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Growth performance, haematology and serum biochemistry of female rabbits (*Oryctolagus cuniculus*) fed dietary fumonisin

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ABSTRACT

To account for the potential effects of dietary mycotoxin on growth performance, haematological and serum biochemical constituents of rabbit, 24 mature female rabbits were assigned to three diets containing 0, 5.0 and 10.0 mg fumonisin/kg constituting the control diet, and diets 1 and 2, respectively. The animals were initially maintained on these diets for 2 weeks before they were mated and subsequently for 4 weeks after mating. Dietary fumonisin significantly ($P<0.05$) reduced the daily dry matter intake (DMI) and final live weight. The daily DMI of the rabbits fed diets 1 and 2 were 6.32 and 50.13% respectively lower than the daily DMI of rabbits fed the control diet. The erythrocyte counts, packed cell volume and haemoglobin values significantly ($P<0.05$) decreased, while the leukocyte values of the pregnant rabbits increased with the increase in the dietary fumonisin concentrations. Pregnant does fed the control diet had significantly ($P<0.05$) higher serum total protein concentrations than those fed diets 1 and 2. The serum enzymes significantly ($P<0.05$) increased in rabbits fed diets 1 and 2. Diet containing 5 mg fumonisin/kg may reduce growth performance and induce negative responses in the haematology and serum biochemistry of pregnant does, which may affect the proper development of foetuses.

Key words: *Fusarium verticillioides*, fumonisin, haematology, pregnant rabbit, serum biochemistry

Introduction

The contamination of feeds and foodstuffs with mycotoxins has presented a hazard to human and animal health for decades, and this threat can only become more important as the demand on the available food supply increases with the increase in population (NELSON et al., 1993). If the food supply is limited, the mycotoxin hazards increase since more fungus-damaged, potentially mycotoxin-containing foodstuffs are consumed rather

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than discarded, and malnutrition has been reported (NELSON et al., 1993) to enhance the susceptibility to lower concentrations of food-borne mycotoxins.

Mycotoxins have been reported to be involved in a chain of metabolic disorders in animals (RILEY et al., 1996). Among such mycotoxins of significant health concern to both man and animals is fumonisin, produced by *Fusarium verticillioides* (Sacc.) Nirenberg, which grows on any nourishing medium (PETZINGER and WEIDENBACH, 2002). Mycotoxins may cause gastrointestinal problems (GBORE and EGBUNIKE, 2007), immune suppression (RICHARD et al., 1991), reproductive organ problems (SZILÁGYI et al., 1994; OGUNLADE et al., 2006), blood abnormalities (EWUOLA and EGBUNIKE, 2008; EWUOLA et al., 2008; GBORE and EGBUNIKE, 2008a, 2009), disturbances in the immune system (VOSS et al., 2007), suppression in sperm production and reproductive performance (GBORE and EGBUNIKE, 2008b; GBORE, 2009a), and delayed sexual maturity (GBORE, 2009b).

Blood contains a myriad of metabolites and other constituents, which provide a valuable medium for clinical investigation and assessment of nutritional status of human beings and animals. Dietary components have measurable effects on blood components; hence, blood constituents are widely used in nutritional evaluation and survey of animals (OLORODE et al., 1995).

Based on the reviewed physiological effects of dietary fumonisin on animals, coupled with a survey of contemporary literature revealing an increasing wave of fumonisin contamination of feeds and feedstuff (FAZEKAS et al., 1997), this study was designed to assess the growth performance, haematological and serum biochemical profiles of pregnant rabbits fed diets containing *F. verticillioides*-contaminated maize.

Materials and methods

Fumonisin production and experimental diets. Autoclaved maize grains were cultured with a toxigenic strain of *F. verticillioides* (MRC 286) inoculum obtained from the Plant Pathology Laboratory of the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria to produce fumonisin as described previously (NELSON et al., 1994). Briefly, the method involved the addition of 500 g of yellow corn kernels and 500 mL of distilled water in a 30.5×61cm autoclavable polyethylene bag. The corn was inoculated by drawing an aqueous suspension from a lyophilized culture into a sterile 5 mL syringe fitted with a 19-gauge needle and injecting 1 mL through the side of each bag. Bags of inoculated corn were incubated in the dark at 20 to 22 °C for four weeks. Seven to eight days after inoculation, holes were punched near the tops of the bags to promote aeration. After a four-week incubation period, the culture material was air dried for 48 hours. Uncontaminated maize grains and the *Fusarium*-contaminated maize grains were used to formulate three diets. Dietary contents of common *Aspergillus mycotoxin*

(aflatoxin), *Fusarium* mycotoxins including deoxynivalenol (DON, vomitoxin), T-2 toxin, zearalenone, and fumonisin were analysed using mycotoxin quantitative CD-ELISA test kits (Neogen, Lansing, MI, USA). The concentrations of fumonisin in the diets were approximately 0, 5 and 10 mg/kg constituting the control diet (which had no *Fusarium*-contaminated maize grains), diets 1 (medium *Fusarium*-infected diet) and 2 (high *Fusarium*-infected diet), respectively. All other mycotoxins screened were below the 0.2 mg/kg detection limit.

Experimental animals and treatment. Twenty-four clinically normal matured crossbred female rabbits weighing between 1.65 and 2.0 kg sourced from the Animal Science Unit of the Federal College of Agriculture Farm, Akure, Ondo State, Nigeria, were randomly assigned into one of the three diets (eight per treatment) in a six-week feeding trial. The animals were maintained on the diets for 2 weeks before they were mated and subsequently for 4 weeks after mating. The composition of the experimental diets is shown in Table 1.

Data collection and analysis. Feed consumption for each animal was measured daily by the difference between the daily feed supplied and refusal, and live-weight changes of the animals were taken weekly throughout the experimental period. At the end of the feeding experiment, a blood sample was collected from the jugular vein of each animal into two sets of Monoject® vacutainers. One set containing Ethylene diaminetetraacetic acid (EDTA) for haematology, while the other set without EDTA was covered and centrifuged, the serum decanted and deep-frozen for serum biochemical and enzymological analyses.

The erythrocyte, the total leukocyte and the differential leukocyte counts, the packed cell volume (PCV) and haemoglobin (Hb) concentrations were determined as described by EWUOLA and EGBUNIKE (2008), the blood corpuscular constants: mean cell volume (MCV), mean cell haemoglobin (MCH) and mean cell haemoglobin concentration (MCHC) were determined using appropriate formulae as described by JAIN (1986).

The serum chloride (Cl^-), creatinine, and urea nitrogen were estimated as described previously (GBORE et al., 2006). The routine flame photometric technique of VARLEY et al. (1980) was used to determine the serum levels of sodium (Na^+) and potassium (K^+). The serum phosphate (PO_4^{3-}) was determined spectrometrically as described by GARBER and MILLER (1983), the serum bicarbonate (HCO_3^-) was determined by titration; while the serum calcium (Ca^{2+}) was determined by atomic absorption photometry as outlined by TRUDEAN and FREIER (1967). The serum enzymes: alanine aminotransferase (ALT), aspartate aminotransferase (AST) and alkaline phosphatase (ALP), were evaluated using a commercial test kit (Randox Laboratories Ltd., Crumlin, Co. Antrim, UK).

All the data obtained were subjected to statistical analysis using ANOVA procedure of SAS (1999). The Duncan's multiple range test of the same software was used to separate all means at 5% probability level.

Results

The daily dry matter intake (DMI) and weight gain of female rabbits fed varying levels of dietary fumonisin are shown in Table 2. The DMI and final live weights of the animals were significantly ($P<0.05$) influenced. The DMI of the rabbits fed diets 1 and 2 were 6.32 and 50.13% respectively lower than the daily feed intake of rabbits fed the control diet. Similarly, the weight gains of the rabbits fed diets 1 and 2 were 79.67 and 76.92% of the weight gained by rabbits fed the control diet.

Table 1. Gross composition (%) of the test diets

	Dietary fumonisin level		
Ingredient	Control (0 mg/kg)	Diet 1 (5 mg/kg)	Diet 2 (10 mg/kg)
Non-inoculated maize	25.00	20.00	15.00
Inoculated maize*	-	5.00	10.00
Rice husk	30.00	30.00	30.00
Wheat offal	25.00	25.00	25.00
Palm kernel cake	10.00	10.00	10.00
Soybeans meal	5.00	5.00	5.00
Fishmeal	2.00	2.00	2.00
Dicalcium phosphate	2.00	2.00	2.00
Salt	0.50	0.50	0.50
Minerals/vitamin premix**	0.45	0.45	0.45
Methionine	0.03	0.03	0.03
Lysine	0.02	0.02	0.02
Calculated nutrients			
Crude protein (%)	13.15	13.15	13.15
Crude fibre (%)	13.97	13.97	13.97
Digestible energy (kcal/kg)	2225.21	2225.21	2225.21

*Inoculated with *F. verticillioides*. ** To provide per kg of diet: vitamin A (10,000 i.u.), vitamin D (20,000 i.u.), vitamin E (5 i.u.), vitamin K (2.5 mg), choline (350 mg), folic acid (1 mg), manganese (56 mg), iodine (1 mg), iron (20 mg), copper (10 mg), zinc (50 mg), cobalt (1.25 mg).

Table 2. Performance of pregnant does fed dietary fumonisin (Mean ± SE)

	Dietary fumonisin level		
Parameter	Control (0 mg/kg)	Diet 1 (5 mg/kg)	Diet 2 (10 mg/kg)
Initial live weight (kg)	1.79 ± 0.04	1.88 ± 0.55	1.73 ± 0.03
Final live weight (kg)	1.82 ± 0.05^{a}	1.45 ± 0.38^{b}	1.40 ± 0.04^{c}
Dry matter intake (g)	41.15 ± 2.59^{a}	38.55 ± 10.23^{b}	20.57 ± 9.49^{b}

$^{abc:}$ means on the same row with different superscripts differ significantly ($P<0.05$).

Table 3. Haematological parameters of pregnant does fed dietary fumonisin (Mean ± SE)

	Dietary fumonisin level		
Parameter	Control (0 mg/kg)	Diet 1 (5 mg/kg)	Diet 2 (10 mg/kg)
Packed cell volume (%)	36.67 ± 1.33^{a}	33.00 ± 4.00^{a}	20.33 ± 1.45^{b}
Haemoglobin (g/L)	139.67 ± 2.19^{a}	119.00 ± 7.00^{b}	87.67 ± 5.21^{c}
Erythrocyte ($\times 10^{12}$/L)	5.60 ± 1.07^{a}	3.80 ± 0.70^{ab}	2.30 ± 18.95^{b}
Mean cell volume (fL)	69.74 ± 11.21	87.89 ± 5.66	89.29 ± 5.46
Mean cell Haemoglobin (ug)	269.21 ± 52.23	320.65 ± 40.65	385.24 ± 20.19
MCHC* (%)	38.18 ± 1.32	36.34 ± 2.28	43.34 ± 2.62
Leucocytes ($\times 10^{9}$/L)	7.80 ± 1.77^{a}	12.05 ± 1.75^{b}	12.63 ± 1.69^{b}
Neutrophils (%)	38.67 ± 4.10^{b}	61.50 ± 13.50^{a}	47.67 ± 1.20^{ab}
Lymphocytes (%)	60.00 ± 4.04^{a}	36.50 ± 13.50^{b}	50.33 ± 1.76^{ab}
Monocytes (%)	0.33 ± 0.33	0.50 ± 0.50	0.67 ± 0.33
Eosinophils (%)	1.00 ± 0.58	1.50 ± 0.50	1.33 ± 0.33

*MCHC: - Mean cell haemoglobin concentration. ^{abc}: Means within the same row with different superscripts differ significantly ($P<0.05$).

Table 4. Serum proteins and enzymes of pregnant does fed dietary fumonisin (Mean ± SE)

	Dietary fumonisin level		
Parameter	Control (0 mg/kg)	Diet 1 (5 mg/kg)	Diet 2 (10 mg/kg)
Total protein (g/L)	80.00 ± 4.08^{a}	70.00 ± 0.09^{b}	65.00 ± 2.04^{b}
Albumin (g/L)	51.50 ± 5.10^{a}	47.50 ± 2.65^{ab}	38.50 ± 1.43^{b}
Globulin (g/L)	28.50 ± 1.02	22.50 ± 2.65	26.50 ± 3.47
Albumin/globulin	1.81 ± 0.24	2.11 ± 0.40	1.45 ± 0.27
ALT* (U/L)	55.50 ± 1.38^{b}	100.00 ± 1.23^{a}	122.50 ± 1.02^{a}
AST** (U/L)	46.25 ± 0.62^{c}	108.25 ± 0.72^{b}	125.00 ± 2.04^{a}
ALP*** (U/L)	11.05 ± 0.14^{b}	12.40 ± 0.14^{b}	18.52 ± 0.16^{a}

*Alanine aminotransferase, **Aspartate aminotransferase, *** Alkaline phosphatase. ^{abc}: Means on the same row with different superscripts differ significantly ($P<0.05$).

Table 5. Serum electrolytes of pregnant does fed dietary fumonisin (Mean ± SE)

	Dietary fumonisin level		
Parameter	Control (0 mg/kg)	Diet 1 (5 mg/kg)	Diet 2 (10 mg/kg)
Calcium (mmol/L)	12.60 ± 0.33	12.10 ± 0.86	11.65 ± 0.31
Phosphate (mmol/L)	4.30 ± 0.20^{b}	7.50 ± 0.45^{a}	7.60 ± 0.08^{a}
Sodium (mmol/L)	132.0 ± 01.63	129.00 ± 0.41	131.00 ± 2.04
Potassium (mmol/L)	4.05 ± 0.06^{a}	3.85 ± 0.06^{a}	4.00 ± 0.04^{ab}
Chloride (mmol/L)	108.75 ± 0.51^{ab}	117.50 ± 3.06^{a}	100.00 ± 4.08^{b}
Bicarbonate (mmol/L)	24.50 ± 0.61^{c}	27.50 ± 0.20^{a}	25.75 ± 0.10^{b}
Urea nitrogen (mmol/L)	16.50 ± 0.60	19.50 ± 0.43	19.50 ± 0.44
Creatinine (μmol/L)	1.60 ± 0.02^{b}	1.90 ± 0.05^{a}	1.70 ± 0.04^{ab}

^{abc}: Means on the same row with different superscripts differ significantly (P<0.05)

The haematological values of pregnant rabbits fed varied levels of dietary fumonisin are shown in Table 3. The mean values of the erythrocyte counts, PCV and Hb significantly (P<0.05) decreased with the increase in the dietary fumonisin concentrations, while the leukocyte values of the pregnant rabbits increased. The PCV of the pregnant rabbits fed diet 2 was significantly (P<0.05) lower than those fed diet 1 and the control diet, while the erythrocyte count of the rabbits fed diet 2, which was significantly (P<0.05) lower than the erythrocyte counts of those fed the control diet, was not statistically different from those fed diet 1. The mean leukocyte count of the rabbits fed diet 2 was significantly (P<0.05) higher than those fed the control diet but not different statistically from those fed diet 1. The neutrophils increased significantly (P<0.05) while the lymphocytes significantly (P<0.05) decreased with the increase in the dietary fumonisin concentrations.

Table 4 shows the serum proteins and enzyme activities of pregnant rabbits fed varied dietary fumonisin levels. Pregnant does fed the control diet had significantly (P<0.05) higher mean serum total protein concentrations than those on diets 1 and 2. The serum total protein concentrations of the rabbits on diets 1 and 2, respectively, were about 12.5 and 19% lower than those on the control diet. The mean serum albumin concentration of the pregnant rabbits fed diet 2 was significantly (P<0.05) lower than the mean serum albumin of those fed the control diet, which was not significantly (P>0.05) higher than the serum albumin of those on diet 1. The serum ALT and AST values of the rabbits fed the control diet were significantly (P<0.05) lower than the serum ALT and AST of those fed diets 1 and 2, while the serum ALP activities of the rabbits fed the control diet and diet 1 were significantly (P<0.05) lower than those on diet 2.

The serum phosphate, bicarbonate and creatinine values significantly ($P<0.05$) increased, while the serum potassium and chloride values decreased with increase in the dietary fumonisin (Table 5).

Discussion

The United States Federal Department of Agriculture (ANONYM., 2001a) considered rabbits, grouped with horses, as the most sensitive species to fumonisin in animal feeds. In this study, since all the animals were fed *ad libitum*, the drastic decline in the DMI and the relative change in the body weight of rabbits fed diets 1 and 2 may be attributed to the adverse effects of the mycotoxin on feed intake and nutrient utilization as observed in pigs fed dietary fumonisin by GBORE and EGBUNIKE (2007). As all the animals were fed *ad libitum* and all the diets were isocaloric and isonitrogenous, the concentration-dependent decline in final live weight and feed intake indicates the role that fumonisin can play in animal nutrition and subsequent growth performance. These results are in agreement with results from similar studies that dietary fumonisin depressed live weight gain in animals. GELDERBLOM et al. (1988) reported that the mean body weights of BD IX rats, consuming a diet containing 1 g fumonisin B_1/kg during a 4-week promotion treatment were 50% lower than those of non-treated rats. Also, US NTP (ANONYM., 2001b) reported less gain in body weight in rats exposed to fumonisin-containing diet at 56 mg fumonisin B_1/kg body weight after 28 days of feeding in a range-finding study.

Haematological indices are an index and a reflection of the effects of dietary treatments on animals in terms of the quality of feed ingested and nutrients available to an animal to meet its physiological requirements. In this present study, the significantly reduced erythrocyte and PCV values were inversely related to the fumonisin concentrations in the diets, with the animals that consumed the diet containing the higher dietary mycotoxin concentrations recording the lowest values for both parameters. The mean values of the erythrocytes and PCV of pregnant does on diets 1 and 2 fed varied levels of dietary fumonisin were not within the normal physiological ranges of $5.11 - 6.51\times10^{12}$/L and 31.0 - 48.6% reported by MITRUKA and RAWNSLEY (1977) for young adult female rabbits. The values of haemoglobin, an iron-containing conjugated protein that performs the physiological function of transporting oxygen and carbon dioxide, which significantly decreased in rabbits fed diets 1 and 2 compared with those on the control diet, suggest that the animals on diets 1 and 2 suffered depressed respiratory capability. The results also revealed that the rabbits exposed to diets containing *Fusarium*-inoculated maize (diets 1 and 2) suffered significantly from the synthesis (erythropoiesis) and concentration of erythrocytes. The corresponding statistical decrease in the PCV of the animals exposed to diets 1 and 2 revealed that the animals were anaemic.

The circulating leukocyte counts of the animals fed diets 1 and 2 were above the normal physiological range of 5.20 - 10.6×10^9/L for leukocyte counts of young adult female rabbits reported by MITRUKA and RAWNSLEY (1977). The results indicate that the animals fed diets 1 and 2 might have suffered leukocytosis. According to COLES (1986), leukocytosis may result from intoxications including those produced by metabolic disturbance. The significant effects of dietary fumonisin on haematological parameters observed in this study were in contrast to the report of OGUNLADE et al. (2004). Also, PARENT-MASSIN and PARCHMENT (1998) and ZOMBORSZKY-KOVÁCS et al. (2002) considered fumonisin as non-haematotoxic. The findings in this present study however agreed with the report of ESPADA et al. (1994) that revealed altered haematological parameters in broiler chicks fed diets formulated from *F. verticillioides* (MRC 826) culture containing 30 to 300mg fumonisin B_1/kg diet. Also, altered haematological parameters have been reported in minks (POWELL et al., 1996), rabbit bucks (EWUOLA and EGBUNIKE, 2008) and pigs (ROTTER et al., 1996; GBORE and EGBUNIKE, 2008a) fed dietary fumonisin. In one-year old carp, consumption of nutritionally balanced pellets contaminated with 0.5 and 5.0 mg fumonisin B_1 per kg body weight for 42 days resulted in alterations of haematological and serum biochemical parameters compared with the control (PEPELJNJAK et al. 2003). The authors suggested that fumonisin B_1 probably interferes with the carp's respiratory process.

Reduced tissue protein synthesis has been reported (DÄNICKE et al., 2006) to be one of the major symptoms seen in pigs consuming *Fusarium*-contaminated feed. The significantly lower levels of serum proteins in rabbits fed diets 1 and 2 in this study indicated that the dietary fumonisin might have induced some alterations in protein metabolism in the animals, since serum protein synthesis is related to the amount of available protein in the diet (IYAYI and TEWE, 1998). The mycotoxin might have inhibited protein metabolism in the animals as reported for sphingolipid synthesis (RILEY et al., 1996) or protein digestibility and absorption as observed by GBORE and EGBUNIKE (2007). Also, the disruption of membrane cellular structure by cytotoxic mycotoxins, which interferes with vital cellular processes, including protein synthesis, has been reported (GUERRE et al., 2000).

The decrease in total protein, globulin and albumin concentrations in the sera of pregnant rabbits fed diets 1 and 2 suggested deficient protein synthesis in the animals compared with the rabbits fed the control diet. The dietary mycotoxin might have elicited some pathological and physiological changes in the animals, leading to poor digestion, poor absorption or poor utilization of protein in the diets.

CHAMPE et al. (2007) stated that aminotransferases are normally intracellular enzymes, with low levels found in the plasma representing the release of cellular contents during normal cell turnover. The serum ALT and AST levels, according to CHAMPE et al. (2007),

are elevated in nearly all liver diseases and are particularly high in conditions that cause extensive cell necrosis, including severe viral hepatitis or toxic liver injury. Mean values of ALT and AST obtained for rabbits fed diets 1 and 2 were above the reported ranges of 48.5-78.9 U/L and 42.5-98.0 U/L for normal young adult female rabbits (MITRUKA and RAWNSLEY, 1977) for the respective serum enzymes. However, only the ALP value of 18.52 i.u/l obtained for the female rabbits on diet 2 was above the physiological reference range reported by MITRUKA and RAWNSLEY (1977). The serum enzyme activities above the normal ranges are abnormal and are an indication that the animals might have suffered liver and/or kidney damage. Significant increases in the serum activities of these enzymes, indicating damage to the liver and kidney, were reported by VOSS et al. (1993) in male and female Sprague-Dawley rats fed diets containing 0-150 mg of fumonisin B_1 for 4 weeks. RESTUM et al. (1995) reported higher serum ALT, AST and ALP activities in minks fed 119 ppm fumonisin B_1 diet as compared to the control. Similar evidence of abnormal increases in serum enzyme activities, probably due to cellular destruction induced by fumonisin, has been reported (GELDERBLOM et al., 1994; MEHTA et al., 1998; EWUOLA and EGBUNIKE, 2008). Recently, significant increases in serum enzymes, urea and creatinine were reported in rabbits administered a single oral dose of 31.5 mg fumonisin B_1/kg body weight by ORSI et al. (2009), a finding the authors described as characterizing hepatic and renal injury.

The control of intracellular calcium (seemingly via sphingosine 1-phosphate) and control of plasma membrane potassium permeability in myocytes are examples of cellular regulatory processes that have been reported by ANONYM. (2000) to be modulated by *de novo* ceramide biosynthesis as shown by inhibition of the process by fumonisin. The significantly higher values of the serum phosphate obtained for the pregnant rabbits on diets 1 and 2 were above the serum phosphate reference range of 2.30-6.90 mmol/L for normal young adult female rabbits reported by MITRUKA and RAWNSLEY (1977). This finding is significant as this may alter the normal calcium-phosphate ratio for proper foetal growth and development in pregnant rabbits fed diets 1 and 2. Incidences of increased foetal deaths, hydrocephalic foetuses and skeletal anomalies, in addition to decreased foetal length and foetal weight were observed by COLLINS et al. (1998) in pregnant rats given 25 and 50 mg/kg bw purified fumonisin B_1. The serum phosphate, bicarbonate and creatinine values, which increased with increase in the dietary fumonisin levels, agreed with the results of MOTELIN et al. (1994) who reported dose-dependent increases in biochemical parameters measured in pigs fed diets containing total fumonisins of over 5 mg/kg for 14 days. However, the significant influence of dietary fumonisin levels on the serum electrolytes in this study was at variance with the report of GBORE et al. (2006) that observed no significant difference in serum electrolytes of male rabbits fed diets containing 12.30-24.60 mg fumonisin/kg for five weeks. The variability in the effects of dietary fumonisin levels on the serum electrolytes observed by various authors might be

the result of the physiological state of the animals as the developing embryos in pregnant rabbits would place more demand for these electrolytes, the doses of the toxin used or the length of exposure of the animals to the mycotoxin.

This study has demonstrated that the exposure of pregnant does to diets containing 5 mg fumonisin/kg may result in significantly reduced growth performance and altered haematological and serum biochemical parameters, which may negatively influence the proper growth and development of foetuses in pregnant rabbits.

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SAŽETAK

Radi istraživanja mogućih učinaka mikotoksina u hrani na rast, hematološke i biokemijske pokazatelje u serumu, 24 odrasle kunice dobivale su hranu koja nije sadržavala fumonizin i bila je kontrolna, te hranu s oznakom 1 koja je sadržavala 5,0 i hranu s oznakom 2 koja je sadržavala 10,0 mg fumonizina/kg. Kunice su takvu hranu dobivale tijekom dva tjedna prije parenja i četiri tjedna poslije parenja. Fumonizin u hrani značajno je smanjio ($P<0,05$) dnevni unos suhe tvari i konačnu tjelesnu masu. Dnevni unos suhe tvari kunica hranjenih hranom 1 bio je 6,32%, a onih hranjenih hranom 2 bio je 50,13% manji nego u onih kontrolne skupine. Broj eritrocita te vrijednosti hematokrita i hemoglobina bile su značajno smanjene ($P<0,05$), dok se broj leukocita u gravidnih kunica povećao poslije povećanja koncentracije fumonizina u hrani. Gravidne ženke hranjene kontrolnom hranom imale su značajno veću koncentraciju ($P<0,05$) ukupnih serumskih proteina nego one koje su dobivale hranu 1 i 2. Aktivnost serumskih enzima značajno se ($P<0,05$) pojačala u kunica hranjenih hranom 1 i 2. Hrana koja je sadržavala 5 mg fumonizina/kg smanjila je sposobnost rasta i uzrokovala negativne učinke na hematološke i biokemijske pokazatelje kunica što može poremetiti pravilan razvoj plodova.

Ključne riječi: *Fusarium verticillioides*, fumonizin, haematologija, gravidne kunice, serum, biokemijski pokazatelji