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Original Article

Effect of Dimethoate on the response of antioxidants in Albino rat

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ABSTRACT

There is a considerable interest in detailed study of free radical-mediated damage to biological systems due to pesticide exposure. These Compounds have induced an excessive production of free radicals which are responsible for several cell alterations in the organism. Recent investigations have proved the crucial role of nutritional antioxidants to prevent the damage caused by toxic compounds. Dimethoate (DM) is an organ phosphorous insecticide and acaricide used to kill mites and aphids among other insects and is applied on citrus, cotton, fruit, olives, potatoes, tea, tobacco and vegetables. The aim of the present work was to study biochemical changes that might occur in the kidney of albino rats as a result of DM intoxication. In the present investigation the animals were kidney treated with $1/10^{th}$ of LD_{50} of DM via oral gavage (34.5mg/kg body weight. The first group animals were considered as control animals. Second group of animals were treated with Dimethoate via oral gavage (34.5mg/kg body weight which is $1/10^{th}$ of LD_{50}) for 10 days, third and fourth groups of animals were administered for 20 and 30 days with an interval of 48h respectively. The present findings indicate that chronic exposure to DM has clear toxic effect on the kidney of albino rats.

Keywords:
Dimethoate, Albino rat, Kidney, Antioxidants.

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Introduction

The pollution of the environment plays a crucial role in the occurrence of many disease a Organophosphorus effecting plants, animals and man. One of the main factors causing pollution of the environment is the irrational use of organophosphate insecticides (Al-Haj et al., 2005). Toxicity of these OP compounds results in negative effects in many organs like liver, heart, kidney, nervous system and reproductive systems. Ferah Sayim et al., (2007). Many alterations have been observed in organs of animals due to the Organophospharus insecticides kidney (Kossmann et al., 1997). (OPI) constitute one of the most widely used classes of pesticides being employed for both agricultural and landscape pest control. Use of OPI has increased considerably due to their low toxicity and low persistence in the mammalian system compared to organochlorine pesticides. OPI are primarily recog- nized for their ability to induce toxicity in mammals through inhibition of acetyl cholinesterase (AChE) and subsequent activation of cholinergic receptors. Costa et al .,(2006) The main mechanism of toxicity of OPI is due to irreversible binding to aChE as opposed to reversible binding by car- bamates, thereby resulting in prolonged e? ects of acetyl- choline. Matsumura et al., (1985) various complications have been reported in OPI intoxication cases, Hsiao et al., (1996) and hyperglycemia has been widely reported as one of the major adverse e? ects in poi- soning by OPI in humans and animals. Abdollahi et al., (2003). Dimethoate (O, O-dimethyl S-N-methyl carbomyl methyl phosphorodithioate) (DM) is one of the most important OPI used extensively on a large number of crops against several pests. Organophospharus insecticide

(OP) represents one group of pesticides that is widely used and has proved to have toxic effects in humans and animals (De-Bleecker et al., 1993: Betrosian et al., 1995: Tsatsakis et al., 1998: Hagar and Fahmy, 2002). Yahya et al., (2012) studies the effect of DM induced oxidative stress and morphological changes in the liver of guinea pig. Devi Sri Lakshmi kala et al., (2013) studied the effect of DM on different regions of the brain in the albino rat. It is well known that pesticides, which we are widely used in agriculture, have many harmful effects on living organisms. Animals in the natural environment are usually exposed to low concentrations of xenobiotics, which are sub – lethal. Dimethoate (S- methylcarbamoyl-methyl-O, O- dimethyl phosphorodithioate) has been used for many years in many countries as a broad – spectrum insecticide.

2. Materials and methods

Test Chemical: Dimethoate Technical (94%) pure in crystalline form was obtained from Hyderabad chemical limited, Hyderabad A.P., India.

Animal model:

Male adult Albino rat of 7 weeks old and aged 200 ± 20 g. were obtained from Indian Institute of Science (II.Sc.), Bangalore. They were housed at an ambient temperature 28 ± 2°C in a 12-h light/dark cycle and a minimum humidity of 40%. The animals had free access to commercial pellet diet supplied by Sai Durga Feeds and Foods, Bangalore, India and water ad libitum.

Experimental Design:

All the male healthy adult male albino rats were randomly divided into four groups having with six rats per group. The first group animals were considered as control animals. Second group of animals were treated with Dimethoate via oral gavage (34.5mg/kg body weight which is 1/10th of LD50) for 10 days, third and fourth groups of animals were administered for 20 and 30 days with an interval of 48h respectively.

Biochemical Assays

The activity of SOD was assayed by the reduction of nitro blue tetrazolium. Here the Superoxide was produced by riboflavin mediated photochemical reaction system. Superoxide dismutase activity was determined according to the method of Beachamp and Fridovich (1971). Catalase activity was measured by a slightly modified version of Aebi (1984) at room temperature. Se-Dependent Glutathione Peroxidase was determined by a modified version Flohe and Gunzler (1984) at 37℃. GR activity was determined by a slightly modified method of Carlberg and Mannervik (1985) at 37℃.

Statistical treatment

The data was subjected to statistical treatment. One way analysis of variance (ANOVA) and S-N-K tests were performed using SPSS (ver. 12) in the personal computer and $p < 0.05$ was considered as statistically significant.

Results

Kidney was one of the target organs of experimental animals attached by acute, sub-chronic and chronic exposure to o5rgano phosphate insecticide. Alterations in kidney function were characterized by signs of injury such as changes in relative kidney weights urinary volume and the fractional excretion of potassium. (Amira Mahjoubi-Samet 2008).

The data presented in tables are showed the changes in SOD, CAT, GPx and GR Activity. Gradual decreased in these enzymes activity was observed from single dose to multiple doses treated rats in dose dependant manner. The alterations in antioxidant enzyme activities were more pronounced in multiple dose treated Albino rats. The decrease in SOD, CAT, GPx and GR markers of radical oxygen species generation, which indicates the Oxidative Stress induced by Dimethoate. The SOD, CAT, GPx and GR activity levels were depleted significantly in different tissues during repeated exposure of rats to Deltamethrin (Manna et al. (2005).

Superoxide dismutase activity (SOD) was assayed to observe the levels of detoxification of superoxide anion radicals contains the increasing days of pesticide, the SOD activity levels decreased. The Dimethoate induced oxidative stress resulted in tissue damage and in depletion of SOD activity levels. Ferrari, (2007) reported the decreased

catalase content in liver and kidney of rainbow trout. The early inhibitory effect in CAT activity may be associated with a high degree of oxidative stress. Verma Radhey and Srivastava (2003) reported decrease in CAT in liver kidney and spleen. The data provide evidence for induction of oxidative stress on Chlorpyrifos exposure. GPx converts GSH to oxidized form (GSSG). In return to recycle GSSG to GSH cells utilize Glutathione Reductase (Gerard-Monier et al., 1996, Lu 1999, Dringer 2000, Zasadowski et al., 2004). Thus, changes in the activity of GPx are connected with GR activity and with changes in tissue GSH level. The GPx enzymes play a critical role in protecting the cell from free radical damage, particularly lipid peroxidation. The activity of glutathione peroxidase is significantly reduced in all tissues. The oxidized form of glutathione disulfide (GSSG) is reduced to GSH by the enzyme Glutathione Reductase (GR), which uses NADPH as a co-factor. In tissues GR activity is for lower than GSH-Px activity. All tissues have shown a decreased trend of enzyme activity.

Discussion

Dimethoate effects on various enzymatic antioxidant such as SOD, Catalase, GPX and GR. All the enzyme activities in the present study decreased as compared to their respective controls. This indicates the failure of anti oxidant defense system.

The kidneys are the major detoxification organ for many xenobiotics, is frequently susceptible to their nephrotoxic effects. Acute renal failure was reported following exposure to OPs. The transient renal injury was attributed in these studies to both a direct action of the OP, causing tubular cell necrosis, and to a secondary mechanism that followed the cholinergic crisis, causing hypovolemic shock and rhabdomyolysis. Administration of Dimethoate induced typical signs of OP toxicity in different biochemical parameters studied in the present investigation and the effect was more pronounced in 30 days when compared to 10 days. The extensive use of OP compounds during the last several decades in agriculture and for public health purposes has led to drastic effects on non-target animals. Most of these chemicals are unfortunately not highly selective and therefore have been proved highly toxic to non-target animals including man and other desirable forms of life that co-inhabit the environment. Therefore, the improper application of these pesticides may result in serious illness and even death.

In conclusion, the results of the present study revealed that dimethoate induces the toxicity in the kidney of rat. The majority of the changes observed in our study clearly indicate that the kidney is severely damaged under dimethoate toxicity in a dose dependent manner. The pollutants such as pesticides are known to induce a broad spectrum of toxicological effects and biochemical dysfunction constituting serious hazards to health. The results of present study are mirror to several extent of toxicity of pesticides used by human beings to non target organisms and for human beings too.

Table -1.Changes in Superoxide Dismutase (SOD) activity levels in different tissues of *Albino rats* exposed to sub-lethal dose of Dimethoate.

Tissues	Control	10 days	20 days	30 days	F ratio
Liver	4.657	4.237[a]	2.364[a]	1.577	93.270*
± SD	0.531	0.332	0.328	0.101	
(% Change)		(-9.02)	(-49.24)	(-66.14)	
Heart	3.489	2.211	1.338	0.771	221.792*
± SD	0.259	0.17	0.116	0.074	
(% Change)		(-36.63)	(-61.65)	(-77.90)	
Kidney	3.401	2.883	2.599	2.110	37.169*
± SD	0.239	0.148	0.217	0.145	
(% Change)		(-15.23)	(-23.58)	(-37.96)	
Pancreas	4.234	3.889	3.370	2.690	18.575*
± SD	0.426	0.306	0.487	0.231	
(% Change)		(-8.15)	(-20.41)	(-36.48)	

Values expressed in units of superoxide anion reduced / mg protein / min are Mean ± SD of six individual observations. Values in the parenthesis indicate % change over control. Mean values with the same superscript do not differ among themselves through S-N-K test.
*P<0.001

Table – 2.Changes in Catalase activity levels in different tissues of *Albino rats* exposed to sub-lethal dose of Dimethoate.

Tissues	Control	10 days	20 days	30 days	F ratio
Liver	3.096	2.488	2.370	1.726	44.791*
± SD	0.228	0.154	0.220	0.059	
(% Change)		(-19.64)	(-23.45)	(-44.25)	
Heart	1.788	1.546	1.402	1.114	31.633*
± SD	0.128	0.084	0.096	0.110	
(% Change)		(-13.53)	(-21.59)	(-37.70)	
Kidney	2.730	2.414	2.056	1.729	99.072*
± SD	0.101	0.091	0.077	0.111	
(% Change)		(-11.58)	(-24.69)	(-36.67)	
Pancreas	2.661	2.264	2.042	1.832	227.532*
± SD	0.057	0.025	0.062	0.071	
(% Change)		(-14.92)	(-23.26)	(-31.15)	

Values expressed in µ moles of H2O2 decomposed / mg protein / min are Mean ± SD of six individual observations. Values in the parenthesis indicate % change over control. Mean values with the same superscript do not differ among themselves through S-N-K test.
*P<0.001

Table - 3. Changes in Glutathione peroxidase activity levels in different tissues of *Albino rats* exposed to sub-lethal dose of Dimethoate.

Tissues	Control	10 days	20 days	30 days	F ratio
Liver	2.701	2.399	1.998	1.610	23.653*
± SD	0.239	0.217	0.260	0.145	
(% Change)		(-11.18)	(-26.03)	(-40.39)	
Heart	2.310	1.657	1.421	1.127	106.053*
± SD	0.129	0.102	0.148	0.070	
(% Change)		(-28.27)	(-38.48)	(-51.21)	
Kidney	2.243	1.980	1.836	1.425	44.788*
± SD	0.102	0.138	0.096	0.110	
(% Change)		(-11.72)	(-18.14)	(-36.47)	
Pancreas	2.333	2.115	1.832	1.595	71.798*
± SD	0.077	0.055	0.072	0.107	
(% Change)		(-12.50)	(-20.83)	(-33.33)	

Values expressed in µ moles of NADPH oxidized / mg protein / min are Mean ± SD of six individual observations. Values in the parenthesis indicate % change over control. Mean values with the same superscript do not differ among themselves through S-N-K test.
*P<0.001

Table – 4. Changes in Glutathione Reductase activity levels in different tissues of *Albino rats* exposed to sub-lethal dose of Dimethoate.

Tissues	Control	10 days	20 days	30 days	F ratio
Liver	1.456	1.260[a]	0.794[a]	0.794	47.691*
± SD	0.127	0.075	0.061	0.061	
(% Change)		(-13.46)	(-45.47)	(-44.47)	
Heart	1.251	1.057	0.890	0.712	11.347*
± SD	0.054	0.069	0.030	0.046	
(% Change)		(-15.51)	(-28.86)	(-43.09)	
Kidney	1.632	1.552	1.301	1.029	18.217*
± SD	0.151	0.183	0.156	0.087	
(% Change)		(-4.91)	(-20.28)	(-36.95)	
Pancreas	1.750	1.363	1.189	0.995	48.910*
± SD	0.107	0.124	0.062	0.082	
(% Change)		(-22.11)	(-32.06)	(-43.12)	

Values expressed in µ moles of NADPH oxidized / mg protein / min are
Mean ± SD of six individual observations. Values in the parenthesis indicate % change over control. Mean values with the same superscript do not differ among themselves through S-N-K test.
* P<0.001

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