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Effects of Yeast Glucomannan on Performance of Broiler Chickens

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ABSTRACT

A total of 720 days-old Ross chicks with average live weight of 58 g were used to evaluate the effects of yeast glucomannan on performance of growing broiler chicks given a naturally contaminated (184 µg aflatoxin kg^{-1}) maize-soybean meal basal diet. Birds were divided at random into 24 replicates of 30 chicks each having equal number of males and females. Four dietary treatments were prepared. Birds were equally divided into four groups (A, B, C & D). Each group had 180 birds (90 males & 90 females) in six replicates (pens) and was assigned to one of the four dietary treatments in a randomized complete block design experiment. Treatments consisted of a control (0 g glucomannan kg^{-1} diet) group and three test groups with 0.5, 1 and 1.5 g glucomannan kg^{-1} diet, respectively. Feed and water provided *ad libitum*. The parameters measured were feed intake, weight gain, feed conversion ratio, mortality, efficiency index and relative weight of liver. Supplementation of glucomannan increased feed intake, which was not statistically significant between treatments during the 42 days experiment. It, however, tended to be the lowest for the control group. Glucomannan added to the aflatoxin-containing diet at 1 and 1.5 g kg^{-1} significantly improved live weight, feed conversion ratio and efficiency index and significantly reduced the weight of liver and mortality. Results of this research revealed that glucomannan added to the aflatoxin containing diet at 0.5, 1 and 1.5 g kg^{-1} improved performance in broiler chickens. Performance significantly improved by increasing the concentration of glucomannan in diets. Birds given diet containing 1 and 1.5 g glucomannan kg^{-1} had significantly higher performance than birds given diet including 0.5 g glucomannan kg^{-1}. In general, however, concentration of 1 g glucomannan kg^{-1} diet was more effective than concentrations of 0.5 and 1.5 g kg^{-1} diet.

Key Words: Aflatoxin; Broiler chickens; Feed conversion; Efficiency; Weight gain

INTRODUCTION

Mycotoxins are the toxic metabolites, produced by certain strains of fungi during the metabolism of nutrients present in feed ingredients and feeds. Aflatoxins are group of closely related mycotoxin that can be produced by three species of *Aspergillus; A. flavus, A. parasiticus* and the rare *A. romius* growing on a variety of feedstuffs, mainly maize, peanuts and cottonseed (Dersjant-Li *et al.,* 2003). Aflatoxins B_1 (AF B_1) is produced by certain strains of fungi in greater quantities than in others (Akande *et al*., 2006; Denli & Okan, 2006). Among aflatoxins, AFB_1 is an extremely hepato-toxic and carcinogenic compound (Girish & Devegowda, 2006). Aflatoxin B_1 is more predominantly found than others and is the most toxic type to poultry and frequently contaminates animal's feeds at low levels.

The stability of B_1 to thermal and chemical treatment increases its potential. Aflatoxins cause a variety of effects in poultry including decreased feed utilization, poor growth, egg production and break in immunity. Even small amounts of AFB_1 in feeds may cause poor growth, hatchability and increase susceptibility to disease. Liver damage and bleeding decreased egg production and overall performance and suppressed immunity have been noted in animals consuming relatively low dietary levels of aflatoxin (Denli *et al*., 2004; Zaghini *et al*., 2005; Denli & Okan, 2006). High dosages cause acute loss of appetite, depression, haemorrhage, diarrhoea and death.

Susceptibility of animals to aflatoxins varies with species and age. Among poultry, ducks and turkey poults are more susceptible for aflatoxicosis than any other species. In general, younger animals are more susceptible than adult animals. Broilers are more susceptible than layers. Significant reduction in body weight and feed efficiency has been reported in broiler chicken fed diet with AFB_1 at 80 µg kg^{-1} (Denli & Okan, 2006) and 78 and 170 µg aflatoxin kg^{-1} diet (Afzal & Saleem, 2004). Similar effects reported by Mani and Sundaresan (1998), Ledoux *et al*. (1999),

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Pimpukdee *et al*. (2004), Girish, and Devegowda (2006). The Food and Drug Administration (FDA) of United States and European Union (EU) set maximum allowable levels of aflatoxins at 20 and 2 μg kg^{-1} diet, respectively. However, there is no safe level and risk depends on the amount of aflatoxins and also on presence of other mycotoxins in the feed.

Several nutritional, physical, chemical and biological approaches have been proposed to detoxify mycotoxin contaminated feed and feedstuffs. Bentonite (Santurio *et al*., 1999; Rosa *et al*., 2001), hydrated sodium calcium aluminosilicate (HACAS) (Scheideler, 1993; Jindal *et al*., 1993), Zeolite (Miazzo *et al*., 2000), activated charcoal (AC) (Jindal *et al*., 1994; Edrington *et al*., 1997), inorganic sorbents (Baily *et al*., 1998) and a blend of organic acids and aluminosilicates (Mahesh & Devegowda, 1996) have shown considerable promise in detoxifying aflatoxins in contaminated feeds. A live yeast, *Sacchromyces cerevisiae,* (Celik *et al*., 2001; Aravind *et al*., 2003) was found to alleviate the adverse effects of aflatoxins in poultry. Advances in biotechnology have opened a new venue preventing mycotoxicosis. A natural organic product, esterified glucomannan a cell wall derivative of *Sacchromyces cerevisiae,* have shown considerable binding ability with several commonly occurring mycotoxins (Devegowda & Murthy, 2005) and is also found beneficial as a low-inclusion binder in minimizing the adverse effects of aflatoxins present in contaminated livestock and poultry feeds (Raju & Devegowda, 2000; Dvorska & Surai, 2001; Aravind *et al*., 2003; Murthy & Devegowda, 2004; Karaman *et al.*, 2005; Girish & Devegowda, 2006).

The present trial was conducted to evaluate the ability of the glucomannan-containing yeast product (Maycosorb) added to a naturally aflatoxin contaminated diet on the performance of broiler chicks.

MATERIALS AND METHODS

A total of 720 days-old broiler chicks (Ross, with average live weight of 58 g) were divided at random into 24 replicates of 30 chicks each having equal number of males and females. All birds were given a naturally contaminated (184 μg aflatoxin kg^{-1}) maize-soybean meal basal diet, formulated to meet all requirements for nutrients (Table I). Four dietary treatments were prepared. All birds were equally divided into four groups (A, B, C & D). Each group had 180 birds (90 males & 90 females) in six replicates (pens). The birds of each group were assigned to one of the four dietary treatments in a randomized complete block design. Treatments consisted of a control group (A), with no additive and three test groups (B, C & D) with 0.5, 1 and 1.5 g glucomannan-containing yeast product (Mycosorb) kg^{-1} diet, respectively (Table II). Mycosorb is a trademark of Alltech, Inc., that has been registered with the U.S. trademark office. Floor pens were bedded with rice hulls. A broiler starter diet was offered days 1-10, a grower diet days 11–28 and a finisher feed days 29 to 42. Diets were adjusted for energy and nutrients level corresponding to starter, grower and finisher broiler requirements.

All birds were vaccinated against New Castle disease (B1 at 8 d & Lasota at 17 d.), Bronchitis disease at 11 d and Gumboro disease at 13 and 27 d of age. Temperature and lighting regimen were in accordance with recommendation of the Ross commercial broiler chicken. Feed and water provided *ad libitum*. Chicks were individually weighed at the end of week and feed consumption for each pen was measured weekly. Cumulative weight gain and feed intake were determined; whereas, weekly and cumulative feed conversion ratios were calculated. Feed intake and feed conversion was adjusted for mortalities when appropriate. At the end of experimental period, 12 birds (6 males & 6 females) in each treatment were humanely euthanized and livers were removed and weighed. All experimental chicks acquired, retained and used in compliance with the national laws and regulations of the I.R. of Iran. The naturally contaminated maize and soybean meal were obtained from a commercial feed mill and mixed with the other feed ingredients used in formulating diet. Three representative samples of diet were collected at 5, 21 and 35 days of experiment and aflatoxin concentrations were measured. The average aflatoxin concentration in diet was 184 μg kg^{-1}. Results were subjected to analysis of variance for randomized complete block designs with four dietary treatments and six repetitions.

RESULTS AND DISCUSSION

Aflatoxins are a cause of concern in the poultry industry, because of their toxicity and frequent occurrence in feedstuffs (Denli *et al*., 2004; Tessari *et al*., 2006). Feed contaminated with aflatoxins can cause significant economic losses to the poultry industry due to the lower efficacy in animal production. Broilers are fed with compounded diets that are combination of several feed ingredients grown in different agro-climatic conditions. Most of the required maize and soybean meal for poultry production are imported, and these feedstuffs are mainly contaminated during transportation and storage process. The aflatoxin content of most poultry feedstuffs is higher than maximum allowable level of 20 μg kg^{-1} diet. The United States Food and Drug Administration (FDA) set regulatory levels for poultry feeds for 20 μg kg^{-1} aflatoxin (Aravind *et al*., 2003). Denli and Okan (2006) reported that inclusion of AFB_1 at 80 μg kg^{-1} diet resulted in a significantly lower body weight gain and feed efficiency and increased weight of the liver in broilers. Afzal and Saleem (2004) also recorded significant decreased body weight gain in broiler chicken fed contaminated feed at both

Table I. Ingredients and nutrient composition of the diets

Ingredients (kg ton^{-1} diet)	Feed		
	Starter (1–10 days)	Grower (11–28 days)	Finisher (29–42 days)
Maize	542.5	563.4	491.2
Soybean meal	373.3	351.5	258
Wheat	-	-	149.6
Fish meal	-	-	23.2
Vegetable oil	35.2	42	42.3
Sodium Chloride	2.4	2.5	2.4
De Calcium Phosphate	20	18	14
Sodium Bicarbonate	2	2.1	1.6
Vitamins and Minerals	5	5	5
Dl-methionine	3.5	2.5	1.6
L-lysine (Hydrochloride)	3.2	1.5	0.6
Sea shell meal	12.9	11.5	10.5
Nutrients:			
ME (MJ/kg DM)	12.08	12.19	12.54
Crude protein (g kg^{-1} DM)	216	198.5	180
L-lysine (g kg^{-1} DM)	14.2	11.9	11
Methionine (g kg^{-1} DM)	6.6	5.8	5
TSAA* (g kg^{-1} DM)	10.2	8.9	7.7
Tryptophan (g kg^{-1} DM)	8.2	8.6	7.8
Treonine (g kg^{-1} DM)	7.6	8.6	8.7
Ca (g kg^{-1} DM)	11	9	8.4
P available (g kg^{-1} DM)	5.3	4.5	4.5
Na (g kg^{-1} DM)	1.9	1.7	1.7
K (g kg^{-1} DM)	8.5	7.9	8.3
Cl (g kg^{-1} DM)	2.1	2.1	2.2
Anion/Cation	231	194	217

* Total Sulphur Amino Acids

Table II. Test diets and use rates

Dietary treatment	Description	Use rate (g kg^{-1} diet)
A (Control)	No additive	0
B	Mycosorb	0.5
C	Mycosorb	1
D	Mycosorb	1.5

Table III. Effect of glucommnan-containing yeast product (Mycosorb) on broiler performance and efficiency at 42 days of age

	Control group (A)	0.5 g kg^{-1} diet (B)	1 g kg^{-1} diet (C)	1.5 g kg^{-1} diet (D)
Number of Birds	180	180	180	180
Feed intake (kg/bird)	3.729^{a}	3.755^{a}	3.759^{a}	3.765^{a}
Live weight (kg/bird)	1.950^{a}	2.003^{ab}	2.076^{b}	2.095^{b}
Feed conversion (kg/kg)	1.91^{a}	1.87^{ab}	1.81^{b}	1.80^{b}
Mortality (%)	2.8^{a}	1.7^{b}	1.2^{c}	1.2^{c}
Efficiency Index	236^{a}	250^{b}	270^{c}	275^{c}
Liver weight (g/bird)	53^{a}	51.2^{ab}	49.6^{b}	49^{b}

^{abcd} values within each row with different superscripts differ significantly ($P < 0.05$)

78 and 170 µg aflatoxin kg^{-1} diets. They also reported significant mortality in broilers given feed containing 170 µg aflatoxin kg^{-1} diet. Most of the pervious works on the effect of Mycosorb are the studies where aflatoxin was added to the diet at required concentrations. In contrast, present experiment was conducted to study the effect of Mycosorb on a naturally aflatoxin contaminated diet.

The means of feed intake, live weight, feed conversion ratio, mortality, efficiency index and the weight of liver are presented in Table III. Addition of Mycosorb to the naturally contaminated diet significantly improved the performance of broilers. Feed consumption increased by addition of Mycosorb, but was not statistically different between treatments during the 42 days experiment, however tended to be lowest for the control group (Fig. 1). The results showed that supplementation of 0.5, 1 and 1.5 g Mycosorb kg^{-1} diet increased feed intake by 0.7, 0.8 and 1%, respectively. Raju and Devegowda (2000) reported that supplementation of 1 g kg^{-1} Mycosorb to the diet containing 0.3 mg aflatoxin kg^{-1} caused 1.6% increase in feed intake of broiler chicks. Similar result has been recorded by Girish and Devegowda (2006).The live weight of birds in group given diet with 0.5 g Mycosorb was higher compared to the birds in control (0 g Mycosorb kg^{-1} diet) group, but was not statistically different ($P>0.05$). Live weight increased ($P<0.05$) by increasing the concentration of Mycosorb in diets. Birds in groups given diets with 1 and 1.5 g Mycosorb kg^{-1} showed higher ($P<0.05$) live weight than birds in control group (Fig. 2). The results of this experiment showed that live weight of birds in groups given diets with 0.5, 1 and 1.5 g Mycosorb kg^{-1} increased by 2.72, 6.46 and 7.44%, respectively. The beneficial effects of yeast glucomannan on performance of broilers have been reported earlier by Raju and Devegowda (2000), Swamy *et al.* (2002), Aravind *et al.* (2003), Karaman *et al.* (2005) and Girish and Devegowda (2006). Raju and Devegowda (2000) studied the influence of modified glucomannan (Mycosorb) on performance in broilers exposed to aflatoxin (0.3 mg kg^{-1}) and reported that addition of Mycosorb (1 g kg^{-1} diet) increased body weight by 2.26%. Karaman *et al.* (2005) evaluate the detoxifying effect of yeast glucomannan on aflatoxicosis in broilers and reported that yeast glucomannan added to the aflatoxin containing diet at 0.5 and 1 g kg^{-1} diminished the severity of pathological changes, slightly and moderately, respectively. Girish and Devegowda (2006) also evaluate the effects of modified glucomannan (Mycosorb) and hydrated sodium calcium aluminosilicates (HSCAS) to reduce the individual and combined toxicity of aflatoxin and T-2 toxin in broiler chickens and showed that supplementation of Mycosorb (1 kg ton^{-1} of feed) improved ($P<0.05$) live weight gain. These beneficial effects of Mycosorb might be attributed to its ability to trap the mycotoxins in the gastrointestinal tract (Girish & Devegowda, 2006).

Mycosorb supplementation improved feed efficiency. The feed conversion ratio of birds in group given diet with 0.5 g Mycosorb kg^{-1} was lower compared to the birds in control (0 g Mycosorb kg^{-1} diet) group, but was not statistically different ($P>0.05$). Feed conversion ratio decreased ($P<0.05$) by increasing the concentration of Mycosorb in diets. Birds in

Table IV. Effect of Mycosorb on percentage improvements in live weight, feed conversion and efficiency index relative to control group

Treatments	Live weight		Feed conversion		Efficiency index	
	kg bird^{-1}	(% change)	kg kg^{-1}	(% change)	—	(% change)
A (Control)	1.950	-----	1.91	-----	236	-----
B (0.5 g/kg diet)	2.003	2.72	1.87	2.09	250	5.93
C (1 g/kg diet)	2.076	6.46	1.81	5.24	270	14.41
D (1.5 g/kg diet)	2.095	7.44	1.80	5.76	275	16.53

Fig. 1. Effect of treatments on cumulative feed intake (1-42 days)

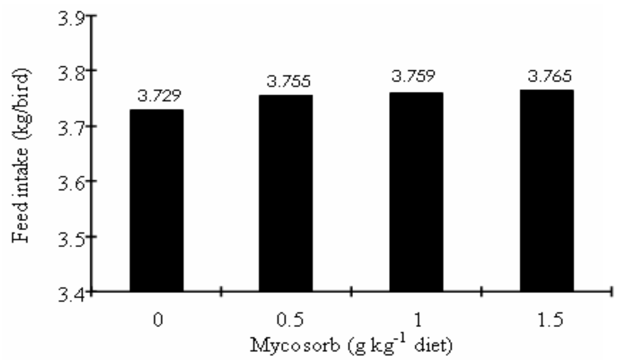
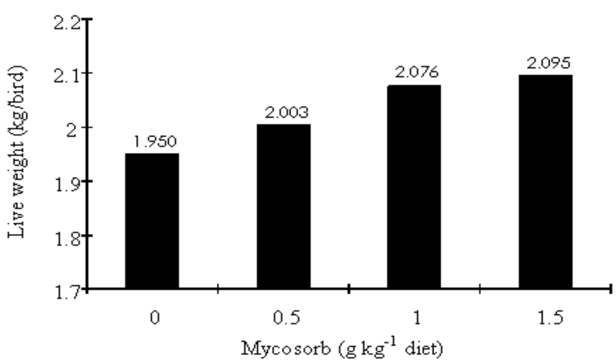


Fig. 2. Effect of treatments on live weight at 42 days of age



groups given diets with 1 and 1.5 g Mycosorb kg^{-1} showed lower ($P<0.05$) feed conversion ratio than birds in control group (Fig. 3). Inclusion of Mycosorb reduced feed conversion by 2.09, 5.24 and 5.47% in treatments with 0.5, 1 and 1.5 g Mycosob kg^{-1} diet, respectively. Similar effects were reported by Valarezo *et al.* (1998), Raju and Devegowda (2000), Aravind *et al*. (2003), Oguz and Parlat (2004) and Girish and Devegowda (2006). Raju and Devegowda (2000) reported that inclusion of 1 g kg^{-1} Mycosorb to the diet containing 0.3 mg aflatoxin kg^{-1} reduced feed conversion ratio by 2.63% and Valarezo *et al.* (1998) also recorded 2.95% reduction in feed conversion ratio.

Mortality reduced by supplementation of Mycosorb (Table III). Mortality was lower ($P<0.05$) in groups fed diets with 1 and 1.5 g Mycosorb kg^{-1} diet. Mortality of birds in

Fig. 3. Effect of treatments on feed conversion ratio (1- 42 days)

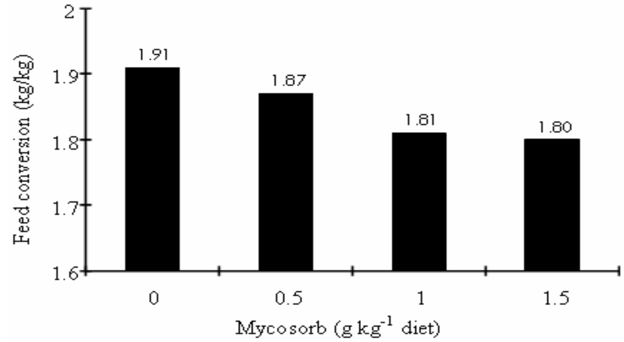
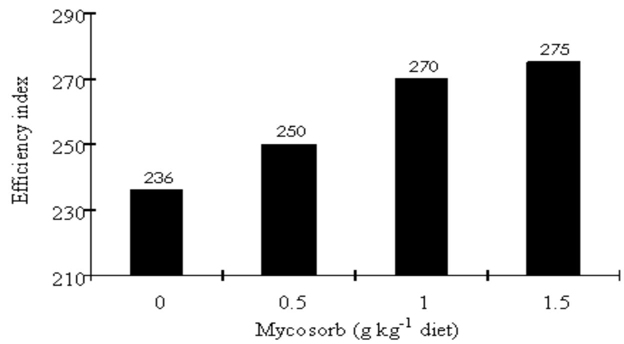


Fig. 4. Effect of treatments on efficiency index [(live weight (kg) X % survival rate)/ (feed conversion X days of age)] X 100



groups given 1 and 1.5 g Mycosorb kg^{-1} diet was similar. This observation support earlier report of Girish and Devegowda (2004) for decreased mortality in broiler chicks.

The efficiency index calculations were higher ($P<0.05$) for treatments with Mycosorb compared to the control treatment. Efficiency index improved ($P<0.05$) by increasing the concentration of Mycosorb in diets. Birds given diet with 1 and 1.5 g Mycosorb kg^{-1} had higher ($P<0.05$) efficiency index than birds given diet with 0.5 g Mycosorb kg^{-1}. However, there was not difference ($P>0.05$) between birds fed diet with 1 and 1.5 g Mycosorb kg^{-1} (Fig. 4).

The weight of the liver decreased ($P<0.05$) with addition of the Mycosorb compared to the control. There was not difference ($P>0.05$) for weight of the liver among treatments given 0.5, 1 and 1.5 g Mycosorb kg^{-1} diet, but the relative weight of liver reduced by increasing the concentration of Mycosorb in the diet (Table III). This observation supports the earlier works of Raju and Devegowda (2000), Aravind *et al.* (2003) and Girish and Devegowda (2006). Raju and Devegowda (2000) supplemented the diet containing 0.3 mg aflatoxin kg^{-1} by 1 g Mycosorb kg^{-1} and reported that weight of the liver decreased by 32.5%. However, Girish and Devegowda (2004) tested two dietary levels of aflatoxin (0 & 2 mg kg^{-1} diet) and reported that aflatoxin increased the relative weight of liver by 21.72%, but supplementation of Mycosorb (1 g kg^{-1} diet) restored the weight of the liver.

Aravind *et al.* (2003) also recorded higher relative weight of liver in birds given a naturally contaminated diet containing 168 µg aflatoxin kg^{-1}. The precise mode of action of glucomannan-containing yeast product in decreasing the weight of liver is not clear. It is hypothesized that it might trap the mycotoxin molecule in its glucomannan matrix and prevents toxin absorption from gastrointestinal tract and the subsequent toxin-induced tissue changes.

The principal finding from this research is that the glucomannan-containing yeast product (Mycosorb) added to the aflatoxin contaminated diet at 0.5, 1 and 1.5 g kg^{-1} improved performance and efficiency in broiler chickens. Performance and efficiency improved ($P<0.05$) by increasing the concentration of Mycosorb in diets (Tables III & IV). Birds given diet containing 1 and 1.5 g Mycosorb kg^{-1} had higher ($P<0.05$) performance and efficiency than birds given diet including 0.5 g Mycosorb kg^{-1}. However, in general, concentration of 1 g Mycosorb kg^{-1} diet was more effective than concentrations of 0.5 and 1.5 g kg^{-1} diet.

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