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Evaluation the efficacy of different mycotoxin adsorbents on performance traits of breeder hens fed with graded levels of aflatoxin B_1

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Abstract

A study was conducted with an objective to compare the efficacy of bentonite (BT), *Spirulina platensis* (SP) and glucomannan mycotoxin binders (GMA) on aflatoxicosis in broiler breeders. Three levels of AF, three binders and combination of different levels of AF with binders were evaluated. The AF fed at the levels of 300, 400 and 500ppb for three periods, each with duration of three weeks in broiler breeders from 28 to 36 weeks of age. Inclusion of 500 AF in the diet significantly ($P \leq 0.05$) affected feed consumption and feed efficiency when compared to that of control. The results indicated no significant ($P \geq 0.05$) effect of AF on body weight when compared to that of control. The results showed dose dependent cumulative effects of AF on all the affected parameters. Among the binders, GMA showed better counteracting effect.

Keywords: bentonite; *Spirulina platensis*; glucomannan; broiler breeders; performance parameters.

Introduction

Contamination of poultry feeds with mycotoxins is one of the major problems associated with the feeding of poultry. Aflatoxins are a group of secondary metabolites produced by a certain species of fungus of the genus *Aspergillus* (especially *A. flavus* and *A. parasiticus*). These fungi are capable of growing and contaminating the grains and cereals at any time before and/or after the harvest, during storage, transportation and processing of feed ingredients and the formulated feeds after processing. Aflatoxin contamination of feedstuffs has been reported to be of a wide range from 1 to 900µg/kg in commonly used ingredients as well as mixed feed samples in developing countries (Mohanamba et al., 2007).

Poultry industry suffers greater economic losses due to the greater susceptibility of the species in comparison with other animals to the toxin apart from continuing intermittent occurrences in feeds (Fraga et al., 2007 and Thapa, 2008). Extensive research was conducted to counteract aflatoxicosis by physical, chemical, nutritional and biological approaches. Chemical adsorbents such as bentonites, zeolites and aluminosilicates have been tested. Clay materials have the capability to bind molecules of certain size and configuration only. It is postulated that the bentonite forms a complex with the toxin, thus preventing the absorption of aflatoxin across the intestinal epithelium. *Spirulina platensis*, a blue-green algae, is known to be a rich source of important nutrients including several vitamins, minerals, essential amino acids, essential fatty acids, source of carotenoids and possess profound antioxidant property (Verma et al., 2004).

It is known that dietary inclusion of modified mannanoligosaccharides (MOS), extracted from the cell wall of yeast, has some beneficial effects in preventing adverse effects of mycotoxins (Chandrashekharan, 2000). Yegani et al. (2006) reported that the feeding of mycotoxin contaminated grains decreased eggshell thickness. However, dietary supplementation with Glucomannan Mycotoxin Adsorbent (GMA) prevented this effect. Considering the above facts, an investigation was undertaken with the objective of studying the effects of graded levels of aflatoxin on production, reproduction of broiler breeders and to assess the efficacy of bentonite, *Spirulina platensis* and glucomannan as mycotoxin binders in counteracting the adverse effects of graded levels of aflatoxin in broiler breeders.

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Materials and Methods

The present study was carried out in with an objective of assessing the performance parameters of broiler breeder hens fed with aflatoxin and also to evaluate the counteracting effects of bentonite, *Spirulina platensis* and glucomannan as mycotoxin binding agents.

Experimental design

One hundred and ninety two broiler breeder hens with uniform body weight at the age of 16weeks were chosen and individually housed in Californian cages. They were fed with standard diets free from toxins till the start of experiment (28weeks). The hens were randomly divided into 48 groups of four birds each. Three such groups were fed with one of the experimental diets for three periods of 21 days each starting from 28th week. Each hen was fed at the rate of 160g/day throughout the study with *ad libitum* water supply. The hens were inseminated twice a week with the semen from those cocks fed with the corresponding experimental breeder diet as hens.

Experimental diets

Four levels of aflatoxin (0, 300, 400 and 500ppb) with two levels each of bentonite (0 and 1%), *Spirulina platensis* (0 and 0.1%) and Glucomannan mycotoxin adsorbent (0 and 0.2%) were incorporated into the basal diet in a 4 X 4 factorial manner, forming a total of 16 dietary treatment combinations. The basal diet was formulated using commonly available feed ingredients which were screened for AF prior to the formulation of diets. The experimental diets were prepared by adding required quantity of contaminated rice culture containing aflatoxin to arrive at the levels of 0, 300, 400 and 500ppb of AFB_1. Bentonite (1%), *Spirulina platensis* (0.1%) and Glucomannan mycotoxin adsorbent (0.2%) were used in the diets as sources of chemical, herbal and glucomannan extract mycotoxin binders, respectively. The formulated diets were analyzed for AF content to counter check the required levels. Basal diet was formulated as per BIS (1997) and compounded to meet the nutrient requirements of broiler chicks during the starter (0-3 wks) and finisher (4-5 wks) phases without inclusion of either aflatoxin or binder.

Changes in body weight

Hens were weighed individually at the start of the experiment (28th week) and at the end of the experiment (36th week).

Feed consumption

Feed offered was 160g/bird/day. Total feed consumption for each of the three periods studied was recorded. The cocks were also fed with corresponding treatment diets *ad libitum* throughout the study as that of hens.

Feed conversion ratio

Based on the egg production and quantity of feed consumed, the average feed efficiency was computed as the unit feed consumed to produce a unit of egg mass (kg feed/kg egg).

Statistical analysis

The data were analyzed using the General Linear Model procedure of Statistical Analysis System (SAS®) software (SAS Institute, USA, 2000). Period wise data were analyzed by 4 x 4 factorial manner. Overall period data were analyzed by repeated measurement design (Gill, 1985). Duncan multiple range test at 0.05 probability level was employed for comparison of the means (Duncan, 1955).

Results

Changes in body weight

The data obtained on mean body weight of broiler breeder hens fed with different levels of AF and toxin binders in the beginning and at the termination of the experimental periods are presented in Table 4.2. The mean squares from analysis of variance are shown in Table 1. Statistical analysis revealed that there is no significant ($P\geq0.05$) difference between body weights of broiler breeder hens belonging to different treatment groups at 28 weeks of age. This indicated the uniformity of birds selected for the experiment. The range of highest and lowest body weight recorded were 3010g and 2959g for 300 AF+GMA and control groups, respectively. At the end of the experiment, the analysis of variance indicated a non significant ($P\geq0.05$) difference in body weights of breeders at 36 weeks of age pertaining to different treatments. The maximum and minimum body weights recorded were control+BT (3445g) and 300 AF (3340g) groups, respectively.

Feed consumption

The data on feed consumption (g/day) in AF fed breeder hens and supplemented with bentonite, *Spirulina platensis* and GMA during different periods is presented in Table 2. During the first period the feed consumption (g/day) in all AF fed groups showed a significant ($P\leq0.05$) decrease compared to the control group. Among the binders fed groups without AF, the group GMA only showed a significant ($P\leq0.05$) increase in feed consumption compared to the control group. All the three levels of AF fed groups along with BT and GMA showed significant ($P\leq0.05$) increase in feed consumption compared to their respective control groups. All three levels of AF fed groups along with SP showed non significant (P≥0.05) differences in feed consumption compared to their respective control groups.

Table 1: Effect of binders on BW (g) of broiler breeders fed with different levels of aflatoxin

Description		Binder	Body weight (g)	
			28 weeks	36 weeks
Aflatoxin ppb	0	Nil	2959.58±12.67	3394.58±14.85
		BT	2990.67±10.78	3445.25±11.87
		SP	2968.67±10.67	3401.83±21.29
		GMA	2991.42±13.89	3409.00±23.10
	300	Nil	2964.75±10.67	3340.25±27.79
		BT	2992.33±8.09	3397.08±21.79
		SP	2975.75±13.22	3373.58±14.03
		GMA	3010.00±14.61	3403.25±17.32
	400	Nil	2989.08±10.77	3345.67±18.61
		BT	2993.67±11.33	3432.58±15.93
		SP	2981.58±9.80	3390.50±17.52
		GMA	2991.83±14.64	3401.83±15.86
	500	Nil	2974.83±7.40	3403.75±24.19
		BT	2984.58±11.25	3412.08±14.85
		SP	2987.75±11.77	3414.25±19.64
		GMA	3003.75±15.25	3366.58±24.30

AF: Aflatoxin B_1; BT: Bentonite (1%); SP: *Spirulina platensis* (0.1%); GMA: Glucomannan Mycotoxin Adsorbent (0.2%)

During the second period the feed consumption was significantly (P≤0.05) lower in all AF fed groups compared to that of control. Among the binders fed groups without AF, there was no significant (P≥0.05) difference when compared to that of the control. All three levels of AF fed groups along with BT and GMA showed significant (P≤0.05) increase in feed consumption, compared to their respective control groups. All three levels of AF fed groups along with SP showed a no significant (P≥0.05) difference in feed consumption values when compared to their respective control groups.

During the third period feed consumption values for 500 AF fed group showed a significant (P≤0.05) decrease when compared to that of control. Among the binders alone fed groups, the groups fed with BT only showed a significant (P≤0.05) decrease in feed consumption compared to that of control. All three levels of AF fed groups along with BT and SP showed non significant (P≥0.05) difference in feed consumption values compared to their respective control groups. Values ranged from 156g to 158g. The 500 AF+GMA group showed significantly (P≤0.05) higher feed consumption, compared to their respective control group.

Feed efficiency

The feed efficiency measured as kg of feed consumed to produce a kg of egg mass in breeder hens subjected to different dietary treatments is presented in Table 4.6 and depicted graphically in Fig. 4.3. The mean squares from analysis of variance are showed in Table 4.7. During the first period all three AF fed groups (300, 400 and 500ppb) showed significantly (P≤0.05) poor feed efficiency values of 3.60, 3.75 and 3.92, respectively when compared with 3.33 of control group and they differed significantly (P≤0.05) with each other. Similar feed efficiency as that of control group was observed when binders alone were included in the diets of breeder hens. The groups fed with AF at different levels when treated with BT, SP and GMA showed no significant (P≥0.05) improvement in their feed efficiency. During the second period the same

Table 2: Effect of binders on feed consumption (g/day) of broiler breeders fed with different levels of aflatoxin

Description		Periods			
		Binder	I	II	III
Aflatoxin ppb	0	Nil	157.00 ± 0.28^{b}	158.00 ± 0.28^{a}	158.66 ± 0.16^{a}
		BT	157.33 ± 0.16^{ab}	157.33 ± 0.16^{abc}	157.33 ± 0.16^{b}
		SP	157.66 ± 0.16^{ab}	157.66 ± 0.16^{ab}	158.66 ± 0.16^{a}
		GMA	158.00 ± 0.28^{a}	158.00 ± 0.28^{a}	158.00 ± 0.28^{ab}
	300	Nil	155.00 ± 0.28^{c}	156.66 ± 0.16^{c}	158.00 ± 0.28^{ab}
		BT	157.00 ± 0.28^{b}	158.00 ± 0.28^{a}	158.00 ± 0.28^{ab}
		SP	155.00 ± 0.28^{c}	156.66 ± 0.16^{c}	158.00 ± 0.28^{ab}
		GMA	157.00 ± 0.28^{b}	158.00 ± 0.28^{a}	158.66 ± 0.16^{a}
	400	Nil	154.66 ± 0.16^{c}	157.00 ± 0.28^{bc}	158.00 ± 0.28^{ab}
		BT	157.00 ± 0.28^{b}	158.00 ± 0.28^{a}	158.00 ± 0.28^{ab}
		SP	154.66 ± 0.16^{c}	157.00 ± 0.28^{bc}	158.00 ± 0.28^{ab}
		GMA	157.00 ± 0.28^{b}	158.00 ± 0.28^{a}	158.66 ± 0.16^{a}
	500	Nil	154.33 ± 0.44^{c}	154.66 ± 0.33^{d}	156.11 ± 0.35^{c}
		BT	157.00 ± 0.28^{b}	158.00 ± 0.28^{a}	156.11 ± 0.35^{c}
		SP	154.33 ± 0.44^{c}	154.66 ± 0.33^{d}	156.11 ± 0.35^{c}
		GMA	157.00 ± 0.28^{b}	158.00 ± 0.28^{a}	158.66 ± 0.16^{a}

Means within each column bearing common superscript do not differ significantly (P≤0.05); AF: Aflatoxin B_1; BT: Bentonite (1%); SP: *Spirulina platensis* (0.1%); GMA: Glucomannan Mycotoxin Adsorbent (0.2%); Periods: I: 28-30 weeks; II: 31-33 weeks; III: 34-36 weeks

Table 3: Effect of binders on feed efficiency (kg feed/kg egg mass) of broiler breeders fed with different levels of aflatoxin

Description		Binder	Periods I	Periods II	Periods III
Aflatoxin ppb	0	Nil	$3.33±0.04^{d}$	$3.42±0.03^{d}$	$4.08±0.02^{b}$
		BT	$3.33±0.04^{d}$	$3.42±0.03^{d}$	$4.08±0.02^{b}$
		SP	$3.33±0.04^{d}$	$3.42±0.03^{d}$	$4.08±0.02^{b}$
		GMA	$3.33±0.04^{d}$	$3.42±0.03^{d}$	$4.08±0.02^{b}$
	300	Nil	$3.60±0.03^{c}$	$3.71±0.03^{c}$	$4.15±0.03^{b}$
		BT	$3.60±0.03^{c}$	$3.71±0.03^{c}$	$4.15±0.03^{b}$
		SP	$3.60±0.03^{c}$	$3.71±0.03^{c}$	$4.15±0.03^{b}$
		GMA	$3.60±0.03^{c}$	$3.71±0.03^{c}$	$4.15±0.03^{b}$
	400	Nil	$3.75±0.01^{b}$	$3.88±0.01^{b}$	$4.17±0.01^{b}$
		BT	$3.75±0.01^{b}$	$3.88±0.01^{b}$	$4.17±0.01^{b}$
		SP	$3.75±0.01^{b}$	$3.88±0.01^{b}$	$4.17±0.01^{b}$
		GMA	$3.75±0.01^{b}$	$3.88±0.01^{b}$	$4.17±0.01^{b}$
	500	Nil	$3.92±0.01^{a}$	$4.03±0.01^{a}$	$4.36±0.04^{a}$
		BT	$3.92±0.01^{a}$	$4.03±0.01^{a}$	$4.36±0.04^{a}$
		SP	$3.92±0.01^{a}$	$4.03±.0.01^{a}$	$4.36±0.04^{a}$
		GMA	$3.92±0.01^{a}$	$4.03±0.01^{a}$	$4.36±0.04^{a}$

Means within each column bearing common superscript do not differ significantly (P≤0.05); AF: Aflatoxin B_1; BT: Bentonite (1%); SP: *Spirulina platensis* (0.1%); GMA: Glucomannan Mycotoxin Adsorbent (0.2%); Periods: I: 28-30 weeks; II: 31-33 weeks; III: 34-36 weeks.

trend as that of first period continued. The values ranged from 3.42 to 4.03 in this period. During the third period all three AF fed groups (300, 400 and 500ppb) showed significantly (P≤0.05) poor feed efficiency compared to the control group. The groups which received binders alone in their diets had similar feed efficiency as that of control group, which in turn did not differ significantly (P≥0.05) from 300 and 400 AF fed groups with and without binders. Further, AF fed groups (at different levels) when treated with BT, SP and GMA showed no significant (P≥0.05) difference in their respective feed efficiency levels. The values ranged from 4.15 to 4.36 in this period.

Discussion

Changes in body weight

The AF at levels of 300, 400 and 500ppb fed to broiler breeders from 28 to 36 weeks of age did not significantly (P≥0.05) affect the body weight at 36 weeks of age. This is in agreement with the findings of Yegani et al. (2006) who reported no significant change in BW of broiler breeders fed with mycotoxin. Similar observation on body weight was also reported bymany investigators (Iqbal et al., 1983; Zaghini et al., 2005; Pandey and Chauhan, 2007; Thapa, 2008) in layer chicken fed with 1.00 to 5.00ppm of AF from 4 to 40 weeks. However, Sims et al. (1970) found significant (P≤0.05) decrease in body weight in laying hens fed with 2.0 to 8.00ppm of AF for 29 days. Similarly, feeding AF (500ppb) to layer chicken from 15 to 67 weeks of age reduced the body weight (Kim et al., 2003).

The possible reasons for the non-significant (P≥0.05) effect of AF on body weight would be due to the dose at which it is fed in the diet may not be sufficient to reduce the body weight or the birds (colored broiler breeders) are more tolerant to AF at these levels.

Feed consumption

The results of the present investigation showed that AF at all levels in the diet decreased significantly (P≤0.05) feed consumption of breeder hens during the first two periods (28-30 and 31-33 weeks) whereas only AF 500 significantly (P≤0.05) decreased feed consumption in the third period (34-36 weeks). This could be due to the fact that the birds get used to the toxic effect of the lower doses by the time the experiment entered the third period. Further, feeding of 500 AF significantly (P≤0.05) reduced feed consumption clearly indicating its toxic effect on the breeders. Upon incorporation of binders alone in the diet, significant (P≤0.05) improvement in feed consumption was noticed only in GMA group in the first period while BT and SP in the third period. Feeding of AF+BT diet significantly (P≤0.05) increased the feed consumption of breeder hens during the first two periods only while in AF+GMA increased the feed consumption of breeder hens during the third period only. Bentonite, a layered aluminosilicate being a nonnutritive sorptive material, reduces absorption of the fungal metabolites in GIT by forming an inert, stable and insoluble complex with AF which is assumed to be responsible for preventing toxin absorption and is excreted in the faeces (Miazzo et al., 2005). This property of bentonite triggered indirectly the hens to consume more feed even in the presence of AF. The increased feed consumption in AF+GMA groups could be due to binding of AF and subsequent prevention of hepatic damage. It is hypothesized that the glucomannan matrix of modified–MOS preparations traps the mycotoxins in an irreversible way (Afzali, 1998). This finding supports the results of the present experiment. Similar result was also reported by Raju and Devegowda (2000) on broilers. Further, many investigators opined that significant drop in feed consumption with AF feeding is a constant observation in commercial broilers (Rajendra, 1993; Manafi et al., 2011). In contrast, a non significant effect of *Fusarium* mycotoxins contaminated diets on feed consumption was observed in commercial layers and broiler breeders, respectively by Chowdhury and Smith (2004) and Yegani et al. (2006). The probable reason for the variation in results reported could be attributed to differences in the source of contamination (natural and purified), using a single source of mycotoxin compared with a blend of contaminated grains, and the level and duration of exposure in different experiments.

Feed efficiency

The results of the present investigation on feed consumption among all AF fed hens (300, 400 and 500ppb) showed significant ($P \leq 0.05$) reduction in feed efficiency in the first two periods. In the third period, only hens fed with 500 AF showed significantly ($P \leq 0.05$) reduced feed efficiency with respect to egg production. Feeding of AF+binders in the diets of breeders did not influence their feed efficiency positively. Afzali (1998) reported a numerical improvement of feed efficiency in broiler breeder hens fed with AF and modified MOS for 12 weeks. The current study indicated that binders are not effective in improving feed efficiency of egg production in broiler breeders. This is similar to the findings of Iqbal et al. (1983), Muthiah et al. (1998) and Pandey and Chauhan (2007) in commercial layers. Chowdhury and Smith (2004) reported that feed efficiency decreased when layers were fed *Fusarium* mycotoxins contaminated diets compared with controls and supplementation of GMA increased the feed efficiency values.

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