Indian J Physiol Pharmacol 2003; 47 (4) : 447–452

EVALUATION OF VITAMIN E AGAINST DELTAMETHRIN TOXICITY IN BROILER CHICKS

U. JAYASREE, A. GOPALA REDDY*, K. S. REDDY, Y. ANJANEYULU[1] AND B. KALAKUMAR

Department of Pharmacology & Toxicology and
[1]*Department of Pathology,*
College of Veterinary Science,
Rajendranagar, Hyderabad – 500 030

(Received on June 26, 2003)

Abstract : Deltamethrin toxicity was studied in broilers and vitamin E was evaluated for therapeutic management. Day old male broiler chicks were randomly divided into 3 groups consisting of 6 chicks in each. Group 1 was maintained as control for 6 wks, group 2 was fed on deltamethrin (100 mg/kg feed) for 6 wks and group 3 was fed on deltamethrin for the first 4 wks and during the subsequent 2 wks with vitamin E (300 mg/kg feed) with out deltamethrin. Weekly body weights, feed conversion ratio, glutathione (GSH) concentration and high density lipoproteins (HDL) were significantly ($P<0.05$) reduced, while the activities of glutathione peroxidase (GSH-Px), glutathione reductase (GSH-R), catalase, aspartate aminotransferase (AST) and lactate dehydrogenase (LDH), and the lipid profile and renal biomarkers were increased significantly ($P<0.05$) in group 2 and 3 at the end of 4th wk as compared to group 1. Following treatment with vitamin E during the last 2 wks in group 3, all the parameters in study revealed improvement. From this study, it is concluded that deltamethrin induces toxicity by oxidative damage in biological system and supplementing vitamin E in feed is useful in treating accidental toxicity.

Key words : broilers deltamethrin vitamin E oxidative stress

INTRODUCTION

The adverse effects of pyrethroids because of the indiscriminate use of pesticides on feed grains indirectly affect birds. Any alteration in liver function of birds makes them highly susceptible to pesticides. Deltamethrin is a type-II pyrethroid insecticide and is moderately toxic to birds with the LD_{50} values greater than 1000 mg/kg (1). It has been reported to modify the activities of glutathine S-transferase, catalase etc. (2) and concentration of glutathione (1), which indicate the possibility of free radical – induced oxidative damage. It is now being realized that one

*Corresponding Author

of the reasons for majority of toxicities/ disorders is imbalance between amounts of free radicals generated in the body and antioxidants to scavenge and protect the body against their deleterious effects (3, 4). Vitamin E is known for its antioxidant property protecting the unsaturated bonds of phospholipids present in the cell membrane against free radical damage (5). Vitamin E deficiency has been reported to be frequently associated with an increased susceptibility to free radical oxidation (6). Vitamin E has been shown to restore the normal levels of lipids in the liver, lung, heart and kidney of rats exposed to the peroxidative damage of free radicals induced by lead (7). Dietary supplementation of vitamin E is beneficial to the overall immunocompetence of growing broilers (8). The present study was undertaken to evaluate the extent and mechanism of toxicity, in terms of oxidative stress, due to deltamethrin in broilers and to evaluate the antioxidant and therapeutic role of vitamin E against deltamethrin toxicity in broilers.

METHODS

A total of 18 male broiler chicks of day old age belonging to Cobb strain were procured for the study. The day old male broiler chicks were randomly divided into 3 groups, consisting of six chicks in each. The experiment was started from the day old (day 1) onwards and water was provided ad libitum. All experimental protocols were approved by Institutional Ethics Committee. The birds in each group were given the diets as follows : Group I was maintained on basal feed for 6 wks, group 2 on deltamethrin (Butox; Intervet India Ltd., Pune) at the rate of 100 mg/kg feed for 6 wks and group 3 on deltamethrin at the rate of 100 mg/kg feed for the first 4 wks followed by vitamin E (DL - α-tocopherol 50% premix; E. Merck Chemicals, Germany) at the rate of 300 mg/ kg in feed during the subsequent 2 wks without deltamethrin.

The experiment was carried out for a period of 6 weeks. Birds of all the groups were vaccinated with New Castle Disease vaccine on 4th and 21st day, Fowl pox vaccine on 10th day and IBD vaccine on 14th day.

Body weights and feed consumption of the birds were recorded at weekly intervals to determine growth pattern and feed efficiency. The blood samples were drawn from wing vein once in 2 wks for assay of glutathione peroxidase (9), glutathione reductase (10), catalase (11) and glutathione (12). Serum was separated for the estimation of AST, LDH, total cholesterol, HDL, LDL, triglycerides, urea, creatinine and BUN by using the commercially available diagnostic kits (Sigma Diagnostics Pvt. Ltd., Baroda). The data were subjected to analysis of variance (13).

RESULTS

The average body weight in group 2 and 3 (553 ± 25 and 581 ± 13, respectively) was significantly ($P<0.05$) lower as compared to group 1 (715 ± 26) at the end of 4th wk. Following treatment with vitamin E in group 3, the body weight (1308 ± 25) was significantly ($P<0.05$) increased and comparable to that of group 1 (1457 ± 48),

while in group 2 the body weight was significantly ($P<0.05$) lower (1158 ± 35). The FCR revealed a significant ($P<0.01$) increase (2.86 ± 0.02) in group 2 as compared to that of group 1 and 3 (2.59 ± 0.02 and 2.70 ± 0.02, respectively) at the end of 6th wk. FCR was significantly ($P<0.05$) increased in group 3 following treatment with vitamin E at the end of 6th wk as compared to 4th wk value (2.13 ± 0.02).

The antioxidant enzymes in blood such as GSH-Px, glutathione reductase and catalase were significantly ($P<0.05$) elevated, while GSH level was significantly ($P<0.05$) lowered in toxic controls (2 and 3) than group 1 at the end of 4th week. On supplementation of vitamin E, in group 3 as a therapy, the antioxidant enzyme level in blood revealed a decreasing trend at 6th week (Table I), though the values did not match those of control. Similarly, GSH revealed an increasing trend following therapy.

The value of AST (units/ml) in group 2 was 71.9 ± 0.38 at the end of 6th wk, which was significantly higher as compared to the value of control group 1 (16.07 ± 1.34). At the end of the experiment, following therapy with vitamin E, the activity of AST in group 3 was significantly ($P<0.05$) reduced to 30.78 ± 0.85 from the 4th wk value of 71.18 ± 0.26. The activity of LDH (IU/L) in group 2 and 3 at the end of 4th wk was 361.02 ± 1.27 and 368.97 ± 2.09, respectively, which were significantly ($P<0.05$) higher as compared to group 1 (137.58 ± 3.8). Following treatment with vitamin E in group 3, the LDH activity was significantly ($P<0.05$) reduced to 193.5 ± 1.97) at the end of 6th wk.

Total cholesterol (mg/dl), triglycerides

TABLE I: Antioxidant defense profiles of chicks fed on basal diet, deltamethrin and vitamin E.

Parameter	*Group*	*2nd week*	*4th week*	*6th week*
Glutathione	1.	79.53±1.97	82.41±1.85	83.73±2.62
Peroxidase	2.	106.73±3.93**	132.96±2.55**	158.13±2.63**
(units/ml)	3.	108.03±3.94**	134.82±1.13**	96.20±3.63*
Glutathione	1.	42.40±2.22	39.81±1.69	38.85±1.55
Reductase	2.	80.10±1.61**	91.90±2.28**	118.38±1.21**
(units/ml)	3.	78.57±1.84**	91.60±1.73**	47.52±1.82*
Catalase	1.	3.23±0.02	3.49±0.01	3.55±0.01
(moles/sec)	2.	4.17±0.02**	5.33±0.02**	6.29±0.01**
	3.	4.38±0.01**	5.58±0.01**	4.27±0.02*
Glutathione	1.	9.86±0.42	10.73±0.42	11.05±0.35
(mg/100 ml)	2.	9.78±0.12	5.82±0.12**	4.60±0.32**
	3.	9.72±0.15	5.73±0.12**	9.47±0.62*

Values are mean ± SE of 6 observations.
*P<0.05; *P<0.01 in relation to control (ANOVA)
1. Control
2. Deltamethrin
3. Deltamethrin (1–4 wks) followed by vitamin E (5–6 wks)

(mg/dl) and LDL (mg/dl) in group 2 were 287.28 ± 1.37, 211.78 ± 1.2 and 220.91 ± 1.66, respectively at the end of 6th wk, which were significantly ($P<0.05$) higher as compared to those of group 1 (175.45 ± 2.7, 102.83 ± 0.91 and 115.62 ± 3.09, respectively). The values of the above variables of group 3 (186.85 ± 1.31, 114.7 ± 0.93 and 139.01 ± 1.35, respectively) were significantly ($P<0.05$) reduced at the end of 6th wk as compared to the 4th wk values (267.28 ± 1.43, 191.58 ± 1.07 and 205.70 ± 1.85, respectively). The HDL concentration (mg/dl) was significantly ($P<0.05$) lower in group 2 (24.02 ± 0.77) at the end of 6th wk as compared to that of control (39.26 ± 1.15) and group 3 (30.82 ± 0.69).

Renal profile biomarkers such as serum urea (mg/dl), serum creatinine (mg/dl) and BUN (mg/dl) were significantly ($P<0.05$) higher (35.02 ± 0.13, 3.90 ± 0.01 and 16.35 ± 0.06, respectively) in group 2 as compared to those of group 1 (8.12 ± 0.10, 0.56 ± 0.02 and 3.79 ± 0.49, respectively) at the end of 6th wk. The values of group 3 at the end of 4th wk were 24.60 ± 0.30, 3.19 ± 0.001 and 11.48 ± 0.14, respectively and there was a significant ($P<0.05$) decrease at the end of 6th wk (16.60 ± 0.21, 1.02 ± 0.002 and 7.67 ± 0.10, respectively).

DISCUSSION

In the present study, significantly lower body weight in deltamethrin toxic control was in agreement with the report of Mohapatra and Mallick (1). This could be attributed to the anorectic properties of the pesticide accompanied with poor feed conversion efficiency. In poultry feed, excessive multiplication of saprophytic bacteria results in release of various metabolites that might enhance the toxicity of deltamethrin (14) in terms of depressing growth rate. Vitamin E supplementation in group 3 during the last 2 wks improved the body weight gain.

The activities of GSH-Px, glutathione reductase and catalase enzymes and also the GSH levels were determined as they form the components of antioxidant defense system, which effectively scavenges the organic form of hydroperoxide free radicals (15). In toxic controls, the activities of antioxidant enzymes such as GSH-Px, glutathione reductase and catalase were significantly increased, with a significant decrease in GSH level. These findings indicate ongoing free radical induced damage in the living system (15, 16). This altered enzyme activity could be due to enhancing free radical oxidative damage on account of excessive lysosomal degradation induced by deltamethrin, hence depriving the antioxidant defenses. The supplementation of vitamin E in group 3 during the last 2 wks resulted in the revival of antioxidant defenses towards normal, which confirms the antioxidant effect of vitamin E (5).

The serobiochemical parameters were used as biomarker indices for assessing the extent of tissue damage. Elevated levels of AST and LDH indicate hepatocellular injury (17). The elevated levels of these enzymes could be due to the oxidative damage by free radicals. These results

are in accordance with certain other reports (1). In group 3, following vitamin E supplementation, the enzymatic activity showed the trend of revival to normal, which could be attributed to the antioxidant property of vitamin E in feed.

Significant increase in total cholesterol, triglycerides and LDL and a significant decrease in HDL in the toxic control indicate hepatopathy, cardiac damage as well as renal failure (17), which could be probably due to free radical-induced oxidative damage. The results are in conformity with Majumdar et al. (18), who reported a significant increase in plasma cholesterol level in fenvalerate toxicity. Activation of lipid peroxidation can be correlated with the changes in the lipid composition (19). In group 3, supplementation of vitamin E revealed a significant alteration in lipid profile to normal. This could be attributed to the antioxidant property of vitamin E (7).

Non-protein nitrogenous substances such as uric acid, urea and creatinine are increased only when renal function is below 30% of its original capacity in birds. An increase in BUN reflects an accelerated rate of protein catabolism. Plasma urea appears to be the single most useful variable for early detection of pre-renal causes of renal failure (17). In this study, the serum urea, creatinine and BUN levels were significantly increased in group 2 and 3 at the end of 4th wk, which could be attributed to the free-radical induced oxidative damage by deltamethrin on kidney. On supplementation of vitamin E, the values were revived towards normal in group 3, which further confirms the protective role of vitamin E in treating the free radical mediated renal damage (20).

From this study it is concluded that deltamethrin induces toxicity by generating free radicals in excess and by disturbing the antioxidant defenses, which could be effectively treated by the use of vitamin E as an antioxidant.

REFERENCES

1. Mohapatra M, Mallick PN. Effect of deltamethrin on broilers. Recent Advances in Toxicology. XVII Annual Conference of Society of Toxicology, India, 1998; p.41.
2. Monarca S, Pasquini R, Crea MG, Leonerdis C. Studies of hepatic xenobiotic metabolizing enzymes in rats treated with insecticide deltamethrin. *J Environmental Pathol Toxicol Oncol* 1995; 14: 45–52.
3. Sies H. *Oxidative Stress, Oxidants and Antioxidants.* Academic Press, New York, 1991.
4. Halliwell B. Reactive oxygen species and the central nervous system. *J Neurochem* 1992; 59: 1609–1623.
5. Infers H, Sies H. The protection by ascorbate and glutathione against microsomal lipid peroxidation is dependent on vitamin E. *European J Biochem* 1988; 174: 353–357.
6. Dormandy TL. Free radical oxidation and antioxidants. *Lancet* 1978; 1: 647–650.
7. Upasani CD, Balaraman R. Effect of vitamin E, vitamin C and spirulina on the levels of membrane bound enzymes and lipids in some organs of rats exposed to lead. *Indian J Pharmacol* 2001; 33: 185–191.
8. Erf GF, Bottje WG, Bersi TK, Headrick MD, Fritts CA. Effects of dietary vitamin E on the immune system in broilers : Altered proportions of CD4 T

cells in the thymus and spleen. *Poultry Sci* 1997; 77: 529–537.

9. Paglia DE, Valentine, WN. Studies on the quantitative and qualitative characterization of erythrocyte glutathione peroxidase. *J Lab Clin Med* 1967; 70: 158–159.

10. Raghuramulu. *Manual of Laboratory Techniques.* NIN. ICMR. Jamaia-Osmania, Hyderabad, 1983.

11. Brilton C, Machlly AC. Assay of catalase and peroxidases. *Methods in Enzymol* 1956; 136: 765–768.

12. Patterson JW, Lazarow A. Determination of glutathione. *Methods in Biochemistry Anals II,* 1956; pp.267–270.

13. Snedecor WG, Cochran GW. *Statistical Methods.* 8th ed. USA Iowa State University Press, USA 1994.

14. Prohaszka L, Hajdu E, Doworshak E, Rozsnai T. Growth depression in broiler chicks caused by incompatibility of feed ingredients. *Acta Vet Hung* 1987; 35: 349–358.

15. Yu BP. Cellular defences against damage from reactive species. *Physiol Rev* 1994; 74: 139–162.

16. Bandyopadhyay U, Das D, Banarjee RK. Reactive oxygen species : Oxidative damage and pathogenesis. *Current Sci* 1999; 77: 658–665.

17. Kaneko JJ, Harvey JW, Michael LB. *Clinical Biochemistry of Domestic Animals.* 5th Ed. New York, Academic Press, 1997; pp.857–879.

18. Majumdar S, Chakrabarty AK, Bhattacharya A, Mandal TK, Basak DK. Effect of short term dermal toxicity of fenvalerate on residue, cell architecture and biochemical profiles in broiler chicks. *Indian J Exp Biol* 1997; 35: 162–167.

19. Dormandy TL. Free radical reactions in biological systems. *Annal Royal Coll Surg* 1980; 62: 188–193.

20. Rock CL, Jacob RA, Bouren PE. Update on the biological characteristics of antioxidant micronutrients : Vitamin C, E and carotenoids. *J American Diet Assoc* 1996; 96: 693–702.