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Research Article

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Effects of Acute exposure of Methyl Parathion and Chlorpyrifos on Creatinine Levels in Albino Rats (*Rattus norvegicus*)

[1]Shubham V. Jadhao, [2]Dr. Milind D Kale

[1]Department of Zoology, Kai. Rasika Mahavidyalaya, Deoni Dist. Latur 413 519, India
[2]Department of Zoology, Government Vidarbha Institute of Science and Humanities, Amravati 444 604, India E-mail: *shubhamuchiha01@gmail.com*

Abstract

Organophosphate pesticides, though indispensable in modern agriculture, are presenting a serious health hazard due to their toxicity to non-target organisms. Although OPs are classically recognized for neurotoxic action through the inhibition of acetylcholinesterase, their acute effects on vital metabolic and excretory organs are further to be investigated. The present study was undertaken to evaluate the hepatotoxic and nephrotoxic outcome of acute high-dose oral exposure to a commonly used organophosphate pesticide in adult male albino rats (*Rattus norvegicus*). Animals were divided into control and experimental groups, and the latter group of rats was orally exposed to its sublethal dose calculated from LD{}_{50} values. After 24 h of its administration, biochemical assays revealed significant elevations ($p<0.05$) of serum hepatic enzymes (SGOT, SGPT) and renal function markers (urea, creatinine), which indicated an acute dysfunction of respective organs. Such biochemical alterations were further supported by histopathological changes, including centrilobular necrosis, sinusoidal congestion, and cytoplasmic vacuolation of hepatic tissue and tubular degeneration, glomerular congestion with narrowing of Bowman's space in renal tissue. These findings together indicate that acute OP exposure causes rapid hepatic and renal injury, independent of cholinergic mechanisms, and is likely mediated by oxidative stress and cellular disruption. The study points to an immediate need for increased regulatory oversight and the consideration of strategies involving protective antioxidants for mitigating risks from accidental OP exposure.

Keywords: Organophosphates, albino rats, renal toxicity, creatinine, biomarker

1. Introduction

Agriculture sector's dependence on synthetic pesticides for safeguarding the crop yields to cope up with increasing supply demand has led to a persistent accumulation of OPP in the environment *(Muyesaier Tudi e tal., 2021).* Among these, in our country the major share is of methyl parathion and chlorpyrifos. Potent as they may be, their lack of target specificity poses an

alarming threat to non-target animals including humans as well as domestic animals*(Odunayo T. Ore e tal., 2023).* Acute exposure is occupational hazard resulting from accidental ingestion, improper handling, and lack of protective equipment.

Conventionally, OPP are known for their ability to down regulate acetylcholine esterase enzyme by irreversibly engaging its active site. Inhibition of Acetylcholine esterase leads to accumulation of acetylcholine neurotransmitter in cholinergic synapse causing hyperstimulation *(Tena Cadez et al.,).* Yet, nascent studies and clinical data implies OPP damage extends way beyond synapse. Kidney being pivotal in excretion of these metabolites is predisposed to their toxic effects.

(L Carmona e tal., 2025) Coherence of renal function is assessed by measuring serum creatinine levels. Rise in the levels of creatinine suggests decline in the Glomerular Filtration Rate (GFR).

Inadequacy in the comparative data focusing specifically on acute exposure in a controlled biological model is the motivation of this study.

2. Material and Method

2.1 Animal Model

Albino rats of Wistar strain were used for their docile nature, ease of handling and physiological similarities to humans.

18 adult albino rats of either sex was used. Rats were acclimatized for a period of 2 weeks with equal hour cycles of light and dark. Temperature ranging 24±6 ℃ and humidity of 60%.

Rats had ad *labium* food and water.

2.2 Chemicals and Dosage:

2.2.1 Organophosphate pesticides) Methyl Parathion: O, O-dimethyl O-4-nitrophenyl phosphorothioate $C_8H_{10}NO_5PS$

b) Chlorpyrifos: O, O-diethyl O-(3,5,6 - trichloropyridin-2-yl) phosphorothioate $C_9H_{11}Cl_3NO_3PS$.

The target dose was derived from Lethal Dose (LD50). As per the available literature on toxicological impacts of methyl parathion and chlorpyrifos. The dose rate for methyl parathion was kept 05 mg/kg body weight and for chlorpyrifos it was kept at 10 mg/kg body weight. To ascertain the concentration and purity of the pesticide, animal's weight and the target dose in mg/kg were used for further calculations of mass of the active ingredient. This required volume of the commercially available pesticide was then deduced as follow

General formula:

$$\text{Volume (mL)} = \frac{Dose\left(\frac{mg}{kg}\right) \times Body\ weight(g)}{Concentration\left(\frac{mg}{mL}\right)}$$

For Methyl Parathion: $\frac{5\ mg/kg \times Body\ weight\ (g)}{500mg/ml}$

For Chlorpyrifos: $\frac{10\ mg/kg \times Body\ weight\ (kg)}{500mg/ml}$

2.2.2 Vehicle

To ensure the scientific validity of the experiment, the control groups were administered with distilled water (vehicle). Route of administration, volume, and schedule for administration of vehicle in control group was kept similar as that of drug administration in treated groups. As organophosphates are soluble in water distilled water was vehicle of choice.

2.3 Grouping of animals

All 18 animals were divided in 3 groups with 6 rats each.

Group I (n=6) (C_1, C_2, C_3, C_4, C_5, C_6)	**Control (Marked with 'C')**
Group II (n=6) (MT_1, MT_2, MT_3, MT_4, MT_5, MT_6)	Methyl Parathion Treated (Marked with 'MT')
Group III (n=6) (CfT_1, CfT_2, CfT_3, CfT_4, CfT_5, CfT_6)	Chlorpyrifos Treated (Marked with 'CfT')

2.4 Biochemical Analysis

For the blood sample, the *Lateral Saphenous Vein*was punctured with a fine needle and 0.5 ml blood was collected per rat. Samples were centrifuged at 4500 rpm for 20 minutes. Serum was extracted and stored at -20℃. Each sample of blood yielded nearly 0.2 ml of serum (200µL)

Kidney function marker, Creatinine, was estimated using analysis kit reagents as per the instruction manual of the kit. Creatinine test program was set in Automatic Biochemistry Analyser (Mindray BS 390; Serial no. WT-31001512).

Serum was analysed for levels of creatinine. Mean values of treated groups was compared against that of the control group.

2.5 Statistical Analysis A t-Test paired two samples for mean was used to analyse data as control vs treated. One way ANOVA was performed to establish statistical significance.

3. Observation and Results

Table 3. Comparative analysis of creatinine over 21 days

Creatinine mg/dL		
DAY 1		
Control	**MT**	**CfT**
1.3	1.1	0.6
1.1	0.6	1.2
0.7	0.7	1.1
1.4	1.1	0.9
0.9	1.3	1.5
0.5	1.7	1.8
DAY 21		
0.7	1.3	1.9
0.9	1.7	0.9
0.6	0.9	1.6
1.1	1.9	3.2
1.7	2	1.5
0.5	1.8	2.1

Mean values of Creatinine		
Group	Day 1	Day 21
Control	0.93	0.84
MT	1.01	1.54
CfT	1.11	1.73

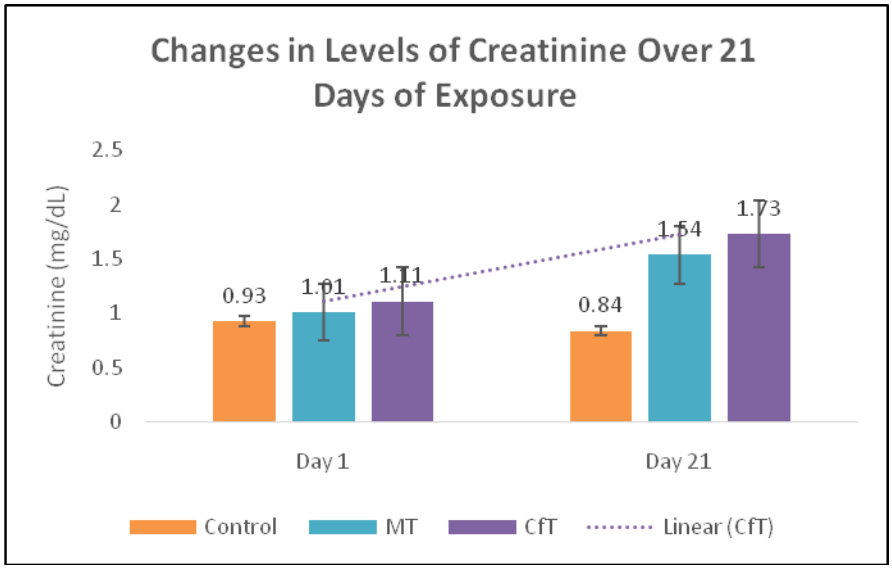

Figure 3 Changes in levels of Creatinine over 21 Days of exposure

Groups	*Count*	*Sum*	*Average*	*Variance*		
Control	12	11.4	0.95	0.144545		
MT Treated	12	16.1	1.341667	0.226288		
Cf Treated	12	18.3	1.525	0.480227		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	2.070556	2	1.035278	3.649368	0.036997	3.284918
Within Groups	9.361667	33	0.283687			
Total	11.43222	35				

P value ≤ 0.05 indicates statistical significance of the experiment. As variation within group is less than variation among the groups.

Control Group showed little to no variation in the levels of creatinine whereas, methyl parathion treated groups' mean at day 1 was 1.01mg/dL and at end of sub-acute exposure it was 1.54 mg/dL,which means increase in creatinine levels by52.47 %

Chlorpyrifos treated groups' mean at day 1 was 1.11mg/dL and at end of sub-acute exposure it was 1.73 mg/dL, which means increase in creatinine levels by 55.85 %

Conclusions

This study provides strong evidences that even acute exposure of organophosphate elicits biochemical disturbances in albino rats. Findings not only highlight the potential health risk associated with acute exposure but also validate the use of these biochemical markers as reliable indices for monitoring pesticides induced toxicity in laboratory and potentially environmental health settings.

Data also serve as foundations for future studies exploring long term ecological impacts and for better agricultural practices.

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