FEDERAL UNIVERSITY WUKARI INTERNATIONAL JOURNAL OF BIOSCIENCES (FUWIJOB)
pISSN: 3121-9799, eISSN: 3121-973x; Volume 2, No. 2, June, 2026
https://fuwijob.com.ng

Toxic Effects of Cypermethrin And Dimethoate on Some Biochemical Parameters of Male Wistar Rats

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ABSTRACT

Cypermethrin, (Pyrethroid) and Dimethoate (Organophosphate) are widely used pesticides with potential toxic effects on non-target organisms, including humans and animals. This study investigated the kidney and liver function of male Wistar rats following exposure to these pesticides, either individually or in combination. The research aimed to evaluate their toxicological impact and elucidate potential alterations in physiological and biochemical parameters. Forty (40) Male Wistar rats randomly allotted into control and experimental groups were administered varying doses of Cypermethrin, Dimethoate, and a combination of both over a period of 28 days. Liver function tests (ALT, AST, ALP, bilirubin) and kidney function markers (urea, creatinine) were measured to evaluate organ function variations. Liver function markers revealed elevated levels of ALT, AST, and bilirubin, indicating hepatocellular damage. Kidney function markers such as urea and creatinine were also elevated, suggesting nephrotoxicity. The combined exposure group exhibited the most severe toxic effects, highlighting potential synergistic toxicity. This study revealed that Cypermethrin and Dimethoate compromised the liver and kidney function in male Wistar rats. The findings underscore the need for cautious use of these pesticides and further research to assess their long-term impacts on human and animal health.

Keywords: Dimethoate, Cypermethrin, Nephrotoxic, Hepatotoxic, Mixture

INTRODUCTION

Pesticides are chemical substance used to control, or kill a pest (Chen *et al.*, 2024; Yarkwan *et al.*, 2024). Pesticides may be in form of insecticides, herbicides, fungicides or rodenticides. They are used for farming purpose to protect crops, and health purpose to control disease carrying insects such as mosquitoes (Datta *et al.,* 2024; Yarkwan *et al.*, 2024). Pesticides are produced under certain compliance procedures with quality control measures due to their toxic effects on humans and environment including soil, water, and air (Chen *et al.*, 2024). Human and some other animals are exposed to pesticides through food intake, contaminated water and air (Chen *et al.*, 2024).

Dimethoate is a systemic organophosphate insecticide that inhibit the enzyme acetylcholinesterase, which is essential for nerve function in insects leading to their paralysis and death (Baratzhanova *et al.,* 2024). When this pesticide is used, more than 98% reach a destination other than its target where it is transformed and produce toxic metabolites, hence, contributing to environmental pollution (Riyaz *et al.,* 2021). This results in higher concentration of dimethoate in marine animals especially (Okogwu *et al.,* 2022). Dimethoate has been reported to interact with DNA causing its damage as a

result of accumulation of free radicals causing oxidative stress (Panda *et al*., 2024).

Cypermethrin is an insecticide that acts as neurotoxin in its target organism (Scheepers *et al.,* 2023). Higher percentage of the insecticide reaches non-target organisms exposing them to toxic metabolites that are detrimental to the health. Apart from agricultural purpose, cypermethrin is found in domestic item such as mosquitoe repellant (Major and Brander, 2020). The toxicity of this chemical can cause skin and eye irritation. It can also modulate gamma-amniobutyric acid causing neurotoxicity. It is essential that pesticides is degradable to ensure a safer environment. This study aims at determinig the effects of cypermetrin and dimethoate on some biochemical parameters of male wistar rats.

MATERIALS AND METHODS

Materials

Experimental Animal

Forty healthy adult male Wistar rats weighing between 200 and 250g were used for this experiment. The rats were purchased from Mctemmy Concept Ogbomoso, Oyo State. The animals were bred in plastic and wire gauze cages in the animal house of the Science Laboratory Technology, Federal Polytechnic Ayede, Ayede, Oyo State, Nigeria. The rats were allowed to acclimatize for two weeks; during which they were fed with a standardized pellet diet and allowed free access to water. The care and handling of the animals followed the internationally accepted standard guidelines for animals' use by the National Research Council (Percie *et al.,* 2020)

Chemicals and Reagents

Cypermethrin and Dimethoate were obtained from Irorun Agbe Farm Boosters, Caretaker junction, Ogbomoso, Oyo State. All other chemicals that were used in the study were of analytical grade.

Methods

Animal Grouping

Forty (40) male wistar rats weighing between 200g and 220g were used for the study. They were randomly grouped into 4 of 10 rats each after acclimatization period of 2 weeks. Table 1 shows the animal grouping and description.

Table 1: Animal Grouping and Description

Groups	Doses Administration (g/kg Body Weight)
Control	rats were given normal feed and water
Cypermethrin	rats were given 1.9ml/kg of cypermethrin once daily orally
Dimethoate	rats were given 1.9ml/kg of dimethoate once daily orally
Cypermethrin + Dimethoate	rats that were given 1.9ml/kg of cypermethrin + dimethoate once daily orally

The animals were administered with the toxicants for 4 weeks, after which they were sacrificed.

Then, biochemical assays including haematological parameters (including white blood cell count, Red blood cell count), Liver Function Tests (ALT, AST, ALP, bilirubin) and Kidney Function Indices (Creatinine, urea, and electrolytes) were carried out.

Preparation of Tissue Homogenate and Serum

Rats were anaesthetized with diethyl ether fumes. Following the unconsciousness, the jugular veins were cut, and 5ml of blood was collected into clean, dried centrifuge tubes. Clear serum was collected after centrifuging at 503 x g for 10 minutes. The sera were frozen in refrigerator before various biochemical assays.

Liver Function Indices

The method described by Reitman and Frankel (1957) was used to assay for the activity of alanine aminotransferase and aspartate aminotransferase while alkaline phosphatase (ALP) was assayed using the method described by Wright *et al* (1972).

Kidney Function Indices

To determine the amount of serum urea, the procedure analyzed by Veniamin and Vakirtzi (1970) was used.

Serum uric acid and potassium ion were determined by the method described by Tietz (1995). Serum Creatinine was analyzed following the method described by Bartels and Bohmer (1972). The procedure described by Tietz *et al*. (1986) was used to determine the amount of Bicarbonate ion.

Data Analysis

The data generated from the study is presented as the mean ± standard deviation of the ten replicates and subjected to a one-way analysis of variance (ANOVA). The data was considered statistically different at ($p < 0.05$) using Graph Pad Prism version 10.0

RESULTS

Table 2: Liver Function Parameters of Experimental Rats

Parameter/Group	Control	Cypermethrin	Dimethoate	Mixture
Total Bilirubin(mg/dL)	0.43±0.05	0.43±0.03	0.39±0.03	0.43±0.07
Total Protein(g/L)	55.98±0.89	70.10±1.02[a]	57.72±0.92[a]	64.82±0.95[a]
Albumin(g/L)	36.45±0.55	43.55±0.62[a]	41.18±0.60[a]	41.18±0.63[a]
SGOT(U/L)	48.96±0.88	31.34±0.78[a]	54.00±0.82[a]	33.76±0.76[a]
SGPT(U/L)	6.56±0.22	6.58±0.24	9.60±0.28[a]	5.60±0.21[a]
ALP(U/L)	35.87±0.62	41.33±0.67[a]	34.93±0.63[a]	31.60±0.59[a]

Data are expressed as means ± S.D. of ten animals per group. Values in the same row with superscript a are significantly different ($p < 0.05$) from the control

Table 3: Kidney Function Parameters of Experimental Rats

Parameter/group	Control	Cypermethrin	Dimethoate	Mixture
K+(mmol/L)	3.19 ±0.05	2.65±0.04[a]	3.32±0.05[a]	2.15±0.02[a]
Chloride (mmol/L)	79.37 ±1.18	89.21±1.19[a]	49.21±1.02[a]	74.29±1.11[a]
HCO_3(mmol/L)	24.75 ±0.88	10.77±0.56[a]	32.1±0.90[a]	12.1±0.84[a]
Na+(mmol/L)	120.90 ±2.04	103.50±2.08[a]	125.00±2.11[a]	97.07±1.09[a]
Urea(mg/dL)	38.95 ±0.12	20.23±0.10[a]	31.70±0.11[a]	43.50±0.14[a]
Creatinine(mg/dL)	1.20 ±0.01	1.30±0.01[a]	1.00±0.01[a]	1.00±0.01[a]

Data are expressed as means ± S.D. of ten animals per group. Values in the same row with superscript are significantly different ($p < 0.05$) from the control.

DISCUSSION

The discussion of the results focuses on understanding how Cypermethrin, Dimethoate, and their mixture affected liver and kidney function when compared to the control group. The analysis of total bilirubin levels showed no significant differences across all groups, indicating that the treatments did not impair bilirubin metabolism or the liver's detoxification processes. This suggests that the liver maintained its ability to excrete waste products efficiently despite the exposure to these chemicals.

In terms of total protein and albumin levels, Cypermethrin and Dimethoate led to significant elevations when compared to the control group, with the Mixture group showing similarly elevated levels, consistent with a previous study. (Khaled *et al*., 2023). These changes imply heightened protein synthesis, which could be a response to stress or toxicity (Zhang *et al*., 2015). Elevated albumin levels might reflect the liver's adaptive response to increased protein demands or inflammation, as albumin is a major plasma protein synthesized in the liver (Sun *et al*., 2019).

The liver enzymes SGOT (AST) and SGPT (ALT) provided further insights into potential liver damage. Dimethoate significantly elevated both SGOT and SGPT, indicating hepatocellular injury and possible leakage of these enzymes due to damaged liver cells (Saleem *et al*., 2025). In contrast, the Cypermethrin-administered group showed reduced changes in these enzymes, suggesting less severe or negligible hepatotoxicity compared to Dimethoate. This pattern suggests that Cypermethrin might not strongly affect liver cells as much as Dimethoate, while the mixture may exhibit antagonistic effects that reduce the toxic impact of Dimethoate.

For alkaline phosphatase (ALP), Cypermethrin caused significant elevation, which could suggest cholestasis or an effect on biliary function (Sarkar *et al*., 2025). However, the ALP levels in Dimethoate and Mixture groups remained close to the control, although significantly different when compared with the control group.

Interestingly, the mixture group generally displayed intermediate effects compared to the individual chemicals. This finding suggests potential antagonistic interactions between Cypermethrin and Dimethoate that may have reduced the overall toxic impact when they were combined (Ramon-Yusuf *et al*., 2017). Further research would be necessary to explore the mechanisms behind this interaction.

When compared to the control group, the variations observed in the treated groups highlight the toxic effects of these chemicals, with Dimethoate causing the most pronounced hepatotoxicity. These findings underline the need to assess the safety of these substances, especially when used individually or in combination, as they may have varying impacts on liver function.

Studies have reported the nephrotoxic effects of various pesticides, particularly organophosphates and pyrethroids (Sidhu *et al*., 2019). Findings from our study revealed consistencies with previous studies, administration of the pesticides either singly or in combination was able to distort the renal indices assessed

Generally, the results emphasize the hepatotoxic as well as the nephrotoxic potential of Dimethoate, and Cypermethrin, and the toxicity observed in the Mixture group.

CONCLUSION

Overall, the results emphasize the hepatotoxic as well as the nephrotoxic potential of Dimethoate, and Cypermethrin, and the toxicity observed in the Mixture group.

ACKNOWLEDGEMENTS

The authors would like to appreciate the Federal Government of Nigeria's Tertiary Education Trust Fund (TETFUND) for it's support towards this research.

CONFLICTS OF INTEREST

The authors declare no conflict of interest whatsoever.

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