg. ME – Metabolizable Energy, BB = bentonite-montmorillonite binder, Y = yeast.

Data collection

Determination of feed intake

Feed consumption in each replicate was determined daily by the difference between the daily feed supply and the left over the feed intake was recorded in gram

Determination of feed conversion ratio

This was calculated as the ratio of Feed Intake and Weight gain

FCR = Feed Intake/Weight Gain

Determination of cummulative weight gain

The live weight changes of the chicks were taken weekly throughout the experimental period. The average cumulative weight gain per poult was obtained by taking the difference between the initial weight at the start of the experiment and the weight at the end of the experiment.

Determination of percentage mortality

The data on mortality were recorded on daily basis per treatment and summed up at the end of the experiment. This is calculated in percentage as:

Mortality (%) = number of dead birds/number alive X 100

Determination of haematology

Blood samples were obtained from the jugular vein of two poults per replicate at day 28. Blood samples collected with EDTA were used for haematological analysis. PCV was determined using Wintrobe haematocrit method. Haemoglobin was determined by Cyanmethaemoglobin method by Coles (1986). RBC was determined using improved Neubaeur haemocytometer after the appropriated dilution.

Statistical analysis

Data collected were analyzed using analysis of variance (ANOVA) in statistical analysis software (1999) as completely randomized and means were separated using Duncan multiple range test of the same software.

Results and discussion

In this study, no clinical signs were observed in the positive control group (with no aflatoxin or supplementation) while in the negative control group, all signs associated with aflatoxicosis e.g. anorexia, mortality, severe depression, ruffling and stunting were seen but were less pronounced in turkeys fed diets supplemented with BB and yeast (D3 to D6). Mortality was 56% and 12% in D2 and D5 respectively while other groups recorded no mortality. Results on mortality in this study is in agreement with the work of Rauber*et al*. (2007) that turkeys fed 200ppb and more of aflatoxin during 21 days of age recorded more than 37% mortalities. Two important factors may be responsible for this. During aflatoxicosis, aflatoxin B1 is hydrolysed to 8, 9-epoxide and then to 2, 3-dihydrodiol which is the most carcinogenic form of the toxin. This results to quick onset of necrosis of the liver and death of the animal (TDRI, 1984). Mortality could be high during acute aflatoxicosis because of the interference of the toxin with the immune system of the turkey poults thereby reducing their resistance to other infections (Sharma, 1993). Aflatoxin is known to induce immune-suppression and increase susceptibility of affected birds to viral and parasitic infections (Sharma, 1993). The effects of yeast and BB additives on feed intake, body weight gain and feed conversion ratio are presented in Table 2. Feeding of aflatoxin-contaminated diet without supplementation with a binder caused a significant reduction ($p<0.05$) in feed intake and body weight gain. The feed intake of the turkey poults that were fed with aflatoxin and graded levels of yeast and BB showed significant increase ($p<0.05$) in their values compared with diet with aflatoxin alone. Turkeys fed diets containing no aflatoxin and binders recorded the highest feed intake (1493.13g) while turkeys fed with diets containing aflatoxin and no binders recorded the least intake of feed (1139.09g). The values of feed intake in diets D3, D4 and D6 with3g/kg yeast, 6g/kgyeast and 3g/kg BB respectively were not significantly different but their numerical values were higher than that of the negative control (D2).

Table 2: Performance of turkey poults fed aflatoxins contaminated diets supplemented with BB or yeast at 28 days

Parameters	D1	D2	D3	D4	D5	D6	SEM
Initial weight (g)	168.75	162.50	157.75	159.00	159.50	163.25	2.04
Feed intake (g)	1493.13^{a}	1139.09^{c}	1432.94^{ab}	1360.63^{b}	1334.38^{b}	1359.39^{ab}	23.04
Final weight (g)	858.25^{a}	572.25^{c}	774.25^{ab}	739.50^{b}	747.75^{ab}	750.25^{ab}	17.67
Weight gain (g)	689.50^{a}	409.75^{c}	571.00^{b}	580.50^{b}	588.25^{b}	522.50^{b}	13.90
Feed Conversion Ratio	2.17^{b}	2.75^{b}	2.55^{ab}	2.34^{b}	2.28^{b}	2.34^{b}	0.06
Mortality (%)	0.00	56.00	0.00	0.00	12.00	0.00	

D1 (control diet without aflatoxin), D2 (diet with 0.15mg/kg of aflatoxin), D3 (0.15mg/kg aflatoxin + 3g/kg BB), D4 (0.15mg/kg + 6g/kg BB), D5 (0.15mg/kg + 1.5g yeast/kg diet), D6 (0.15mg/kg + 3.0g yeast/kg diet)
Means on the same row with different superscripts are significantly different ($P<0.05$). SEM = standard error of mean. BB = bentonite-montmorillonite binder, Y = yeast

These results are consistent with the earlier reports on the performance depressing effects of aflatoxin B1 (Santurio *et al*., 1999). The depression in growth in turkeys fed with aflatoxin alone without binders could be attributed to reduced protein synthesis as reported by Verman *et al*. (2002), increased lipid excretion in droppings, impaired nutrient absorption and reduced pancreatic digestive enzyme production (Osborne and Hamilton (1981). Nelson *et al*. (1982) reported that aflatoxin

reduces the ability of the bird to digest dry matter and amino acids and to utilize energy from aflatoxin-contaminated ration. Supplementation with BB or yeast improved the performance parameters as seen in turkeys fed diets containing BB or yeast supplements, although with variations but the best performance among them was seen in turkeys fed 3g/kg BB supplement in terms of feed intake and weight gain. Similar results were obtained by Sehu *et al*. (2007) and Zhao *et al.* (2010) who concluded that hydrated sodium calcium aluminosilicate (HSCAS) at 5% concentration could significantly and completely ameliorate the growth depressing effect of aflatoxin B1 as silica binders have been shown to bind the toxins in the digestive tract, making them unavailable for gut absorption and allowing them to pass harmlessly through the animal. The mean values of packed cell volume, haemoglobin, red blood cells, white blood cells and platelets were significantly increased ($p<0.05$) with the addition of BB and yeast to the aflatoxin-contaminated diets (Table 3). The effect of aflatoxin on haematological parameters has been reported in earlier studies. Oguz *et al.* (2000) observed significant decreases in RBC, PCV, haemoglobin, thrombocyte and lymphocytes counts in broilers that were fed with aflatoxin contaminated diets during 21 days period. The suppressive effect of aflatoxin on haematopiesis and immune response was also reported by Huff *et al*. (1986). The values of haematological parameters in the present study were significantly improved by the supplementation of bentonite-montmorillonite binder (BB) and yeast (Table 3). Packed cell volume, haemoglobin and red blood cells also showed significant improvement in turkeys fed diets supplemented with BB or yeast compared with those that were fed with aflatoxin diet alone.

Table 3: Haematological values of poults fed aflatoxin contaminated diets supplemented with BB or yeast at 28 days

Parameters	D1	D2	D3	D4	D5	D6	SEM
Packed Cell Volume (%)	37.50^{b}	39.80^{ab}	37.00^{b}	43.13^{a}	41.75^{ab}	41.75^{ab}	2.42
Haemoglobin (g/dL)	12.46^{b}	13.09^{ab}	12.36^{a}	14.44^{a}	14.05^{ab}	14.15^{ab}	0.21
Red Blood Cell ($x10^6/mm^3$)	$3.74b^{c}$	3.85^{abc}	3.63^{c}	4.23^{ab}	4.34^{a}	4.27^{ab}	0.06
White Blood Cell (x106/mm3)	19213^{bc}	22056^{ab}	21631^{ab}	20369^{ab}	17888^{c}	23775^{a}	369.06
Heterophil. ($x10^6/mm^3$)	50.25	60.88	53.13	60.25	56.13	60.75	1.43
Lymphocytes ($x10^6/mm^3$)	46.13	34.25	43.63	34.75	40.13	35.50	1.43
Monocytes ($x10^{6/mm3}$)	2.63	3.88	2.00	3.63	2.50	3.25	0.21
Eosinophil ($x10^6/mm^3$)	1.38	0.75	1.13	1.38	1.00	0.50	0.13
Basophil ($x10^6/mm^3$)	0.38	0.25	0.13	0.00	0.25	0.00	0.05
Platelets ($x10^6/mm^3$)	168750^{ab}	192625^{ab}	176000^{ab}	154875^{b}	154625^{b}	204250^{a}	0.16

D1 (control diet without aflatoxin), D2 (diet with 0.15mg/kg of aflatoxin), D3 (0.15mg/kg aflatoxin + 3g/kg BB), D4 (0.15mg/kg + 6g/kg BB), D5 (0.15mg/kg + 1.5g yeast/kg diet), D6 (0.15mg/kg + 3.0g yeast/kg diet)
Means on the same row with different superscripts are significantly different ($P<0.05$), SEM = standard error of mean, BB = bentonite-montmorillonite binder, Y = yeast

No significant differences were observed in the serum parameters of the turkey poults in this study. In contrast to this, Wafaa *et al*. (2013) reported that addition of HSCAS and tumeric powder to diets contaminated with aflatoxin were significantly effective in the protection against aflatoxin by ameliorating the alterations in serum biochemical parameters. Also some authors (Rosa *et al*., 2001; Aravind *et al*., 2003; Miazzo *et al*., 2005), reported that adding sodium bentonite and yeast glucomannan to the diet was effective in reducing aflatoxicosis in terms of growth performance,

haematological and serum biochemical analyses.

Conclusion

It can be concluded that addition of bentonite-montmorillonite binder or yeast up to 6g/kg and 3.0g/kg, respectively reduced the toxicity of 0.15mg/kg aflatoxin in turkey, resulted in improved performance and reduced mortality.

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References

Aravind, K. L., Patil, V.S., Devegowda, G.U., makantha, B. and Ganpule, S. P. 2003. Efficacy of esterified glucomannan to counteract mycotoxicosis in naturally contaminated feed on performance and serum biochemical and haematological parameters in broilers. *Poult. Sci*., 82:571-576.

Cheeke, P. R. and Shull,L. R. 1985. Natural toxicants in feeds and poisonous plants. *AVI Publishing Company Inc. Westport, Connecticut* 492pp.

Cole, R. J. 1986. Etiology of Turk8ey x dieasein retrospect: a case for the involvement of cyclopiazonic acid, and mycotoxin Res., 2, pp3-7

Diaz, D. E., Hagler, W. M. Jr., Blackwelder, J. T., Eve, J. A., Hopkins, B. A., Anderson, K. L., Jones, F. T., Whitlow, L. W. 2004. Aflatoxin adsorbents II: Reduction of aflatoxin M_1 in milk by sequestering agents of cows consuming aflatoxin in feed. Mycopathologia 157:233–241

Giambrone J.J., Diener, U.L., Davis, N.D. Panangala, V.S. Hoerr, F. J. 1985. Effects of purified aflatoxin on broiler chickens. *Poults. Sci*. 64:852-858.

Huff, W. E., Kubena, L. F, Harvey, R. B., Hagler, V. M., Swanson, S. P., Phillips, T. D., Creger, C. R. 1986. *Individual and combined effects of aflatoxin and deoxnivalenol (DON, vomitoxin) in broiler chickens. Poult. Sci. 65:1291–1298.*

Kutz, R.E., Sampson, J.D., Pompeu, L.B., Ledoux, D.R., Spain, J.N., Vazquez-Anon, M., Rottinghaus, G.E., 2009. Efficacy of Solis, NovasilPlus, and MTB-100 to reduce aflatoxin M1 levels in milk of early to mid lactation dairy cows fed aflatoxin B1. *Journal of Dairy Science*, 92, 3959-3963.

Katouli M. S. Boldaji F. Daystar B. and Hassani S. 2010. Effect of different levels of kaolin, bentonite and zeolite on broilers performance. *Journal of Biological Sciences*. 10, 58-62.

Krska, R. Welzig, E. and Boudra, H 2007. Analysis of fusarium toxins in feed. *Animal Feed Sci. Technol*. 137:241-264.

Miazzo, R., Peralta, M.F., Magnoli, C., Salvano, M., Ferrero, S, Chiacchiera, S.M., Carvalho, E. C. Q., Rosa, C. A. Dalcero, A. 2005. Efficacy of sodium bentonite as a detoxifier of broiler feed contaminated with aflatoxin and fumonisin. *Poult. Sci*. 84:1–8.

National Research Council 1994. Nutrients Requirements of Poultry, 9th Edition. *National Academy Press, Washington DC*, 44-45.

Nelson, T.S. Johnson, Z.B., Kirby, L.K and Beasly, J.N. 1982. Digestion

of dry matter and amino acids and energy utilization by chicks fed molded corn containing mycotoxins. Poult Sci., 61, 584-585.

Oguz, H., Kecceci, T., Birdane, Y. O., Onder, F., Kurtoglu, V., 2000 .Effect of clinoptilolite on serum biochemical and haematological characters of broiler chickens during experimental aflatoxicosis. *Res. Vet. Science,* 69; 89-93.

Osborne, D.J. and Hamilton, P.B. 1981. Decreased pancreatic digestive enzymes during aflatoxicosis. *Poult. Sci*., 60: 1818-1821.

Oyegunwa, A.S. Agboola, A.F., Ewuola, E.O. and Iyayi, E.A., 2015. Alleviation of effect of dietary aflatoxin using bentonite-montmorillonite binder or yeast. *Ph.D Thesis* Department of Animal Science, University of Ibadan.

Pasha, T. N., Farooq, Khattak, M. U.,Jabbar, F. M., Khan, M. A., A.D. 2007. Effectiveness of sodium bentonite and two commercial products as aflatoxin absorbents in diets for broiler chickens. *Anim. Feed Sci. Technol*. 132:103–110.

Phillips, T. D., Kubena, L. F., Harvey, R. B., Taylor, D. R., Heidelbaugh, N. D. 1988. Hydrated calcium aluminosilicate: A high affinity sorbent for aflatoxin. *Poult. Sci. 67:243–247.*

Rauber R.H., Dilin, P. Giacomini, L.Z. Araujo de Almeida, C.A. and Mallmann, C.A. 2007 performance of turkey poults fed different doses of aflatoxins in the diet. *Poult. Sci.* 86:1620-1624.

Rosa, C.A., Miazzo, R., Magnoli, C., Salvano, M., Chiac, S.M., Ferrero, S., Saenz, M., Carvalho, E.C., Dalcero, A. 2001. Evaluation of the efficacy of bentonite from the south of Argentina to ameliorate the toxic effects of Aflatoxin in broilers. *Poultry Sci*.., 80, 139-144.

Santurio, J.MMallmann, ., C.A. Rosa, A.P. Appel, G.Heer, A.Dageforde,S and Bottcher, M 1999. Effect of sodium bentonite on the performance and blood variables of broiler chickens intoxicated with Aflatoxin. Br. *Poult Sci*., 40: 115-119.

Sharma, R.P., 1993. Immunotoxicty of mycotoxins. *Journal of Diary Science*, 76, 892-897.

Sehu, A., Ergun, L.Cakir, S. Ergun, E. and Cantekin, Z. 2007. Hydrated sodium calcium aluminosilicate for reduction of Aflatoxin in quails (Coturnixcoturnix japonica) *Deutsche TierarztlWochenschr*, 114: 252-259.

Shotwell, O., Hesseltine, L. C. W., Stubblefield, R. D. 1966. Production of aflatoxin on rice. *Appl. Microbio*l. 15425.

Smith, J. W. and Hamilton, P.B. 1970. Aflatoxicosis in the broiler chicken. *Poult. Sci*., 49: 207-215.

Tropical Development and Research Institute (TDRI), 1984. Mycotoxin Training Manual,

Verma, J. Swain, B.K. Johri, T. S. 2002. Effect of various levels of Aflatoxin and ochratoxin A and combinations thereof on protein and energy utilization in broilers. *J. Sci. Food Agric.*, 82, 1412-1417.

Wafaa .A.E., Mahmoud Essam E.H., 2013 Evaluation of the efficacy of feed additives to counteract the toxic effects of aflatoxicosis in broiler chickens. Research *Journal of Poultry Sciences 6(1): 1-12, 2013.*

Yiannikouris, A., Andre, G., Buleon, A., Jeminet, G., Canet, I., Francois,

J., Bertin, G. Jouany, J. P. 2004. Comprehensive conformational study of key interactions involved in zearalenone complexation with β-d-glucan. Biomacromolecules 5:2176–2185.

Zhao, J. Shirley, R.B. Dibner, J.D. Uraizee, F. and Officer, M., 2010. Comparison of hydrated sodium calcium aluminosilicate and yeast cell wall on counteracting aflatoxicosis in broiler chicks.*Poult. Sci*., 89:2147-2156.

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