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Original article

EVALUATION OF MYCOTOXIN BINDER SUPPLEMENTATION ON PRODUCTION PARAMETERS AND ORGAN WEIGHTS IN TOULOUSE GEESE WITH EXPERIMENTAL AFLATOXICOSIS

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Summary

Valchev, I., K. Stoyanchev, V. Marutsova, D. Kanakov, L. Lazarov, Ts. Hristov & R. Binev, 2022. Evaluation of mycotoxin binder supplementation on production parameters and organ weights in Toulouse geese with experimental aflatoxicosis. *Bulg. J. Vet. Med.,* **25**, No 1, 101–112).

The present study was undertaken to evaluate the beneficial effects of a mycotoxin binder (Mycotox NG 0.05%) in 40 day-old Toulouse geese from both sexes with experimental aflatoxicosis. The birds were reared from day one to 42 days of age on deep litter system and divided into four groups. Normal feed free of aflatoxin (AFB_1), was given to the control (Group 1). The feed of Group 2 was supplemented with 0.5 g/kg Mycotox NG, aflatoxin (0.5 mg/kg feed) was supplemented to the feed of Group 3 and Mycotox NG (0.05%) + 0.5 mg/kg AFB_1 – to the feed of Group 4. Production parameters (body weight gain, feed intake, feed conversion) and relative organ weights were recorded. The results showed that the total feed intake, final live weight of Mycotox NG + AFB_1 treated birds (Group 4) at 6 weeks of age were significantly increased ($P<0.01$) as compared to birds treated only with AFB_1 (Group 3). The total feed conversion ratio of the group given AFB_1 only (Group 3) at 6 weeks of age was significantly increased ($P<0.01$) compared to controls while in *Mycotox Ng* + AFB_1 treated birds (Group-4) it was significantly increased ($P<0.01$) by post treatment week 1 vs controls, but not as compared to birds treated with AFB_1 alone. There was a significant increase in relative weights of liver, kidneys, spleen, heart, pancreas, proventriculus and gizzard in birds fed only aflatoxin (Group 3). The co-administration of Mycotox NG (0.5 g/kg feed) with AFB_1 (Group 4) reduced the relative weights of thymus and bursa of Fabricius. The study concluded that dietary supplementation of Mycotox NG could partially neutralise aflatoxicity in geese.

Key words: aflatoxin B_1, Mycotox NG, performance, relative weights, Toulouse geese

INTRODUCTION

Mycotoxins are thermostable secondary toxic metabolites produced by some fungi. Toxin-producing fungi are globally spread. Their ability for growth and production of mycotoxins on various cereal crops makes them inevitable pollutants

along the food chain of animals and humans (Hassan *et al.,* 2012b; Saleemi *et al.,* 2015). Mycotoxins are dangerous for the health of domestic livestock and men and are a public health concern for more than 30 years (El-Katcha *et al.,* 2017). Among them, aflatoxins are very toxic metabolites produced mainly by *Aspergillus flavus, Aspergillus parasiticus* and *Aspergillus nomius* (Kim *et al.,* 2000). These toxic fungi are best developed in anaerobic conditions on damaged cereals (Saleemi *et al.,* 2017). The most important mycotoxins with respect to their toxicity and immunosuppressive effects are aflatoxins, ochratoxins, trichothecenes, DON and T-2 toxins (Berek *et al.,* 2001).

The public health important of aflatoxins is associated to their teratogenic, mutagenic, carcinogenic and immunosuppressive effects (Yunus *et al.,* 2011). Out of all isolated seventeen aflatoxins, B_1, B_2, G_1 and G_2 are the only 4 main metabolites found in naturally contaminated feeds (Saki *et al.,* 2018). These are coumarin derivatives with a dihydrofurofuran moiety. Aflatoxins are fluorescence compounds with specific features – aflatoxin B_1 (AFB_1) and aflatoxin B_2 (AFB_2) emit blue whereas aflatoxins G_1 and G_2 (AFG_1; AFG_2): yellow-green fluorescence under UV irradiation (Verma, 2004). The sensitivity of animals to aflatoxins is species- and age-dependent. Among domestic fowl, ducklings, goslings and turkey poults are reported to be the most sensitive to aflatoxin-induced toxicity (Kamalzadeh *et al.,* 2009). Aflatoxins are contaminants of cereal (wheat, corn sorghum) and oil crops (sunflower, soybean, peanut and cotton flours) (Shlej *et al.,* 2015). AFB_1 belongs to Group 1 carcinogens as classified by the International Agency for Research on Cancer (IARC). AFB_1 is a strong hepatotoxic and nephrotoxic agent for animals and birds (Hassan *et al.,* 2012a; Khan *et al.,* 2014). In poultry farming, aflatoxins cause enormous losses by impeding growth performance of birds, increasing feed conversion rates (Pasha *et al.,* 2007), reducing meat production (Fan *et al.,* 2013), and changing relative weights of visceral organs. They cause immunosuppression (Indresh *et al.,* 2013), higher mortality rates (Huff *et al.,* 1988), liver and kidney damage (Pappas *et al.,* 2014) and increased susceptibility to infectious diseases (Chang *et al.,* 1991). Contamination of forage crops and cereal foods could occur at any time pre- and post harvest, during storage, transportation and processing of food ingredients. Among aflatoxins B_1, B_2, G_1, and G_2, AFB_1 is recognised as the biologically most important component. Metabolites of aflatoxins are stable to degradation (Desphande, 2002). The maximum allowed level of AFB_1 contamination of poultry feeds stipulated by the European Commission is 0.02 mg/kg in order to protect birds from health hazards and prevent contamination of meat and meat products (Saminathan *et al.,* 2018).

For detoxication of mycotoxin-contaminated fodders, various strategies have been developed – heat inactivation, microbial degradation, physical separation, irradiation, treatment with various chemical agents. Most of these methods have two primary inconveniences: high costs of detoxication protocols and difficult achievement of complete aflatoxins removal without loss of nutritional value of feeds (Méndez-Albores *et al.,* 2007; Eshak *et al.,* 2010).

Studies aimed at evaluation of efficacy of various toxin binders added to feeds were carried out for as great as possible reduction of deleterious effects of contaminants on host biological systems (Shi

et al., 2009; Pappas *et al.,* 2014). Among the commonest chemical adsorbents used for binding mycotoxins through absorbing or degrading them, are activated charcoal, aluminosilicates (zeolites, hydrated sodium calcium aluminosilicate, clays), montmorillonites (minerals), sodium bentonite, chitosan polymers (Pappas *et al.,* 2014). The efficacy of mycosorbents was evaluated *in vivo* to determine their ability to bind mycotoxins and prevent health risks for broiler chickens by monitoring their productive traits, haematological and blood biochemical parameters and liver morphology (Che *et al.,* 2011; Liu *et al.,* 2011; Pappas *et al.,* 2014).

The present study was undertaken to evaluate the effects of aflatoxin B_1 alone or in combination with Mycotox NG on growth performance and relative weights of visceral organs (liver, kidneys, spleen, heart, thymus, bursa of Fabricius, pancreas, proventriculus and gizzard) in goslings.

MATERIALS AND METHODS

The experiment was carried out with forty day-old goslings from both sexes, Toulouse hybrid, allotted randomly in 4 groups (10 birds in each).

Control and experimental goslings were fed a balanced compound feed (starter and grower) according to their age, produced by Zara Furazhi Ltd, Stara

Table 1. Composition and nutritional value of compound feed for goslings

	Compound feed	
	Starter (0–4 weeks of age)	Grower (5–7 weeks of age)
Ingredients, %		
Corn	20%	20%
Wheat	45%	52%
Soybean meal – 46%	13%	3.5%
Sunflower meal – 34%	14%	14%
Wheat bran	2%	5%
Sunflower oil	1%	0.5%
Lysine	0.15%	0.1%
Oxyguard	0.01%	0.01%
БК 2111	4.5%	4%
Mycofix Select	0.05%	0.05%
Nutritional value		
Crude protein, g/kg	180.20	149.07
Metabolisable energy, kcal/kg	2764.39	2784.07
Crude ash, g/kg	57.30	49.12
Crude fibre, g/kg	59.16	57.91
Crude fat, g/kg	30.88	26.32
Calcium, g/kg	10.33	9.20
Phosphorus, g/kg	7.04	5.80
Lysine, g/kg	9.40	7.89
Methionine+cysteine, g/kg	5.08	7.18
Threonine, g/kg	6.67	5.50
Tryptophan, g/kg	2.09	1.71

Zagora (Table 1). The groups were as followed: Group I – control (basal diet); Group II – basal diet + 0.5 g/kg (0.05%) Mycotox NG containing micronised yeasts, montmorillonite, thymol (Ceva Sante Animale, France); Group III – basal diet + 0.5 mg/kg AFB_1 and Group IV: basal diet + 0.5 mg/kg AFB_1 + 0.5 g/kg Mycotox NG.

Aflatoxin B_1 used in the trials was produced by *Aspergillus flavus* (99% purity) and obtained from Sigma-Aldrich (Germany). All birds were housed under optimum microclimatic parameters in line with Ordinance №44/2006.

Live weight, average daily feed intake, average daily weight gain, feed conversion were monitored on experimental days 14, 28 and 42 by weighing. The weight gain for the respective period was calculated by subtraction of initial weight from the final weight of the period. Feed conversion rate (FCR) was calculated as quotient of feed intake and average daily weight gain. Feed intake for each group was determined as the difference between offered food and food remaining at the period of the period. Relative weights of visceral organs (liver, kidneys, spleen, heart, bursa of Fabricius, thymus, pancreas, proventriculus and gizzard) were determined after euthanasia of birds by cervical dislocation as per Ordinance 20/2012 using the formula: (organ weight/body weight) × 100%.

Experiments were approved by Permit No 201/07.01.2018 issued by the BFSA.

Statistical analysis of data was done by one-way ANOVA followed by Tukey-Kramer test ($P<0.05$).

RESULTS

Tables 2–5 present the effects of supplementation of the compound feed with AFB_1 and/or Mycotox NG on growth performance of goslings over 6 weeks. Goslings from Group III, whose diet was supplemented with 0.5 mg/kg AFB_1 showed significantly lower body weight on days 14, 28 and 42 vs controls ($P<0.001$). During the first monitoring period, body weight decreased by 21.41%. During the second (days 15–28) and third (days 29–42) periods observed changes were more obvious and body weight reduction was by 18.84% and 18.8%, respectively. In birds from group IV, that received 0.5 mg/kg AFB_1 and mycosorbent (Mycotox NG) at 0.5 g/kg, deleterious effects of AFB_1 on body weight were partly compensated ($P<0.05$ – $P<0.001$) and its reduction was by 12.46% on day 14, 10.11% by day 28 and 4.99% by day 42.

Compared to control group, weight gain during the first monitoring period (days 1–14) was reduced by 24.45% in Group III ($P<0.001$). During the next periods (days 15–28 and 29– 42) the weight gain was lower by 17.55% and 18.77% compared to Group I ($P<0.001$). After addition of the fungal inhibitor Mycotox NG to rations of goslings from Group IV, there was a tendency towards increased weight gain during the three monitoring periods compared to Group III. By the 14^{th} day, tested toxin binder reduced partly weight gain reduction and it was lower by 15.65% ($P<0.01$). By the 28^{th} day, the decrease was only by 7.58 % ($P<0.05$). At the end of the experiment, mycosorbent did not have a preventive effect on weight gain reduction ($P>0.05$).

Daily feed intake was reduced in Group III by 4.46 % during the first period ($P<0.001$), by 3.61 % during the second one ($P<0.001$), and by 5.43% ($P<0.001$) during the third period. In controls, fed intake was not significantly different between periods.

Feed intake per unit weight gain in Group III increased by 28.06% during the first period (P<0.001), by 18.45% during the second period (P<0.001) and by 16.32% during the last period (P<0.01). The group whose feed was supplemented with both 0.5 mg/kg AFB_1 and 0.5 g/kg Mycotox NG feed conversion rate increased by 18.97% on day 14 (P<0.01). Compared to controls, FCR on days 28 and 42 was insignificantly changed, by 5.03% and 2.04% respectively.

During the experiment, control goslings and those from group II, supplemented with 0.5 g/kg Mycotox NG, had similar body weight, weight gain, daily feed intake and feed conversion.

Relative weights of visceral organs (g/100 g body weight) are presented in Table 6. Data showed increased relative weights of organs in Group III as followed: liver by 20.45%; kidneys by 62.90%; heart by 28.26%; pancreas by 30.76%, proventriculus by 33.33%; gizzard by 25.68% and spleen by 53.33% vs controls (P<0.001). Relative weights of bursa of Fabricius and thymus were statistically significantly lower by 36.42% and by 16.67% respectively than those of untreated birds (P<0.001). The addition of the adsorbent to the ration of Group IV resulted in less pronounced increase in relative organ weights (by 10.90% for liver; by 14.51% for kidneys; by 8.69%

Table 2. Effect of aflatoxin B_1 (AFB_1) only or co-administered with Mycotox NG on body weight of goslings. Group I – control; group II – 0.5 g/kg Mycotox NG; group III – 0.5 mg/kg AFB_1; group IV –0.5 mg/kg AFB_1 + Mycotox NG. Data are presented as mean ± SEM; n=10

Groups	Live body weight (g)				
	Initial weight (g)	14 days of age	28 days of age	42 days of age	Difference, %
I	79.4±1.83	514±10.45	1386±25.35	2649±14.41	100
II	77.8±1 .68	515±12.40	1389±26.97	2653±13.25	+0.15
III	79.6±1.42	404±19.92[1c,2c]	1125±31.17[1c,2c]	2151±22.53[1c,2c]	-18.8
IV	79.6±1.42	450±8.02[1b,2c,3a]	1246±38.09[1a,2a]	2517±20.22[1c,2c,3c]	-4.99

*Difference from control group I; [a]P<0.05; [b]P<0.01; [c]P<0.001; 1 – vs control group; 2 –vs group I; 3 – vs group II.

Table 3. Effect of aflatoxin B_1 (AFB_1) only or co-administered with Mycotox NG on daily weight gain of goslings. Group I – control; group II – 0.5 g/kg Mycotox NG; group III – 0.5 mg/kg AFB_1; group IV –0.5 mg/kg AFB_1 + Mycotox NG. Data are presented as mean ± SEM; n=10

Groups	Daily weight gain (g)			
	14 days of age	28 days of age	42 days of age	Difference, %
I	31.01±0.71	62.28±2.16	90.21±2.21	100
II	31.22±0.97	62.06±2.05	90.06±1.89	-0.17
III	23.43±0.95[1c,2c]	51.35±1.65[1a,2a,2a]	73.28±2.34[1c,2c]	-18.77
IV	26.16±0.71[1b,2b]	57.56±2.56[1a,2a]	90.21±3.71[3c]	0

*Difference from control group I; [a]P<0.05; [b]P<0.01; [c]P<0.001; 1 – vs control group; 2 –vs group I; 3 – vs group II.

Table 4. Effect of aflatoxin B_1 (AFB_1) only or co-administered with Mycotox NG on daily feed intake of goslings. Group I – control; group II – 0.5 g/kg Mycotox NG; group III – 0.5 mg/kg AFB_1; group IV –0.5 mg/kg AFB_1 + Mycotox NG. Data are presented as mean ± SEM; n=10

Groups	Daily feed intake (g)			
	14 days of age	28 days of age	42 days of age	Difference, %
I	78.42±0.030	185.38±0.067	263.82±0.076	100
II	78.45±0.032	185.35±0.058	263.90±0.088	0
III	$74.93\pm0.016^{1c,2c}$	$178.69\pm1.40^{1c,2c}$	$249.52\pm1.072^{1c,2c}$	-5,43
IV	78.45 ± 0.025^{3c}	185.37 ± 0.064^{3c}	267.43 ± 0.093^{3c}	+1,36

*Difference from control group I; $^{a}P<0.05$; $^{b}P<0.01$; $^{c}P<0.001$; 1 – vs control group; 2 –vs group I; 3 – vs group II.

Table 5. Effect of aflatoxin B_1 (AFB_1) only or co-administered with Mycotox NG on feed conversion rate of goslings. Group I – control; group II – 0.5 g/kg Mycotox NG; group III – 0.5 mg/kg AFB_1; group IV –0.5 mg/kg AFB_1 + Mycotox NG. Data are presented as mean ± SEM; n=10

Groups	Feed conversion rate (g feed/g weight gain)			
	14 days of age	28 days of age	42 days of age	Difference, %
I	2.53±0.096	2.98±0.29	2.94±0.072	100
II	2.53±0.079	3.01±0.10	2.94±0.052	0
III	$3.24\pm0.12^{1c;2c}$	3.53 ± 0.12^{1c}	$3.42\pm0.11^{1b;2c}$	+16.32
IV	$3.01\pm0.085^{1b,2c}$	3.13 ± 0.19^{3c}	3.00 ± 0.10^{3a}	+2.04

*Difference from control group I; $^{a}P<0.05$; $^{b}P<0.01$; $^{c}P<0.001$; 1 – vs control group; 2 –vs group I; 3 – vs group II.

for the heart; by 15.38% for the pancreas; by 37.77% for the proventriculus, by 13.66% for the gizzard and by 33.33% for the spleen compared to controls ($P<0.05$ – $P<0.001$). Also, size of bursa of Fabricius was reduced by 16.05% and that of the thymus – by 12.5% than those in non-supplemented birds ($P<0.05$ – $P<0.01$). The addition of 0.5 g/kg Mycotox NG to ration of Group II had no adverse effect on relative weights on abovementioned organs ($P>0.05$).

DISCUSSION

Aflatoxin B_1 is the main metabolite produced by genus *Aspergillus* in most animal feeds (Subhani *et al.,* 2018). Poultry are fed feeds composed by various ingredients, produced under different agro meteorological conditions. Toxicogenic threat posed by aflatoxins depends on ingested dose and exposure duration, as well as on animal species, age and nutritional status. It is directly associated to absorption rate through the gastrointestinal tract and binding to serum proteins. In domestic poultry, intoxication with AFB_1 induces considerable economic losses from poor health status and productive performance (Saleemi *et al.,* 2010).

During the present experiment, mortality was not found in any of groups. Similar results are reported also by Subhani *et*

Table 6. Effect of aflatoxin B_1 (AFB_1) only or co-administered with Mycotox NG on relative weight of internal organs (g/100 g live weight) of goslings. Group I – control; group II – 0.5 g/kg Mycotox NG; group III – 0.5 mg/kg AFB_1; group IV –0.5 mg/kg AFB_1 + Mycotox NG. Data are presented as mean ± SEM; n=10

Groups	Liver	Kidneys	Heart	Bursa of Fabricius	Thymus
I	2.20± 0.028	0.62± 0.016	0.46± 0.004	0.162± 0.005	0.24± 0.008
II	2.20± 0.033[c]	0.64± 0.072	0.45± 0.006[c]	0.165± 0.005	0.25± 0.005
III	2.65± 0.081[1c,2b]	1.01± 0.013[1c,2c]	0.59± 0.008[1c,2c]	0.103± 0.003[1c,2c]	0.20± 0.004[1c,2a]
IV	2.44± 0.028[1c,2b,3b]	0.71± 0.012[1b,2b,3c]	0.50± 0.012[1c;2c,3c]	0.136± 0.005[1b,2b,3c]	0.21± 0.004[1a,2c,

Groups	Spleen	Pancreas	Proventriculus	Gizzard
I	0.15± 0.004	0.26± 0.004	0.45± 0.005	1.83± 0.015[1c]
II	0.16± 0.008	0.25± 0.001	0.45± 0.008	1.79± 0.023[c]
III	0.23± 0.003[1c,2b]	0.34± 0.005[1c,2c]	0.60± 0.009[1c,2c]	2.30± 0.030[1c,2c]
IV	0.20± 0.004[1a,2c,	0.30± 0.003[1c,2c;3c]	0.62± 0.013[1C,2c,3c]	2.08± 0.023[1c,2c,3c]

*Difference from control group I; [a]P<0.05; [b]P<0.01; [c]P<0.001; 1 – vs control group; 2 –vs group I; 3 – vs group II.

al. (2018) in broiler chickens after dietary treatment with 350 ppb AFB_1 alone or combined with 250 mg/kg or 500 mg/kg фураж algae (*Chlorella pyrenoidosa*).

In this study, dietary AFB_1 treatment (0.5 mg/kg) caused statistically significant reduction of body weight and other production traits. Similar deleterious effects were earlier reported in broiler chickens with experimentally reproduced aflatoxicosis B_1 (Liu *et al.,* 2016). The observed deterioration of growth performance in broiler chickens fed rations contaminated with aflatoxins could be attributed to ability of toxins to inhibit metabolism (Indresh *et al.,* 2013; Liu *et al.,* 2016; Saminathan *et al.,* 2018) and to suppress protein synthesis through competition with phenylalanine for binding site of phenylalanine-transfer RNA synthetase. Reduced feed intake is due to decreased appetite; a protective mechanism in aflatoxicosis (Rauber *et al.,* 2007; Indresh *et al.,* 2013) or to impaired liver metabolism consequently to liver damage (Yunus *et al.,* 2011). The presence of aflatoxins in poultry feeds decreases appetite and thus, growth rate (Nabi *et al.,* 2018). The lower feed intake consequently to ingestion of aflatoxin-contaminated feed by poultry is due to poorer utilisation of dietary protein and energy (Verma *et al.,* 2002), possibly as a result from impaired digestion and metabolism. On the other side, lower weight gain is a sequel from reduced protein synthesis rate (Verma *et al.,* 2002; Abdel-Ghany *et al.,* 2013), enhanced lipid faecal excretion, impaired absorption of nutrients, reduced secretion of pancreatic digestive enzymes (Nazarizadeh & Pour-

reza, 2019) and suppressed appetite (Shareef & Omar, 2012). Hasan *et al.* (2000) found out that the toxic effect of aflatoxins is characterised with lower weight gain as aflatoxins impaired normal metabolic pathways though inhibition of protein synthesis and enzyme system involved in carbohydrate and energy metabolism. Increased feed conversion is associated with reduced utilisation of feed nutrients (Kana *et al.,* 2014), anorexia, inhibition of protein synthesis and lipogenesis (Dhanapal *et al.,* 2014).

Aflatoxicosis induces abnormalities in some organs as liver and kidneys through increase in their relative weights (Mishra & Das**,** 2003). Liver is a target organ for the toxic effects of aflatoxins, as they accumulate in it and undergo conversion (Gowda *et al.,* 2004). In the liver, AFB_1 is bioactivated to 8,9 epoxide, which binds to proteins and DNA forming adducts damaging hepatic structures and causing increase in liver relative weight (Sridhar *et al.,* 2015). Increased liver weight is probably due to accumulation of lipids and impaired lipid transport under the influence of mycotoxins. Hepatic lipidosis is mainly mediated by inhibition of the synthesis of phospholipids and cholesterol. This also influences lipid transport through the organ (Manegar *et al.,* 2010). Increased relative weights of kidneys was probably due to increased fat deposition (lipaemia) (Sharghi & Manafi, 2011); hypertrophy of proximal kidney tubules with lymphoid cell infiltration (Nataraj *et al.,* 2004) or increased blood uric acid levels with subsequent urate deposition in kidney tubules (Pandey & Chauhan, 2007). Increased relative weight of the proventriculus and gizzard are attributed, on one hand, to the direct cytotoxic effect of aflatoxins on digestive organs during the digestion (Abousadi *et al.,* 2007), and on the other, could be a result from irritating effect of aflatoxins on gastrointestinal mucosa causing its inflammation and thickening (El-Ghany *et al.,* 2013). Spleen weight is believed to be a sensitive indicator of immunotoxicity (immune stimulation or depletion), stress, and physiological disturbances. In this study, the relative weight of the spleen increases in the group fed a diet contaminated with AFB_1 which is interpreted as a compensatory mechanism of reduced functional activity and lower bursa of Fabricius and thymus weights (Nabi *et al.,* 2018). Compared to control birds, relative weights of the latter organs were lower in birds treated with AFB_1 alone. This reduction of the weight of immunocompetent organs is probably due to necrosis and lower density of lymphoid cells (Sakhare *et al.,* 2007). The established increased relative weight of the heart in goslings from experimental group III is confirmed by previous studies with broiler chickens supplemented with AFB_1 (Nazarizadeh & Pourreza, 2019). Higher relative weight of the heart results from congestive events in the myocardium (Jakhar & Sadana, 2004).

Mycosorbents compensate the adverse effects of aflatoxins (Nabi *et al.,* 2018). The presented results showed that the tested concentration of Mycotox NG was able to bind AFB_1 molecules in the gastrointestinal tract of birds. These molecules are with aromatic hydrophilic structure characterised with high affinity for binding to mycosorbent surface (Boudergue *et al.,* 2009). The attachment of aflatoxins to toxin binders is based on the electrical polarity principle – negative pole of mycotoxins binds to positive toxin binder's pole and thus toxins are immobilised and eliminated from the animal body (Kana *et al.,* 2014). The formation of stable complexes between aflatoxins and mycosor-

bents in the stomach and intestines are excreted through the cloaca of birds (Saminathan *et al.,* 2018). These data are in line with results obtained with other mycosorbents, e.g. clinoptilolite **(**Oguz *et al.,* 2003), hydrated sodium calcium aluminosilicate (HSCAS), sodium bentonite, montmorillonite (Ologhobo *et al.,* 2015), essential oils (Saei *et al.,* 2013), antioxidants (resveratrol) (Sridhar *et al.,* 2015) and probiotics (Zuo *et al.,* 2013).

In conclusion, the supplementation of ration of goslings with 0.5 mg/kg AFB_1 worsened their growth performance (reduction of body weight, weight gain, feed intake and higher feed conversion ration) and changes relative weights of internal organs. The addition of 0.5 g/kg Mycotox NG to AFB_1-contaminated rations reduced or prevented its toxic effects on production traits and relative organ weights.

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