WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 7.523
Volume 6, Issue 12, 107-117. Research Article ISSN 2277– 7105

EFFECT OF METHIDATHION ON SOME BLOOD PARAMETERS AND LIVER ENZYMES IN LABORATORY MICE *MUS MUSCULUS* L

Sami J. Al-Maliki and Eman H. Rahi*

Department of Biology, College of Education for Pure Sciences, University of Basrah, Basrah, Iraq.

Article Received on
11 August 2017,
Revised on 31 August 2017,
Accepted on 21 Sep. 2017
DOI: 10.20959/wjpr201712-9742

***Corresponding Author**
Eman H. Rahi
Department of Biology, College of Education for Pure Sciences, University of Basrah, Basrah, Iraq.

ABSTRACT

The present study aimed to investigate the effect of methidathion on blood parameters and liver enzymes in mice when injected by two doses. Adult male and female mice divided into three groups for each sex (8 for each group), the first group injected intraperitoneal (i.p.) with normal saline as a control group, the second and third groups were injected (i.p.) with (1.2, 2.4 mg/kg of body weight) methidathion respectively for 15 day. The results showed significant decrease in red blood cell count (RBC), packed cell volume (PCV), hemoglobin (Hb) in both doses in male mice.in female, The results showed significant decrease in packed cell volume (PCV) in low dose, significant decrease hemoglobin (Hb) in both doses compared control group, there was also showed significant increase in the total number of white blood cells(WBC_S) in both dose compared control group. the study showed a significant increase in the liver enzyme alanine transaminase (ALT), alkaline phosphatase (ALP) in male and female treatment methidathion compared control group.

KEYWORDS: Methidathion, Blood Parameter, Liver Enzyme, Mice.

INTRODUCTION

Environmental pollution is one of the most important problems faced by man in the modern era. This problem began with the beginning of the industrial revolution and the entry of man in the age of industry and mining and his knowledge of the sources of energy such as coal and petroleum, starting with gases and waste, as well as many chemical compounds developed by man, Industrial detergents and pesticides of various kinds, agricultural fertilizers, plastics and industrial plastics, these additives to the environment reached a degree

exceeded the critical limit, which led to the disruption of the balance of the ecosystem and the deterioration of its absorptive capacity.[1]

General pesticides and special insecticide are the most important and dangerous environmental pollutants that affect the environmental balance due to their toxicity, persistence and slow decomposition. Despite the effectiveness of these chemical pesticides and their economic advantages, they have been harmful to human and animal health as well as the eradication of beneficial insects. the indiscriminate use of pesticide and other chemicals has given opportunity to many harmful and secondary insect pests within the environment to multiply and spread rapidly resulting in increased severity due to imbalance that has struck the natural ecological balance.[2,3] Pesticides are currently important technological inputs in agricultural production to reduce losses from herbs, insects, microbial diseases and other agricultural pests, The importance of pesticides to increase production by impact on pests that damage 35% of all potential food crops before harvest, And the causes of plant diseases and weeds.[3,4,5]

Pesticides have become an integral part of our contemporary life because they are used to protect agricultural land and stored grain as well as to eliminate serious pathogenic pests.[6] Pesticides include a variety of chemicals that may be classified according to the nature of their work or use them as herbicides, herbicides, insecticides, fungicides, Rodenticide and other types of insecticides such as Acaricide and Nematicide. Each type contains a group or groups of chemical compounds similar to or Are different from each other, and are synthetically either organic, mineral, or plant-based.[7] Pesticides based on chemical composition and active substances were also classified into several types, including chlorinated hydrocarbons (CHC), organophosphous pesticides and carbamates, Pyrethroids and others.[8]

Methidathion S-(2,3-Dihydro-5-methoxy-2-oxo-1,3,4-thiadiazol-3-ylmethyl) O,O-dimethyl phosphorodithioate, is one of the most widely OP pesticide used in the world for pest control of crop[9], The department of pesticide regulation (DPR) Environmental Protection Agency placed methidathion on high-priority roster for risk and its value based on the conceivable adverse effects in chronic toxicity, carcinogenesis and chromosomal anomalies.[10]

Methidathion and the substances produced by the metabolite within the body of organism their toxic reaction primarily through their irreversible inhibition of cholinesterase (ChE)

enzymes[10,11] the main way to metabolize methidathion in liver was through glutathion-s-transferase and the primary metabolizer was desmethyl methidathion.[12]

[13]Studied the effect of methidathion on blood standards in rabbits exposed to organic phosphorus pesticide methidathion orally and dose (10 mg / kg) and observed reduction of RBC and Hb and increase in red blood cell deposition rate (ESR).

As a result of the widespread use of agricultural pesticides in general and insects, especially in the province of Basrha and the consequences of the health hazards was aimed at this study to see the effect of phosphorous insecticide Methidathion on some blood standards and liver enzymes to male laboratory rats and females.

MATERIALS AND METHODS

Chemicals

Methidathion (Ultracidin) solution concentrated pack size 1L containing methidathion with 40%. Produced by FABCO-Jordan used commercially and purchased from local markets.

Experimental animals and treatment protocol

Male and femal mice aged (10-12) weeks, and weighing (20-25)g were used in study. The mice were obtained from Department of Biology, College of Education for Pure Sciences, University of Basrah, Iraq. They were housed in a room at constant temperature ranging from (20-25 0C) with 12 h light/ dark cycles, the mice were placed in plastic cages of standard size (30× 10×11 cm) manufactured by a company North Kent plastic Kent U.K, the cages were supplied with a log of wood that was changed weekly, and fed integrated diet.

The mice were randomly divided into three groups for each sex with eight animals in each group as follows

1- The first group (control): were intraperitoneally (i.p) injected with 0.1 ml of normal saline.

2- The second group (low dose): were i.p injected with 0.1 ml of 1.2 mg/kg of body weight of methidathion.

3- The third group (high dose): were i.p injected with 0.1 ml of 2.4 mg/kg of body weight of methidathion.

All group were daily injected for a period of 15 days. At the end of the injection period (15 day), the animals were sacrificed, blood was collected directly from heart of each animal, a part of the blood is placed in a container tubing on an anticoagulant(EDTA) and analyzed

using the Hematology Analyzer to determine of Blood parameters, which included red blood cell count (RBCs), the packed cell volume (PCV), hemoglobin (Hb), the mean corpuscular volume (MCV), the mean corpuscular hemoglobin (MCH), the mean corpuscular hemoglobin concentration (MCHC), and total white blood cell count (WBCs). The other part of the blood is placed in the gel tubes, at room temperature for clotting. Serum was separated by centrifuged at 3000 rpm. for 30 min and analyzed, for the concentration Aspartate transaminase (AST) and alanine transaminase (ALT) enzymes activity was measured using the color method depending on the method Reitman & Frankel (1957)[14] and using kit supplied by the French company Biolabo. and alkaline phosphatase ALP enzyme was measured by method Tietz, (1999)[15] using kit supplied by the French company Biolabo.

Statistical analysis

The Results are analyzed statistically by the Analysis of variance (ANOVA-R.L.S.D) test. The results are expressed as Mean± S.E. the statistical package for the social sciences (SPSS, V.11). Significance was set at the level of $P \leq 0.05$.

RESULTS

Table (1) shows the results of the effect of methidathion in the blood parameters of male mice. The results showed a significant decrease ($P \leq 0.05$) in RBC_S, PCV, Hb and MCV in in both doses (1.2, 2.4) mg / kg when compared with the control group, while the results did not show a significan difference in WBC_S, MCH, MCHC compared with the control group, while the two doses did not differed significantly($P \leq 0.05$) between the two doses in PCV, MCV, MCH and MCHC. the two doses did differed significantly($P \leq 0.05$) between the two doses in RBC_S and Hb.

Either in females, The results indicated in Table (2) showed a significant decrease PCV in the low dose only, at the level of probability ($P \leq 0.05$). The results also showed a significant decrease in Hb in the two doses (1.2, 2.4 mg / kg), while no significant difference was observed in both doses of RBC_S, MCV, MCH and MCHC when compared to the control group, while the two doses did not differ significantly PCV compared between them, while Were significantly different in hemoglobin (Hb) between them. The results showed a significant increase in the total number of white blood cells (WBC_S) for the two doses (1.2, 2.4 mg / kg compared to the control group at ($P \leq 0.05$). the two doses showed no significant differences between them. Biochemical tests: The results of the present study showed a significant increase in the level of ALT, ALP for male laboratory rats treated with

methidathion in the high dose of 2.4 mg / kg compared to control group at (P ≤0.05)., as shown in Table(3). The results of the present study showed that there was a significant increase in the level of ALT, ALP for the female mice treated with methidathion in low and high doses (1.2, 2.4) mg / kg, respectively.

Table 1: Effects of methidathion on hematological parameters in male mice.

Parameters / Groups	RBC $x10^6 mm^3$	WBC $x10^3 mm^3$	PCV (%)	Hb (g/dl)	MCV (μm^3)	MCH (pg)	MCHC (g\dl)
Control	^{a}7.6500 ±0.148	^{a}4.8875 ±0.735	^{a}35.2125 ±1.083	^{a}12.8250 ±0.310	^{a}46.0375 ±1.028	^{a}16.7125 ±0.202	^{a}36.6000 ±1.231
low dose 1.2 mg/kg	^{b} 6.7813 ±0.322	^{a} 5.1750 ±0.621	^{b}29.9125 ±1.676	^{b}10.9875 ±0.447	^{b}44.0375 ±0.530	^{a}16.1875 ±0.383	^{a}37.0250 ±1.151
high dose 2.4 mg/kg	^{c}6.1137 ±0.289	^{a}6.6000 ±1.143	^{b}26.5250 ±1.429	^{c}10.0750 ±0.512	^{b}43.3375 ±0.461	^{a}16.4125 ±0.134	^{a}38.0250 ±0.454
R.L.S.D	0.194	N.S	5.58	0.518	1.43	NS	NS

Values are means ± S.E., Different letters refer to a significant difference at (P≤0.05)

N.S refer to non-significant differences at (P≤0.05).

Table. 2: Effects of methidathion on hematological parameters in female mice.

Parameters / Groups	RBC $x10^6 mm^3$	WBC $x10^3 mm^3$	PCV (%)	Hb (g/dl)	MCV (μm^3)	MCH (pg)	MCHC (g\dl)
Control	^{a} 7.5900 ±0.236	^{b}3.2375 ±0.341	^{a} 35.6500 ±0.937	^{a} 12.4875 ±0.245	^{a} 47.0875 ±0.528	^{a} 16.4500 ±0.241	^{a} 35.0250 ±0.364
low dose 1.2 mg/kg	^{a} 7.0950 ±0.128	^{a}5.9750 ±1.079	^{b}32.0625 ±0.882	^{c}11.3000 ±0.207	^{a} 45.2750 ±0.896	^{a} 15.7750 ±0.258	^{a} 35.2750 ±0.540
high dose 2.4 mg/kg	^{a} 7.3975 ±0.176	^{a}6.0750 ±1.089	^{ab}33.6500 ±1.081	^{b}11.9250 ±0.252	^{a} 45.5000 ±0.530	^{a} 16.0875 ±0.192	^{a} 35.4875 ±0.572
R.L.S.D	N.S	2.43	2.78	0.158	N.S	N.S	N.S

Values are means ± S.E., Different letters refer to a significant difference at (P≤0.05)

N.S refer to non-significant differences at (P≤0.05).

Table. 3: Effects of methidathion on some liver enzymes in male mice.

Parameters / Groups	AST IU/ L	ALT IU/ L	ALP IU/ L
Control	96.125 ± 6.479	^{b}47.1250 ±3.870	b14.3526 1.136±
low dose 1.2 mg/kg	120.375 ± 11.770	$^{a\,b}$59.7500 ±5.188	b13.0806 0.701±
high dose 2.4 mg/kg	139.250 ± 17.551	^{a}83.5000 ±13.155	a26.1454 1.807±
R.L.S.D	N.S	25.13	3.34

Values are means ± S.E., Different letters refer to a significant difference at (P≤0.05) N.S refer to non-significant differences at (P≤0.05).

Table. 4: Effects of methidathion on some liver enzymes in female mice.

Parameters / Groups	AST IU/ L	ALT IU/ L	ALP IU/ L
Control	104.750 ± 14.743	[c]42.6250 ±2.359	[b]14.426 ±0.774
low dose 1.2 mg/kg	100.500 ± 9.870	[b]64.5000 ±7.789	[a] 18.967 ±1.236
high dose 2.4 mg/kg	107.625 ± 3.755	[a]156.0000 ±5.199	[a]20.260 ±2.114
R.L.S.D	N.S	14.27	4.40

Values are means ± S.E., Different letters refer to a significant difference at (P≤0.05) N.S refer to non-significant differences at (P≤0.05).

DISCUSSION

The reduction in the number of red blood cells is attributed to the fragility of the cell wall caused by organic phosphorus pesticides, which is caused by the exposure of the red blood cell to the oxidative stress caused by lipid peroxidation.[16,17] The study of Altuntas *et al.*[18] shows that methidathion increases the level of Malondialdehyde MDA in the erythrocytes, which is an indicator of the occurrence of lipid peroxidation (LPO) as well as decrease in the effectiveness of the antioxidants of superoxide dismutase (SOD) and glutathione peroxidase (GSH) And Catalase (CAT) which have a role in protecting the red blood cell from toxic substances and thus decreasing them Makes the pellets more susceptible to peroxidation of membrane lipids, leading to harmful effects on the red blood cell membrane and changes in its permeability, thus weakening the cell wall and its fragility and ease of decomposition.

The decrease in the Packed cell volume (PCV) is likely because of the lack of red blood cells due to their degradation due to the various factors resulting from exposure to pesticides.[19] Suggests that the excessive oxidation of lipids by pesticides leads to disruption of functions Physiological and biochemical processes in the red blood cell and thus the speed of their decomposition.[20] also suggests that oxidative damage caused by pesticides may be due to the lipophilicity characteristic by which the insecticide easily implements the cell membrane and causes lipid peroxidation.

The MCV is important to know the size and condition of the red blood cell.[21] The MCV reduction in the current study was not consistent with[22] study, which showed an increase in the Mean corpuscular volume (MCV) When the male rats of the laboratory are treated with

Chlorpyrifos, this may be due to the different type of animal and the pesticide used.[23] noted that some pesticides provoke changes in the size and shape of the red ball.

The current study showed low hemoglobin levels (Hb) along with reduced red blood cells. This may be due to the effect of pesticides on some organs (bone marrow and liver), inhibition of many steps of hemoglobin synthesis, as well as shortening of the age of the red blood cell[24], and[25] suggests that pesticide residues can cause the development of anemia due to intervention in hemoglobin biosynthesis and shorten the life span of red blood cells.

The current study showed an increase in the number of white blood cells (WBCs) in female laboratory rats injected with methadethione. This is consistent with the study of[26] conducted on female laboratory rats, as well as[27] and[28] and.[29] This increase may indicate activation of the animal defense mechanism and immune system.[27] Possibly due to leukocytosis, which causes progressive infiltration of white blood cells to peripheral blood.[29] The increase in the number of white blood cells may be due to the effect of the toxicity of the pesticide, which weakens the structure of the animal's body, making it acquire an enemy that in turn stimulates the immune response.[30] The increase of white blood cells despite the lack of red blood cellsin the current study indicates the incomplete suppression of bone marrow functions as confirmed by[31], when injecting mice with diazinone for 14 days.

Aspartate transaminase (AST) and alanine transaminase (ALT) enzyme and alkaline phosphatase ALP enzyme are present in the heart, liver, skeletal muscle, kidney, pancreas, spleen, lung Red blood cells and brain tissue and when these tissues are affected by the infection or disease occurs destruction of cells - especially the liver cells - liberated these enzymes into the blood stream.[32,33] reported that high serum levels of these enzymes are often a feature of acute liver damage or obstruction outside liver or both. This increase may be attributed to the levels of intracellular enzymes to be released from the cytoplasm to the circulatory system[34], which may be due to liver damage, indicating the presence of necrosis and inflammatory reactions.[35] The rise of these enzymes is a sign of liver damage[36,37], cell leakage and loss of hepatic cell function integrity as confirmed by.[38]

Phosphatases are critical and important enzymes in biologic processes that are responsible for the removal of toxicity and metabolism, as well as the bio-processing of large active molecules associated with different biologic functions.[39] Any disturbance in the activity of

these enzymes weakens cell functions[40] and increased ALP may be due to liver damage or irritation of undetermined tissues[41], Which show the state of stress experienced by animals.

REFERENCES

1. Rieuwerts J. The Elementts of Environmental pollution. Routledge. 2015; 352.
2. Uqab b.; Mudasir S.; and Nazir, R. Review on Bioremediation of Pesticides. J. of Bioremed. And biodegrade., 2016; 7: 3.
3. Ghorab, M. A. and Khalil, M.S. The Effect of Pollution on our life and Environment. J. Pollut. Cont., 2016; 4: 2.
4. Ghorab, M. A. and Khalil, MS. Toxicological Effects of Organophosphates Pesticides. Int. J. of Environ. Mon. and Ana., 2015; 3: 218-220.
5. Gupta, R. C. Toxicology of Organophosphate and Carbamate Compounds. Chapter 26, Elsevier Academic Press, Amsterdam. 2006; 371-380.
6. Gill, H. K. and Gary, H. Pesticide: Environmental Impacts and Management Strategies, Chapter 8, 187-230. In:. Larramendy, M. L. and Solonekie, S. (Eds.). Pesticides-Toxic Aspects, Intech. 2014; 238.
7. Elersek, T. and Filipic, M. Organophosphorus Pesticides-Mechanisms Of Their Toxicity, chapter 12, 243-260. In: Stoytcheva, M. (Ed.). Pesticides –The Impacts of Pesticides Exposure, In Tech. 2011; 458.
8. Garcia, F. P.; Ascencio, S. Y. C.; Oyarzrzun, J. C. G., Hernandez, A. C., and Alavarado, P. V. Pesticides : classification, uses and toxicity. Measures of exposure and genotoxic risk. J. Res. Environ. Sci. tox., 2012; 1(11): 279-293.
9. Sutcu, R.; Altuntas, I.; Yildirim, B.; Karahan, N.; Demirin, H.; and Delibas, N. The effects of subchronic methidathion toxicity on rat liver: role of antioxidant vitamins C and E. Cell biology and toxicology, 2006; 22(3): 221-227.
10. Lewis, C. M. Methidathion (supracide) risk characterization documen (revision 1) medical toxicology branch. Department of Pesticide Regulation. California Environmental Protection Agency, 2007.
11. Mileson, B. E.; Chambers, J. E.; Chen, W. L.; Dettbarn, W.; Ehrich, M.; Eldefrawi, A. T.; Gaylor, D. W.; Hamernik, K.; Hodgson, E.; Karczmar, A. G.; Padilla, S.; Pope, C. N.; Richardson, R. J.; Saunders, D. R.; Sheets, L. P.; Sultatos, L. G.; and Wallace, K. B. Common mechanism of toxicity: a case study of organophosphorus pesticides. Toxicol. Sci., 1998; 41(1): 8-20.

12. Beauvais, S. Estimation of exposure of persons in California to pesticide products that contain methidathion. California environmental protection agencyHS-1805. 2005.
13. Elias, M. A. and Saif, M. A. The protection effect of vitamins A, C, and e, against the potential toxicity of Methidathion on blood factors in male rabbits. Yem. J. Biol. Sci., 2009; 5(1): 133-136. (cited by Lone et al., 2013).
14. Wyrobek, A. and Bruce, W. Chemical induction of sperm abnormalities. Proc. Nat. Acad. Sci., 1975; 72: 4425-4429.
15. Tietz, N.W. Text book of clinical chemistry. (3rd ed). C.A. Burtis, E.R. Ashwood, W.B. Saunders. 1999; 1917.
16. Ambali, S. F.; Ayo, J. O.; Ojo, S. A. and Esievo, K. A. N. Vitamin E protects Wistar rats from chlorpyrifos-induced increase in erythrocyte osmotic fragility. Food and chemical toxicology, 2010; 48(12): 3477-3480.
17. Uchendu, C.; Ambali, S. F.; Ayo, J. O.; Esievo, K. A.; and Umosen, A. J. Erythrocyte osmotic fragility and lipid peroxidation following chronic co-exposure of rats to chlorpyrifos and deltamethrin, and the beneficial effect of alpha-lipoic acide. Toxicology reports, 2014; 1: 373-378.
18. Altuntas, I.; Delibas, N. and Sutcu, R. The effect of organophosphate insecticide methidathion on lipid peroxidation and anti-oxidant enzymes in rat erythrocytes: role of vitamins E and C. Human &experimental toxicology, 2002; 21(12): 681-685.
19. Kal, M.; Rathore, N.; John, S.; Bhatnagar, D. Lipid peroxidative damage on pyrethroid exposure and alterations in antioxidant status in rat erythrocytes: a possible involvement of reactive oxygen species. Toxicol let. 1999; 105: 197-205.
20. Prasanthi, K.; Muralidhara, R. and Rajini, P. S. Fenvalerate-induced oxidative damage in rat tissues and its attenuation by dietary sesame oil, Food and Chemical toxicology, 2005; 43: 299-306.
21. Nussey, G.; Van Vuren, J. H. J. and Du Preez, H. H. Effect of copper on the hematology and osmoregulation of the Mozambique tilapia, Oreochromis mossambicus (Cichlidae) comp. biochem. Phys., 1995; 111(3): 369-380.
22. Tripathi, S. and Srivastav, K. Alterations in the profile of blood cells of wistar rats induced by long-term ingestion of chlorpyrifos.international journal of pharma and bio sciences. 2010; 1(4): 315-322.
23. Comelekoglu, U.; Mazmanci, B. and Arpaci, A. Investigation of the liver function in agricultural workers chronically exposed to pesticides. Turk J Biol., 2000; 24: 461-466.
24. Ray, G. Pollution and health. Wiley Eastern Ltd. New- Dalhi. 1992; 45.

25. Patil, J. A.; Patil, A. J. and Govindwar, S.P. Biochemical effects of various pesticides on sprayers of grape gardens. Indian J. Clin. Biochem. 2003; 18: 16-22.
26. Mohamed, A.; Mohamed, M. and Mehdi, A. Toxicity of organophosphorus insecticide diazinon to female mice. J. of Sebha Univ. Pured and applied Sci., 2007; 6(2): 77-88.
27. Kalender, Y.; Uzunhisarcikli, M.; Ogutcu, A.; Acikgoz, F. and Kalender, S. Effects of diazinon on pseudocholinesterase activity and haematological indices in rats: The protective role of vitamin E. Environ. Toxicol. Pharmacol., 2006; 22(1): 46-51.
28. Kalender, S.; Uzun, F.G.; Durak, D.; Demir, F. and Kalender, Y. Malathion –induced hepatotoxicity in rats : The effects of vitamins C and E. Food chem. Toxicol., 2010; 48: 633-638.
29. Lone, M. Y., Baba, B. A., Raj, P., Shrivastava, V. K., and Bhide, M. Haematological and Hepatopathological Changes Induced by Dimethoate in Rattus rattus. Indo Am. J. Pharm. Res., 2013; 3(6): 4360-4365.
30. Celik, I. and Suzek, H. The hematological effects of methyl parathion in rats. J. Hazard. Mater. 2008; 153: 1117-1121.
31. El-Shenawy, N. S.; Al-Eisa, R. A.; El-Salmy, F. and Salah, O. Prophylatic effect of vitamin E against hepatotoxicity, nephrotoxicity, haematological indices and histopathology induced by diazinon insecticide in mice. Current Zoology, 2009; 55(3): 219- 226.
32. Banaee, M.; Mirvagefei, A. R.; Rafei, G. R. and Majazi Amiri, B. Effect of sub-lethal Diazinon Concentrations on Blood Plasma Biochemistry. Int. J. Environ. Res., 2008; 2(2): 189-198.
33. Hatoff, D. E. and Hardison, W. J. Hepatic bile acid content control alkaline phosphatase during cholestasis). Gastroenterology, 1980; 78: 1307.
34. Dasgupta, S., Ghosh, S., Das, K.K. Transaminase activities in some metabo- lically active tissues in nickel treated rats under protein restriction. Indian J. Physiol. Appl. Sci., 1996; 50: 27–33.
35. Kuzu, N.; Metin, K.; Ferda Dagli, A.; Akdemir, F.; Orhan, C.; Yalniz, M., et al. Protective role of genistein in acute liver damage induced by carbon tetrachloride. Mediators Inflamm. 2007; 1-6.
36. Eraslan, G.; Kanbur, M. and Silici, S. Effect of carbaryl on some biochemical changes in rats: the ameliorative effect of bee pollen. Food Chem. Toxicol. 2009; (47): 86–91.

37. Gokcimen, A.; Gulle, K.; Demirin, H.; Bayram, D.; Kocak, A. and Altuntas, I. Effects of diazinon at different doses on rat liver and pancreas tissues. Pestic. Biochem. Phys. 2007; 87: 103–108.
38. Ghosh, R.; Das, T.; Paramanik, A. and Choudhury, S. M. Taurine improves lambda cyhalothrin induced biochemical alteration in wistar rat. Intern.J. bio. 2016; 5(11): 5059-5065.
39. Yousef, M. I.; Awad, T. I. and Mohamed, E. H. Deltamethrin- induced oxidative damage and biochemical alterations in rat and its attenuation by vitamin E. Toxicology, 2006; 227(3): 240-247.
40. Khan, I.A.; Reddy, B.V.; Mahboob, M.; Rahman, M.F. and Jamil, K. Effect of phosphorothionate on the reproductive system of male rats. J. Environ. Sci. Health, 2001; (36): 445–456.
41. Bhadaniya, A. R.; Kalariya, V. A.; Joshi, D. V.; Patel,B. J., Chaudhary, S., Patel, H. B., Patel, J. M., Patel, U. D., Patel H.B., Ghodasara, S. N. and Savsani, H. H. Toxicopathology evaluation in wistar rats (Rattus norvegicus) following repeated oral exposure to acephate. Toxicology and Industrial Health, 2012; 31(1): 9-17.