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INFLUENCE OF DIETARY CULTURE MATERIAL CONTAINING AFLATOXIN AND T-2 TOXIN ON CERTAIN SERUM BIOCHEMICAL CONSTITUENTS IN TURKEY POULTS (*Meliagridesgallopavo)* - BELTSVILLE SMALL WHITE VARIETY

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Abstract: Experimental mycotoxicoses were induced singly and in combination in 48 turkey poults (Beltsville small white) for a period of 0 to 13 weeks by feeding diets containing 100 ppb AF and 1 ppm T-2 toxin. Sera samples were collected from each group at the end of 49th and 91st day of trial to study the effect of certain serum biochemical parameters. The toxin fed birds revealed significant ($P<0.05$) reduction for serum total protein, albumin and globulin, serum glucose while no significant ($P<0.05$) differences were observed in the A/G ratio between the control and mycotoxin treated groups. The serum AST, ALT, ALP and serum lipase levels revealed significant ($P<0.05$) increase in the toxin treated groups when compared to the control. There was a significant ($P<0.05$) increase in the uric acid level, decrease in the serum creatinine and no significant differences in BUN between the control and mycotoxin treated groups. The calcium and phosphorus levels revealed significant ($P<0.05$) decrease between the control and mycotoxin treated groups while, calcium/phosphorus ratio showed no significant difference between the control and toxin treated groups.

Keywords: Turkey poults, aflatoxin, T-2 toxin, serum biochemical parameters.

Introduction

Food safety and security have generally remained basic human needs globally. Among the very many hazards contamination of food and feed by mycotoxins (toxic metabolites of fungi) in the form of multiple mycotoxicoses is the current problem faced by the poultry farmers. Aflatoxin (AF) and T-2 toxin are the most frequently encountered mycotoxins. AF is a potent hepatotoxin with dihydrofuran-coumarin moiety and is of

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importance in producing the biological effects and is produced by *Aspergillus flavus* and *A. parasiticus*. T-2 toxin is a 3 hydroxy 4, 15 diacetoxy 8 (3-methylbutryloxy), 12, 13 epoxy trichothec-9-ene metabolite. It is a potent irritant, inflammatory (dermotoxic, alimentary toxic, hepatotoxic and growth inhibitory agent) and radiomimetic agent produced by *Fusarium* species. The AF, by binding to both RNA and DNA blocks transcription whereas, T-2 toxin blocks initiation of translation. The studies on aflatoxicosis in turkey poults were limited owing to the potential sensitivity of the species, the same on T-2 was scant and there were none on AF-T-2 combined toxicity for a period of 91days. Hence, the present study was conducted.

Materials and methods

AF was produced on rice (Shotwell *et al*., 1966) by using A. *Parasiticus* NRRL 2999 strain. The T-2 toxin was produced on corn grits (Burmeister, 1971) by using *F. Sporotrichoides* MTCC 1894 strain (Microbial Type Culture Collection, Chandigarh, India). The mycotoxin content in cultured material was analysed at Pharmaco vigilance Laboratory for Animal Feed and Food Safety (PLAFFS), Centre for Animal Health Studies, TANUVAS, Madhavaram Milk Colony, Chennai, Tamilnadu, India. Known amounts of AF and T-2 toxin containing powdered substrates were incorporated into turkey brooder mash both singly and in combination to yield 100 ppb AF and 1 ppm T-2 toxin. Forty eight newly hatched unsexed turkey poults obtained from standard hatcheries were wing banded, weighed and housed in battery brooders with *ad libidum* supply of feed and water. They were randomly distributed into four groups of twelve chicks each. The control and toxin mixed diets were fed to different groups for 91 days from the day of hatch. Samples of blood were collected from six birds in each group by intracardiac puncture were allowed to clot and centrifuged at 1500 rpm for 20 minutes to separate the sera.

Serum total protein and albumin were estimated by modified Biuret and Dumas method, glucose by glucose oxidase method, aspartate aminotransferase (AST), alanine aminotransferase (ALT) and alkaline phosphatase (ALP) by IFCC (International Federation of Clinical Chemistry) method, blood urea nitrogen (BUN) by glutamate dehydrogenase (GLDH) method, creatinine by Jaffe's kinetic methodand uric acid by enzymatic photometric test by IFCC method by using semiautoanalyzer (MISPA Excel). The data generated from different parameters of the experimental study were subjected to statistical analysis, as per Snedecor and Cochran (1989). The results of the study were subjected to two way analysis of variance (ANOVA).

RESULTS

The mean (± SE) total protein, albumin and globulin and A/G ratio of turkey poults fed AF and T-2 toxin singly and in combination are presented in Tables 1 and 2 respectively. Comparison of overall means revealed significant ($P<0.05$) differences for serum total protein, albumin and globulin between the control and mycotoxin treated groups while no significant ($P<0.05$) differences were observed in A/G ratio between the control and mycotoxin treated groups. AF-T-2 group was significantly ($P<0.05$) different from individual toxin fed groups. Significant ($P<0.05$) reduction in serum total protein, albumin and globulin was observed in the toxin fed birds.

The mean (± SE) serum values of glucose in turkey poults fed AF and T-2 toxin singly and in combination are presented in Table3. Comparison of overall means showed significant ($P<0.05$) differences between the control and mycotoxin treated groups. There was a significant ($P<0.05$) decrease in the serum glucose level in the toxin treated groups.

The mean (± SE) serum AST levels in turkey poults fed AF and T-2 toxin singly and in combination are presented in Table 4. Comparison of overall means revealed significant ($P<0.05$) differences between the control and mycotoxin treated groups. No significant difference was observed among the toxin treated groups. The serum AST levels increased in the toxin treated groups when compared to the control. The mean (± SE) serum ALT levels in turkey poults fed AF and T-2 toxin singly and in combination are presented in Table 5. Comparison of overall means revealed significant ($P<0.05$) differences between the control and mycotoxin treated groups. No significant difference was observed among the toxin treated groups. The serum ALT levels increased in the toxin treated groups when compared to the control. The mean (± SE) serum ALP levels in turkey poults fed AF and T-2 toxin singly and in combination are presented in Table 6. Comparison of overall means revealed significant ($P<0.05$) differences between the control and mycotoxin treated groups. AF-T-2 group differed significantly ($P<0.05$) from other groups. Significant ($P<0.05$) increase in all levels was observed in the toxin treated groups when compared to the control.

The mean (± SE) serum amylase levels in turkey poults fed AF and T-2 toxin singly and in combination are presented in Table 7. Comparison of overall means revealed no significant differences between the control and mycotoxin treated groups. The mean (± SE) serum lipase levels in turkey poults fed AF and T-2 toxin singly and in combination are presented in Table 8. Comparison of overall means revealed significant ($P<0.05$) differences between the control

and T-2 & AF-T-2 groups. Significant (P<0.05) increase in serum lipase was observed in the T-2 & AF-T-2 toxin treated groups when compared to the control group.

The mean± SE serum blood urea nitrogen, serum creatinine and uric acid in turkey poults fed AF and T-2 toxin singly and in combination are presented in Tables 9 and 10 respectively. Comparison of overall means showed significant (P<0.05) differences between the control and mycotoxin treated groups for uric acid while serum creatinine revealed significant (P<0.05) differences between the control & AF-T-2 and AF & T-2 toxin groups while BUN revealed no significant differences between the control and mycotoxin treated groups. There was a significant (P<0.05) increase in uric acid level in the mycotoxin treated groups. Serum creatinine revealed significant (P<0.05) decrease in the AF & T-2 toxin groups.

Themean± SE serum calcium, phosphorus and calcium/phosphorus ratio in turkey poults fed AF and T-2 toxin singly and in combination are presented in Tables 11-13 respectively. Comparison of overall means showed significant (P<0.05) differences between the control and mycotoxin treated groups. There was a significant (P<0.05) decrease in the calcium and phosphorus levels while, calcium/phosphorus ratio had no significant difference between the control and mycotoxin treated groups. Among the toxin treated groups significant (P<0.05) decrease was observed in the AF-T-2 group when compared to the other groups.

DISCUSSION

Feeding 100 ppb AF and 1 ppm T-2 toxin individually or in combination for 13 weeks significantly (P>0.05) reduced the serum total protein, albumin and globulin in turkey poults. Decrease in serum total protein, albumin and globulin in AF and AF-T-2 group was in accordance with Elisângela Aparecida Guaiume (2005) who reported that turkey poultsfed diets containing 2 mg T-2 toxin/kg diet in combination with 0.15 mg/kg AFB1 revealed almost a 2-fold decrease in the serum total protein, albumin and globulin when compared to control group. However, Babu Prasath (2008) reported no significant differences in serum total protein, albumin and globulin between the control and 1 ppm and 3 ppm T-2 toxin fed groups for 0 to 28 days. However, such reduction was reported in T-2 toxin fed birds of other species like male broiler chicks fed with 4 µg T-2 toxin/g for three weeks (Huff *et al*.,1988), male broiler chicks fed with diets containing 4 and 6 mg T-2 toxin/kg from day 1 to three weeks of age (Kubena *et al*.,1989, 1994), broiler chickens fed 1 ppm T-2 toxin from 0 to 28 days of age (Kamalavenkatesh, 2003), Japanese quail fed diet containing 4 ppm T-2 toxin from 0 to 35 days (Madheswaran *et al.*, 2004), broiler chicks fed 0.5 ppm of T-2 toxin from

day 1 to four weeks of age (Krishnamoorthy, 2004) and feeding 0.5 ppm T-2 toxin to layer chicks from 0 to 12 weeks of age (Gounalan, 2005).

The hypoproteinaemia and hypoalbuminaemia observed in all mycotoxin treated groups could be ascribed to the reduction in feed consumption as observed in this study and inactivation of biosynthetic enzymes and impairment of protein synthesis by AF (Krogh, 1987), T-2 toxin (Bunner and Morris, 1988; Pier, 1992). Besides, liver being the main organ of protein synthesis especially albumin (Kaneko *et al*., 1997), the hepatic damage observed in all mycotoxin fed groups in this study could be the other contributing factor for hypoproteinaemia and hypoalbuminaemia. Further, affection of lymphoid organs could have contributed for hypoglobulinaemia.

Feeding 100 ppb AF and 1 ppm T-2 toxin individually or in combination for 13 weeks significantly reduced serum glucose in turkey poults. Among the mycotoxin treated groups, serum glucose revealed significant reduction in AF and T-2 and AF-T-2 groups. Similar observations on reduced serum glucose values were reported by Elisângela Aparecida Guaiume (2005) in turkey poultsfed diets containing 0.15 mg/kg AFB1 from first week onwards in a 21 day. Such observations on decreased glucose were also recorded by Raina *et al.* (1991) in broiler chicks fed 0.1 ppm AF from 7 to 49 days of age. A gradual reduction in blood glucose was reported in Japanese quail fed 0.2 to 0.75 ppm from 6 to 35 days (Panda *et al.,* 1987). Kumar *et al.* (1993) reported marked depression in serum glucose in broiler quails fed 0.5 to 2.0 ppm AF for 35 days. However, no significant alteration was reported in serum glucose levels in Japanese quail fed up to 20 ppm AF for 4 weeks (Chang and Hamilton, 1982) and 0.75 ppm for 100 days (Johri *et al.,* 1990). The hypoglycaemia could be attributed to the reduced feed consumption and hepatic damage observed in toxin fed birds.

Similar observations of reduced serum glucose values were reported by Elisângela Aparecida Guaiume (2005) in turkey poultsfed dietscontaining2mg T-2 toxin/kg diet singly or in combination with 0.15 mg/kg AFB1. Madheswaran *et al.*, 2004 reported that feeding AF (3 ppm) and T-2 toxin (4 ppm) in combination in commercial Japanese quail chicks, from 0 to 5 weeks of age induced hypoglycaemia. The hypoglycaemia observed in this study could be attributed to the impaired digestion and absorption due to alimentary tract lesions and hepatic damage observed in the mycotoxin fed birds.

Feeding 100 ppb AF and 1 ppm T-2 toxin singly and in combination in turkey poults from 0-13 weeks of age caused a significant elevation of AST when compared to the control. In accordance with this study significantly higher concentrations of AST were reported in 4

month old wild turkey poults fed 200 and 400 µg aflatoxin/kg feed for 2 weeks (Quist *et al*., 2000). Elisângela Aparecida Guaiume (2005) observed such elevated levels numerically in turkey poultsfed diets containing 0.15 mg/kg AFB1 from first week onwards in a 21 day trial. Similarly elevated levels of serum AST was reported by Ogunbo *et al.* (2007) in turkey poults fed 4 mg T-2 toxin/kg for a period of 21 days and Babu Prasath (2008) in turkey poults fed 3 ppm T-2 toxin from 0 to 28 days of age. In the combined group, the findings are in accordance with Elisângela Aparecida Guaiume (2005) who reported significant increase in AST from first week onwards in a 21 day trial in turkey poults fed 2 mg T-2/kg diet with 0.15 mg/kg AFB1. Elevated AST level was reported in broiler chickens fed combined toxins of 0.3 ppm AF and 3 ppm T-2 at 21 days of age but decreased at 35 days of age in broiler chicken (Raju and Devegowda, 2000). The elevated levels of AST could be attributed to the degeneration of hepatocyte and skeletal muscle observed in the study.

Feeding 100 ppb AF and 1 ppm T-2 toxin in turkey poults from 0-13 weeks of age caused a significant elevation of ALT when compared to the control. No comparable reports were available for ALT in turkey poults for AF toxicosis. Similar elevation has been reported in Japanese quail fed 0.75 ppm AF for 100 days (Johri *et al.,* 1990) and 3 ppm for 1 to 35 days (Raju and Devegowda, 2000). Elevated ALT levels observed in this study for T-2 toxicosis is in accordance with the findings of Babu Prasath (2008) who reported an increased levelsin turkey poults fed 3 ppm T-2 toxin from 0 to 28 days of age. No comparable reports on elevation of ALT were available in turkey poults for combined AF and T-2 toxicosis. However, reports of no significant changes in Japanese quail fed 3 ppm AF and 4 ppm T-2 toxin from 0-5 weeks of age (Madheswaran *et al.*, 2004) and a decrease in ALT level in broiler chickens after 35 days of feeding with 0.3 ppm AF and 3 ppm T-2 toxin were reported (Raju and Devegowda, 2000). The increased levels of ALT might be attributed to the hepatic damage observed in this study. The increase in the levels of serum enzymes measured was interpreted as a consequence of hepatocyte degeneration and subsequent leakage of enzymes (Leeson *et al.,* 1995).

Feeding 100 ppb AF and 1 ppm T-2 toxin in turkey poults from 0-13 weeks of age caused a significant elevation of ALP when compared to the control. No comparable reports were available for ALP in turkey poults for AF toxicosis. However, similar elevation has been reported in broiler chicks fed 0.5 ppm AF for 45 days (Singh *et al*., 1992) and 0.5 ppm AF for 42 days (Jindal *et al*., 1994). The findings for elevated ALP level for T-2 toxicosis were in accordance with the findings of Babu Prasath (2008) who reported that significant increase in

ALP values were observed in 3 ppm toxin fed turkey poults. Significant increase in the levels of ALP was also reported in broiler chickens fed 4 ppm T-2 toxin from 7 to 49 days of age (Raina *et al*., 1991), 2 and 4 ppm for six weeks (Narayanaswamy, 1998), 3 ppm from 1 to 35 days of age (Raju and Devegowda, 2000), 4 ppm for 35 days (Natraja *et al*., 2004) and 0.5 ppm for four weeks (Krishnamoorthy, 2004).No comparable reports on elevation of ALP were available in turkey poults for combined AF and T-2 toxicosis. However, unaltered ALP level was reported by Madheswaran *et al*., (2004) in Japanese quail fed 3 ppm AF and 4 ppm T-2 toxin from 0-5 weeks of age. Alkaline phosphatase catalyses several reactions in the body but elevated levels of this enzyme are associated with an increase in the osteoblastic activity and damage to the liver (Falconer and King, 1970).

The mycotoxin treated birds showed no alterations in the amylase levels when compared to the control. The findings were in accordance with Gounalan (2005) who did not observe any significant change in the amylase level of layer chickens fed 0.5 ppm of T-2 toxin for 12 weeks.

The serum lipase levels revealed significant elevation in the T-2 and AF-T-2 groups when compared to the control. Balachandran and Ramakrishnan (1988) observed a significant increase in serum lipase levels in broiler chicken fed 1 ppm AF for 28 days. On the contrary Krishnamoorthy (2004) found a decrease in the lipase level in the broiler chicken fed 0.5 ppm T-2 toxin.Elevation in the lipase levels in toxin fed groups could be related to degenerative changes in the acinar cell of pancreas.

Feeding 100 ppb AF and 1 ppm T-2 individually or in combination for 13 weeks significantly increased the serum uric acid in the mycotoxin treated groups, Serum creatinine revealed significant decrease in the AF and T-2 toxin group, while BUN revealed no significant differences between the control and toxin fed groups. However, Elisângela Aparecida Guaiume (2005) reported no changes in uric acid level in turkey poultsfed diets containing 0.15 mg/kg AFB1 from first week onwards in a 21 day study. McKenzie *et al.,* 1998 reported significant increase in BUN in female turkey poults fed AFB1 corn equal to 1220 ± 73.3 ppb for 3 weeks. Decreased uric acid levels were encountered, when broiler chicks were fed 3.5 ppm AF for 21 days (Smith *et al.*, 1992), significant increase in BUN, creatinine and uric acid in layer chicks fed 0.5 ppm AF for 12 weeks (Gounalan, 2005) and 50,150 and 300 ppb AF fed from 0 to 42 days of age (Ajith Jacob George, 2007).

In T-2 toxicosis, feeding 1 and 3 ppm toxin to turkey poults significantly decreased creatinine in 3 ppm T-2 toxin fed birds while BUN and uric acid levels did not differ significantly from

the control group (Babu Prasath, 2008). Madheswaran *et al.* (2004) did not find any significant changes in the BUN, creatinine and uric acid levels in Japanese quail fed 4 ppm T-2 toxin for 35 days. However, feeding 1, 2 and 3 ppm T-2 toxin to Japanese quail significantly increased the creatinine level in 3 ppm and uric acid level in 2 and 3 ppm fed birds (Arun Prasath, 2006).

Elisângela Aparecida Guaiume (2005) reported that turkey poultsfed diets containing 2 mg T-2 toxin/kg diet in combination with 0.15 mg/kg AFB1 revealed no changes in uric acid level. Huff *et al.* (1988) reported that feeding 2.5 µg AF/g and 4 µg T-2 toxin/g in broiler chicks from 1 to 21 days of age resulted in significant reduction in uric acid. Increased uric acid level could be due to renal lesion observed in the study.

Feeding 100 ppb AF and 1 ppm T-2 toxin individually or in combination for 13 weeks significantly decreased calcium and phosphorus levels while, calcium/phosphorus ratio had no significant difference between the control and mycotoxin treated groups. Among the toxin treated groups, significant decrease was observed in T-2 groups compared to the other groups. These findings are in accordance with McKenzie *et al.* (1998) who reported a significant decrease in serum calcium in one-day-old female turkey poults fed AFB1 corn equal to 1,220 ± 73.3 ppb for 3 weeks andElisângela Aparecida Guaiume (2005) who fed diets containing 0.15 mg/kg AFB1 from first week onwards in a 21 day trial. However, no significant changes in serum calcium were reported in 4 month old wild turkey poults fed 200 and 400µg aflatoxin/kg feed for 2 weeks (Quist *et al*. 2000). These findings are in agreement with those of Kumar and Balachandran (2005) who fed 1 ppm AF to broiler chicks for 28 days and Ajith Jacob George (2007) who fed 50,150 and 300 ppb AF in broiler chicken for 42 days of age. The hypocalcemia could be attributed to the fact that AF hindered the absorption of calcium independently of Ca/P (Huff *et al.*, 1977; Shukla and Pachauri, 1995). In addition, Fernandez *et al.* (1994) suggested that the decrease in the calcium levels following aflatoxicosis might be due to impaired calcium metabolism resulting from direct or indirect decrease of endogenous parathormone synthesis and renal insensitivity to parathormone. This also agreed with the proventriculitis, ventriculitis, duodenitis and mild renal damage observed in this study which might have affected the calcium and phosphorus absorption.

Feeding 1 ppm T-2 toxin for 13 weeks significantly decreased calcium and phosphorus level while, calcium/phosphorus ratio had no significant difference between control and mycotoxin treated groups. The findings are in accordance with ElisângelaAparecidaGuaiume (2005)

who reported significant reduction in calcium in turkey poultsfed diets containing 2 mg T-2 toxin/kg from first week onwards in a 21 day trial. Similar findings were reported by Gounalan (2005) who reported that feeding 0.5 ppm T-2 toxin to layer chicks caused hypocalcaemia and hypophosphataemia, while Krishnamoorthy (2004) reported significant reduction in the calcium and Ca/P ratio in broiler chicks fed 0.5 ppm of T-2 toxin to from day 1 to four weeks of age. Elisângela Aparecida Guaiume (2005) was reported significant reduction in serum calcium in turkey poultsfed diets containing 2 mg T-2 toxin/kg diet in combination with 0.15 mg/kg AFB1 from first week onwards in a 21 day trial. Madheswaran *et al*, (2004) reported a significant increase in the serum calcium and unaltered serum phosphorus values in commercial Japanese quail chicks fed AF (3 ppm) and T-2 toxin (4 ppm) in combination for 0 to 5 weeks of age.

Conclusions

Hence, it may be concluded that feeding 100 ppb AF and 1 ppm T-2 toxin individually or in combination for 13 weeks can adversely affect the health of turkey poults. The study also indicated the potential of AF to interact significantly with T-2 toxin in altering serum biochemical constituents like serum total protein, albumin and globulin, serum glucose, AST, ALT, ALP and serum lipase, uric acid, serum creatinine, calcium and phosphorus levels

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TABLE 1

Mean (± SE) serum total protein and albumin (g/dL) of turkey poults fed aflatoxin and T-2 toxin singly and in combination

(n=6)

Groups	Total protein (g/dL)			Albumin (g/dL)		
	7th week	13th week	Overall means	7th week	13th week	Overall means
Control	3.74 ± 0.05	3.57 ± 0.15	3.65[a] ± 0.08	2.08 ± 0.02	1.96 ± 0.08	2.02[a] ± 0.04
Aflatoxin (100 ppb)	3.28 ± 0.06	2.30 ± 0.08	2.79[b] ± 0.15	1.80 ± 0.06	1.31 ± 0.09	1.56[b] ± 0.09
T-2 toxin (1 ppm)	3.03 ± 0.11	2.65 ± 0.14	2.84[b] ± 0.05	1.61 ± 0.04	1.56 ± 0.08	1.58[b] ± 0.04
Aflatoxin (100 ppb)+ T-2 toxin (1 ppm)	2.90 ± 0.07	2.17 ± 0.04	2.54[c] ± 0.12	1.51 ± 0.07	1.20 ± 0.04	1.35[c] ± 0.06

Overall means with different superscripts within a column differ significantly (P<0.05)

TABLE 2

Mean (± SE) serum globulin and AG ratio of turkey poults fed aflatoxin and T-2 toxin singly and in combination

(n=6)

Groups	Globulin (g/dL)			A/G ratio		
	7th week	13th week	Overall means	7th week	13th week	Overall means
Control	1.65 ± 0.06	1.61 ± 0.10	1.63 [a] ± 0.14	1.27 ± 0.05	1.24 ± 0.07	1.25 ± 0.04
Aflatoxin (100 ppb)	1.48 ± 0.08	1.00 ± 0.05	1.25 [b] ± 0.13	1.25 ± 0.11	1.32 ± 0.14	1.28 ± 0.08
T-2 toxin (1 ppm)	1.42 ± 0.10	1.10 ± 0.09	1.25 [b] ± 0.13	1.17 ± 0.09	1.43 ± 0.06	1.30 ± 0.06
Aflatoxin (100 ppb)+ T-2 toxin (1 ppm)	1.38 ± 0.09	0.99 ± 0.03	1.19 [b] ± 0.12	1.14 ± 0.14	1.23 ± 0.05	1.16 ± 0.07

Overall means with different superscripts within a column differ significantly (P<0.05)

TABLE 3

Mean (± SE) serum glucose (mg/dL) in turkey poults fed aflatoxin and T-2 toxin singly and in combination

(n=6)

Groups	7th week	13th week	Overall means
Control	255.62±4.80	304.87±8.42	280.25[a]±8.74
Aflatoxin (100 ppb)	210.51±4.11	270.08±10.06	240.30[b] ±10.37
T-2 toxin (1 ppm)	221.23±5.01	282.63±6.34	251.93[b] ±10.02
Aflatoxin (100 ppb)$_+$ T-2 toxin (1 ppm)	215.00±5.63	230.16±8.87	222.58[c]±5.51

Overall means with different superscripts within a column differ significantly (P<0.05)

TABLE 4

Mean (± SE) serum AST (U/L) of turkey poults fed aflatoxin and T-2 toxin singly and in combination

(n=6)

Groups	AST (U/L)		
	7th week	13th week	Overall means
Control	281.32±4.02	322.42±9.35	301.87[b]±7.87
Aflatoxin (100 ppb)	301.79±5.91	366.84±9.77	334.31[a]±11.21
T-2 toxin (1 ppm)	291.30±2.10	358.21±15.58	324.75[a]± 12.56
Aflatoxin (100 ppb)$_+$ T-2 toxin (1 ppm)	307.06±4.13	382.18±16.26	344.62[a]±13.86

Overall means with different superscripts within a column differ significantly (P<0.05)

TABLE 5

Mean (± SE) serum ALT (U/L) of turkey poults fed aflatoxin and T-2 toxin singly and in combination

(n=6)

Groups	ALT (U/L)		
	7th week	**13th week**	**Overall means**
Control	5.21±0.22	7.17±0.19	6.19^{b}±0.32
Aflatoxin (100 ppb)	6.38±0.25	7.40±0.16	6.89^{a}±0.21
T-2 toxin (1 ppm)	6.12±0.09	7.74±0.25	6.93^{a}±0.27
Aflatoxin (100 ppb)$_{+}$ T-2 toxin (1 ppm)	6.60±0.19	7.52±0.14	7.06^{a}±0.18

Overall means with different superscripts within a column differ significantly (P<0.05)

TABLE 6

Mean (± SE) serum ALP (U/L) of turkey poults fed aflatoxin and T-2 toxin singly and in combination

(n=6)

Groups	ALP (U/L)		
	7th week	**13th week**	**Overall means**
Control	102.66±3.25	158.52±2.90	130.63^{c}±8.67
Aflatoxin (100 ppb)	125.32±1.94	164.25±4.73	144.78^{ab}±6.35
T-2 toxin (1 ppm)	128.03±2.58	160.42±3.83	144.23^{b}±5.35
Aflatoxin (100 ppb)$_{+}$ T-2 toxin (1 ppm)	136.97±2.77	168.06±4.00	152.52^{a}±5.23

Overall means with different superscripts within a column differ significantly (P<0.05)

TABLE 7

Mean (±SE) serum amylase levels (U/L) in turkey poults fed aflatoxin and T-2 toxin singly and in combination

(n=6)

Groups	Serum amylase (U/L)		Overall Means
	7th week	13th week	
Control	369.21±10.51	420.77±10.45	394.99±10.51
Aflatoxin (100 ppb)	388.00±8.63	442.59±11.87	415.29±10.80
T-2 toxin (1 ppm)	383.40±8.55	438.53±8.55	410.97±10.11
Aflatoxin (100 ppb)+ T-2 toxin (1 ppm)	384.21±8.51	445.22±7.52	414.72±10.67

TABLE 8

Mean (±SE) serum lipase levels (U/L) in turkey poults fed aflatoxin And T-2 toxin singly and in combination

(n=6)

Groups	Serum lipase (U/L)		Overall means
	7th week	13th week	
Control	28.31±1.93	30.31±1.86	29.61^{c}±1.34
Aflatoxin (100 ppb)	29.13±1.39	30.75±1.56	29.94^{bc}±1.03
T-2 toxin (1 ppm)	33.10±1.24	31.48±1.45	32.29^{ab}±0.94
Aflatoxin (100 ppb)+ T-2 toxin (1 ppm)	32.46±1.57	35.65±1.59	34.06^{a}±1.17

Overall means bearing same superscripts within a column do not differ from each other (P>0.05)

TABLE 9

Mean (± SE) blood urea nitrogen (mg/dL) of turkey poults fed aflatoxin and T-2 toxin singly and in combination

(n=6)

Groups	Blood urea nitrogen (mg/dL)		
	7th week	**13th week**	**Overall means**
Control	6.03±0.10	6.02±0.28	6.03±0.14
Aflatoxin (100 ppb)	6.56±0.17	6.32±0.21	6.44±0.13
T-2 toxin (1 ppm)	6.29±0.21	6.77± 0.21	6.53±0.16
Aflatoxin (100 ppb)$_+$ T-2 toxin (1 ppm)	5.94±0.18	6.58±0.16	6.26±0.15

TABLE 10

Mean (± SE) serum creatinine (mg/dL) and uric acid (mg/dL) of turkey poults fed aflatoxin and T-2 toxin singly and in combination

(n=6)

Groups	Creatinine (mg/dL)			Uric acid (mg/dL)		
	7th week	**13th week**	**Overall means**	**7th week**	**13th week**	**Overall means**
Control	0.44 ± 0.02	0.49 ± 0.03	0.47^a ± 0.02	5.39 ± 0.11	6.03 ± 0.14	5.71^a ± 0.13
Aflatoxin (100 ppb)	0.31 ± 0.01	0.42 ± 0.04	0.37^b ± 0.03	6.46 ± 0.16	7.19 ± 0.12	6.82^b ± 0.15
T-2 toxin (1 ppm)	0.37 ± 0.01	0.38 ± 0.02	0.36^b ± 0.01	6.68 ± 0.12	7.03 ± 0.11	6.85^b ± 0.09
Aflatoxin (100 ppb)$_+$ T-2 toxin (1 ppm)	0.34 ± 0.01	0.54 ± 0.03	0.44^a ± 0.03	6.98 ± 0.09	7.53 ± 0.17	7.26^a ± 0.12

Overall means with different superscripts within a column differ significantly (P<0.05)

TABLE 11

Mean (± SE) serum calcium (mg/dL) of turkey poults fed aflatoxin and T-2 toxin singly and in combination

(n=6)

Groups	Calcium (mg/dL)		
	7th week	**13th week**	**Overall means**
Control	9.30±0.36	11.21±0.40	10.26^{a}±0.38
Aflatoxin (100 ppb)	8.29±0.22	9.10±0.12	8.69^{b}±0.17
T-2 toxin (1 ppm)	7.56±0.17	9.14±0.34	8.35^{b}±0.30
Aflatoxin (100 ppb)+ T-2 toxin (1 ppm)	7.11±0.15	7.72±0.17	7.41^{b}±0.14

Overall means with different superscripts within a column differ significantly (P<0.05)

TABLE 12

Mean (± SE) serum phosphorus (mg/dL) of turkey poults fed aflatoxin and T-2 toxin singly and in combination

(n=6)

Groups	Phosphorus (mg/dL)		
	7th week	**13th week**	**Overall means**
Control	7.06± 0.19	7.25±0.14	7.16^{a}±0.12
Aflatoxin (100 ppb)	6.02±0.37	6.45±0.21	6.24^{b}±0.21
T-2 toxin (1 ppm)	6.86±0.27	6.31±0.15	6.50^{b}±0.11
Aflatoxin (100 ppb)+ T-2 toxin (1 ppm)	5.56±0.23	5.60±0.30	5.58^{c}±0.18

Overall means with different superscripts within a column differ significantly (P<0.05)

TABLE 13

Mean (± SE) serum calcium / phosphorus ratio of turkey poults fed aflatoxin andT-2 toxin singly and in combination

(n=6)

Groups	Calcium/Phosphorus ratio		
	7th week	**13th week**	**Overall means**
Control	1.32±0.06	1.55±0.06	1.44±0.05
Aflatoxin (100 ppb)	1.40±0.08	1.41±0.03	1.41±0.04
T-2 toxin (1 ppm)	1.11±0.04	1.45± 0.06	1.28±0.06
Aflatoxin (100 ppb)$_+$ T-2 toxin (1 ppm)	1.29±0.05	1.41±0.10	1.35±0.06