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Hepato-toxic Effects of Pyrethroid Pesticides on Adult Mice: Exploring Potential Health Implications.

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ABSTRACT

Pyrethroids are synthetic chemical compounds derived from the naturally occurring pyrethrins found in chrysanthemum flowers. They are effectively used in agricultural and residential settings to control various pests. In this study, the potential toxic effects of cypermethrin on the liver of albino mice are investigated with a multidisciplinary approach by using physiological, biochemical, and histopathological parameters. 126 Adult swiss albino mice weighing 20- 25 grams are used after approval of the institutional ethical committee. In the present study low doses of cypermethrin are given to mice through the oral route. Cymbush 25 EC is used which contains 25% EC cypermethrin. The recommended dose of it is 3-5ml for foliage spraying. On the day of sacrifice, blood is withdrawn from the retro-orbital sinus of mice by using a capillary tube. Biochemical parameters demonstrated the rise in plasma levels of AST and ALT of treated mice according to the dose and duration of the drug given. On histological observation of the liver of treated mice, pathological changes are seen. Marked necrosis of hepatocytes is observed in different groups of treated mice.

Keywords: Pyrethroid pesticide, Cypermethrin, Liver toxicity, Hepatocytes, Necrosis.

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INTRODUCTION

Pyrethroid pesticides have gained significant popularity and widespread use in agricultural and residential settings due to their effectiveness in controlling various pests. They protect the crops and maximize yield. Pyrethroids are synthetic chemical compounds derived from the naturally occurring pyrethrins found in chrysanthemum flowers. They are favored for their potent insecticidal properties, low mammalian toxicity, and quick degradation in the environment [1,2]. However, the toxic effects of these pesticides on non-target species have raised concerns among environmentalists, scientists, and regulatory bodies. Non-target species, including insects, birds, mammals, aquatic organisms, and humans may be inadvertently exposed to pyrethroids through direct contact, inhalation, or consumption of contaminated food or water. Pyrethroids work by targeting the nervous systems of insects, through preventing the closure of the voltage gated sodium channels in the axonal membranes. When the toxin keeps the channels open, the nerves cannot repolarize, leaving the axonal membrane permanently depolarized, thereby paralyzing the organism. While they are generally considered safer alternatives to organophosphates and other older insecticides, the non-target effects of pyrethroids cannot be overlooked.

One of the widely used insecticides in the world is cypermethrin. Cypermethrin is a fourth-generation synthetic pyrethroid pesticide. While main purpose of cypermethrin is to protect crops from pests, the widespread use of it has led to its detection in various food products. Residues of cypermethrin can be found in fruits, vegetables, cereals, dairy products, and other food items due to the agricultural practices employed during cultivation and post-harvest processes. The lipophilic nature of cypermethrin causes it to accumulate in different parts of the body, including body fat, skin, liver, kidneys, adrenal glands, ovaries, and brain. When a person is exposed to high doses of cypermethrin over a short period, it can lead to symptoms like nausea, dizziness, headache, and, in severe cases, seizures or difficulty in breathing. Long-term exposure to low levels of cypermethrin residues, which happens through regular consumption of contaminated food, has been linked to various negative health effects [5]. These effects include developmental disorders, disruption of hormone function, potential to cause cancer, and impacts on the nervous system. As a result, concerns have been raised about the potential risks associated with the presence of cypermethrin residues in food and its impact on human health.

Although pyrethroids are widely used, reports of accidental and intentional poisoning due to pyrethroid compounds are common [3-6].

In this study, the potential toxic efects of cypermethrin on the liver of albino mice are investigated with a multidisciplinary approach by using physiological, biochemical and histopathological parameters. While physiological effects were determined by examining the mice physically, biochemical effects were investigated by alterations in serum parameters and microscopic study of the liver is done by preparing histology slides.

MATERIAL AND METHODS

126 Adult swiss albino mice weighing 20- 25 grams are used after approval of institutional ethical committee. These animals are obtained from animal house of the Department of Anatomy, IMS, BHU, Varanasi. In the present study low doses of cypermethrin are used, which are 1/5 and 1/10 of LD 50 dose. Cymbush 25 EC is used which contains 25% EC cypermethrin. Recommended dose of it is 3-5ml for foliage spraying.

LD 50 (lethal dose 50) represents the amount of drug, which killed 50% of population of animal species employed for the test. The oral LD 50 dose of cypermethrin is found to be 3ml/kg body weight (bw) of 25% of drug diluted in distilled water.

The mice are randomly assigned into four groups. Group I is control group while II to IV are treated groups. Group I is given 3 ml/kg/bw of tap water throughout the duration of the experiment. Groups II - IV are further subdivided into two subgroups, respectively, each of 18 animals. Distilled water is used to dilute the drug to concentrations of 2.5% and 5%. The mice in Group IIa, IIIa, and IVa are treated with 3 ml/kg/bw of 5%, while those in IIb, IIIb, and IVb with 3 ml/kg/bw of 2.5% of the agent orally for a duration of 10, 15 and 20 days each.

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OBSERVATION AND RESULT

After the daily administration of the chemicals to the animals, behaviors such as aggressiveness, suspended tail, erected furs, drowsiness, itching, and changed feeding patterns are observed and recorded for up to 2 h post administration.

On the day of sacrifice, blood is withdrawn from retro-orbital sinus of mice by using capillary tube. The activities of aspartate transaminase (AST), and alanine transaminase (ALT) were determined in plasma. (Table 1).

Biochemical parameters clearly demonstrated the rise in plasma levels of AST and ALT of treated mice according to the dose and duration of the drug given. Group Iva which received maximum concentration of drug for longest duration is showing significantly raised liver enzymes as compared to other groups.

The study showed that nature and intensity of toxic symptoms produced by cypermethrin are dose and time dependent. The observed signs were almost similar to those reported by other workers following repeated administration of deltamethrin and cypermethrin in rodents [7], Neuschl et al [8], studied the toxic effect of super cypermethrin, a cypermethrin analogue, in pheasants after repeated oral exposure and reported clinical signs of mild diarrhea. Ataxia and behavioral changes produced by acute and subacute doses of pyrethroids have been related to sciatic nerve degeneration [9], and alterations in regional brain polyamine levels [10].

Histological findings

On histological observation liver of control mice is showing normal architecture. (Fig.1)

While for treated group, it is observed that a lower dose of cypermethrin caused mild disruption and disarray in the arrangement of liver cell layers. On the other hand, a higher dose of cypermethrin resulted in the necrosis of liver cells, characterized by condensed and shrunken nuclei, as well as the enlargement of blood vessels within the liver and significant disruption of the liver cell layers. (Fig. 2-4)) Various empty lacunar spaces can be seen due to degeneration of hepatocytes which are present as cell debris.

The observed findings are similar to Biernacki et al. [11] who observed variable hepatotoxic effect of cypermethrin in rabbits. Fatty degeneration and necrosis of hepatocytes have been observed following exposure of animals [12].

Table 1: Activities of aspartate transaminase (AST), and alanine transaminase (ALT) in plasma

	AST (U/L)	ALT (U/L)
GroupI(Control)	45.62 ± 1.29	36.24 ± 1.04
Group IIa	194.54 ± 2.98	52.39 ±1.31
Group IIIa	240.45 ± 3.72	60.12 ± 1.56
Group IVa	360.20 ± 4.67	69.49 ± 1.67
Group IIb	70.61 ±1.92	38.19 ± 1.05
Group IIIb	110.56 ± 2.41	41.48 ± 1.09
Group IVb	140.08 ± 2.89	46.39 ± 1.28

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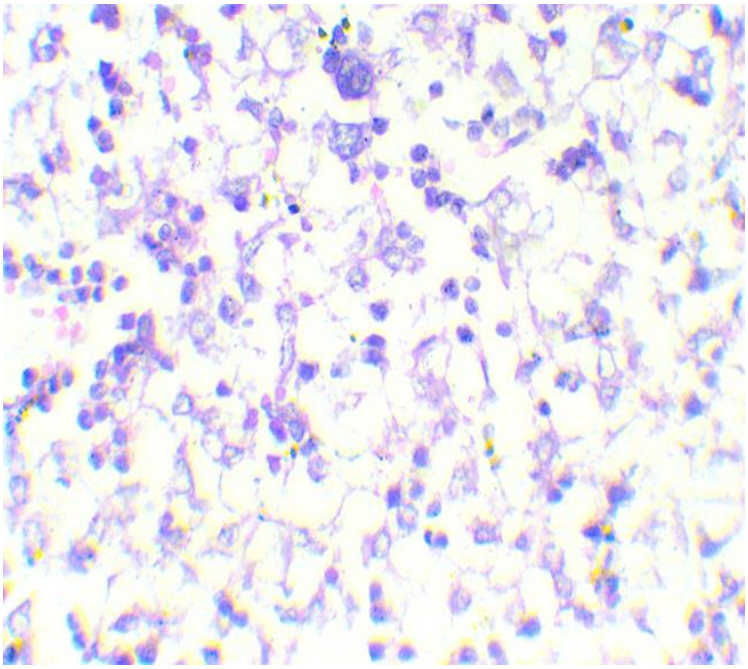

Figure 1: Photomicrograph of control liver (H& E, 400 X)

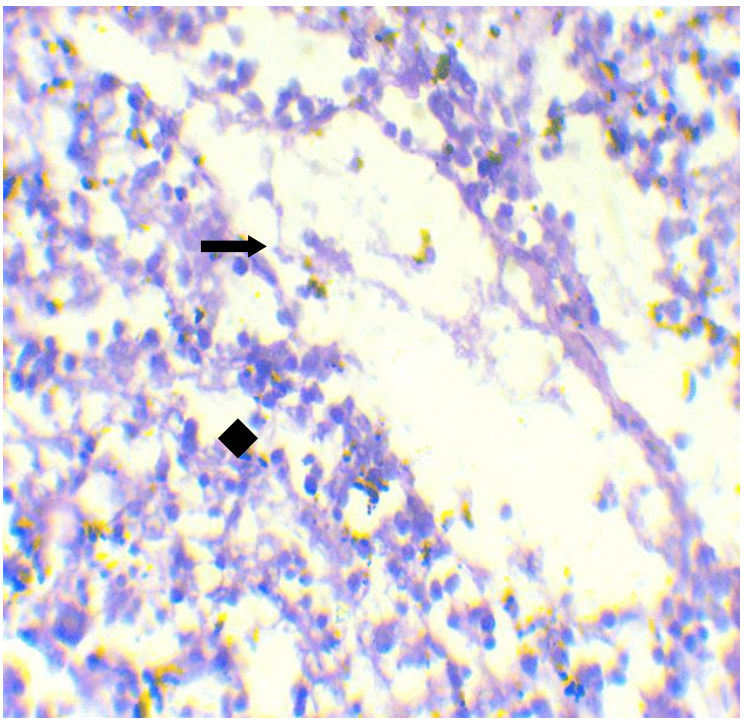

Figure 2: Photomicrograph showing treated liver group IIIa (H& E, 400 X). Reduced cellular density (→) and loss of normal architecture around central vein (♦).

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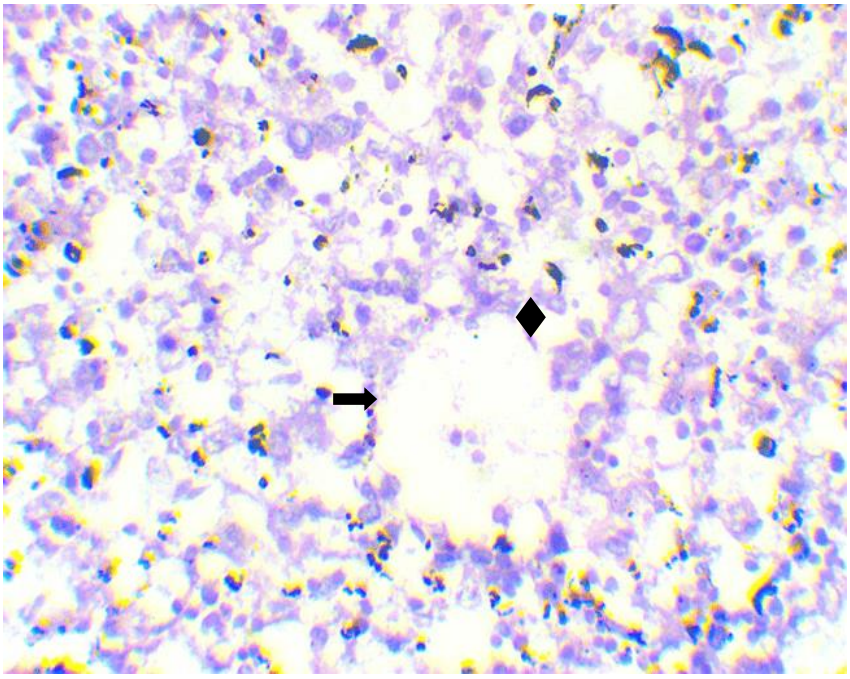

Figure 3: Photomicrograph showing treated liver of group IVb (H & E, 400 X). Reduced cellular density (→) and loss of normal architecture around central vein (♦).

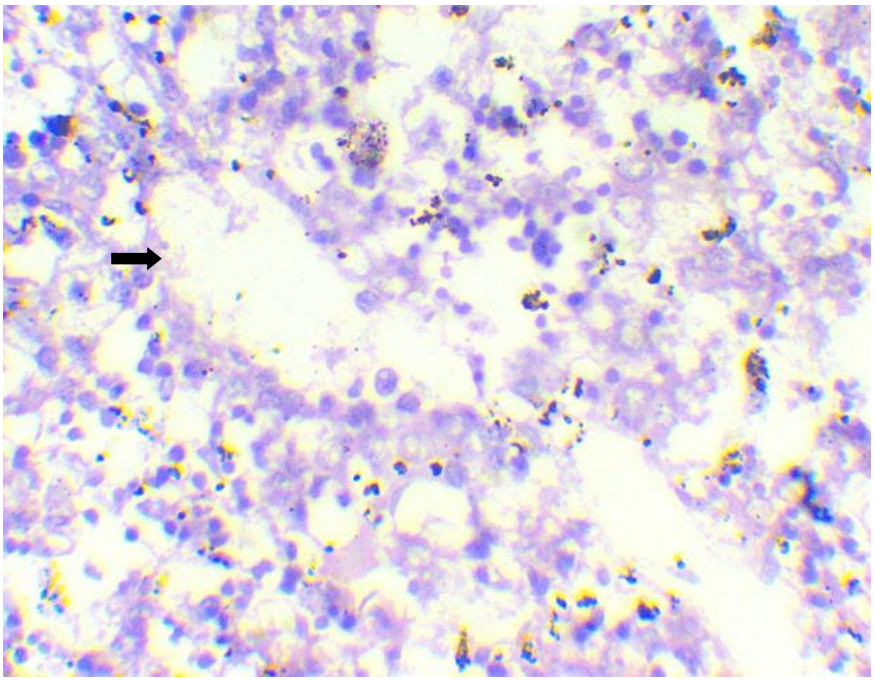

Figure 4: Photomicrograph showing treated liver group IVa (H & E, 400 X). Reduced cellular density (→)

CONCLUSION

The impact of cypermethrin on human health and the environment varies depending on the concentration of cypermethrin and the duration and frequency of exposure. Additionally, individual health factors play a role in determining the effects. It is crucial to note that the excessive accumulation of pesticide residues in food products poses even greater harm to infants and children. These findings emphasize the importance of implementing stringent regulations, thorough monitoring, and minimizing the use of pyrethroid pesticides to effectively mitigate the potential risks they pose to human health.

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