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Effect of Pesticide Chlorpyrifos in Kidney of Catfish

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Abstract

Pesticides have a significant effect on histological changes in fresh water fish, and these pesticides are also extremely dangerous to the untargeted organisms, in both aquatic and terrestrial environments. The purpose of the current study was to examine the effects of a sublethal dosage of chlorpyrifos on catfish kidneys. Chlorpyrifos is an organophosphate and most commonly used in agriculture. Sublethal concentrations of chlorpyrifos caused histopathological alterations in many tissues. Fishes were acclimatized for 10 days in proper aerated condition in lab and subjected to chlorpyrifos at low concentrations (1/50th of LC50) and high concentrations (1/10th of LC50) for 10 days. Then sacrificed and their kidneys were collected. In treated fishes, vacuolation, loss of glomerular structure, significant renal tubular epithelium destruction with necrosis, and total hematopoietic tissue loss were found. The histopathological alterations were discovered to be dose-dependent, with the lowest dose level inducing degenerative changes in tissue architecture and the higher dose level being more substantial.

Keywords: Chlorpyrifos, Histopathology, Toxicity, Catfish, Kidney, Pesticide

Introduction

Pesticides are one of the most hazardous chemicals. Pesticides constitute an important component in agriculture development and used as insect vector (Prakash and Verma, 2020). Pesticides are used by men to control disease and to increase the yield of crops (Prakash and Verma, 2011). Aquatic ecosystem is contaminated by runoff and ground water leaching by a variety of pesticides. Water is contaminated and fishes are more frequently exposed to these pesticides (Sunanda et.al., 2016). According to Becker et al. (2009), they are extremely hazardous to fish and other aquatic organisms. Fish absorb a lot of toxins and pollutants through their skin, gills, and food chain, which can lead to changes in histopathology (Verma et al., 1975; Bandara et al., 2012). In the tissue segment, several histological alternations were noted

like loss of glomerular structure in kidney of treated fish. These alternations were found to be dose dependent (Khatun et.al., 2016).

Chlorpyrifos (O,O-diethyl O-3,5,6 trichloro-2-pyridyl-phosphorothioate) is a organophosphate insecticide (Figure-1). Chlorpyrifos is a common pesticide and agricultural herbicide. Various workers at various periods claimed that fish and other aquatic organisms exposed to chlorpyrifos incurred significant harm to their liver, kidneys, gills, brain, etc. (Srivastava et al., 1990; Raibeemol and Chitra, 2018, Mishra et al., 2021). It is used on fruits, grains, nuts, vegetables etc. (Khatun et.al., 2016).

Organophosphate is the most used pesticide in the world. Numerous investigations have been carried out to evaluate the toxicity of the insecticide chlorpyrifos on various fish species (Prakash and Verma, 2020). Chlorpyrifos is approved for 18 crops in INDIA, while studies found on its use in 23 crops.

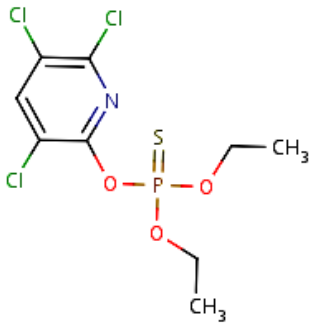

Figure-1: *Chlorpyrifos (IUPAC: O,O-diethyl O-3,5,6 trichloro-2-pyridyl-phosphorothioate)*

Materials and Methods

Chemicals – Chlorpyrifos (1.42ppm & 0.28ppm), 10% formalin (10ml. HCHO in 100ml. water), Graded Alcohol (100%, 90%, 70%, 50%), Xylene, Paraffine wax, Hematoxylin & Eosin (H&E) stain and DPX.

Experimental design – We used three tanks for this experiment. Each tank contains 10ltr. water and 4 fishes. Fishes were exposed for 10 days (IInd and IIIrd tank) and control was left as untreated (Table-1).

Table-1: showing dose selection of Chlorpyrifos

TANK	NO. OF FISHES	STOCK SOLUTION	DOSE	WATER
Ist Tank (control)	4	--	--	10ltr.

IInd Tank (experimental)	4	20%EC (Chlorpyrifos)	0.28ppm ($1/10^{th}$ of LC50)	10ltr.
IIIrd Tank (experimental)	4	20%EC (Chlorpyrifos)	1.42ppm ($1/50^{th}$ of LC50)	10ltr.

Fish Caring and Handling

Fishes were purchased from local market Jhunsi, Allahabad, U.P., INDIA. Fishes were 12 in numbers, 15-17cm in length and 12-15gm in weight. Fishes were kept in tanks in proper aerated condition. Spirulina is given as food to the fishes. Fishes were acclimatized for 10 days. Chlorpyrifos exposure was given to them for 10 days.

Histological Procedure

At the end of exposure, fishes are dissected to collect kidney. Kidney tissues were kept to normal saline for removal of blood then fixed in 10% formalin for 24hr. Then specimen were treated with graded alcohol for dehydration (50% for 30min, 70% for 30min, 90% for 30min, 100% for 1hr.), cleared in Xylene (2 changes each for 30 min.) and embedded in paraffine wax (wax I, wax II for 1hr. and wax III for 1.5hr.). Block was prepared and sectioned using microtome. Tissue sections were cleared with Xylene (2 changes each for 5min.), rehydrate and stained with Hematoxylin and Eosin. After staining sections were dehydrated in ascending order of graded alcohol (only one dip), cleared with xylene and mount with DPX. Finally slides were observed under microscope.

Results

Untreated fish: The kidney tissue of the fish in the control group showed no histopathological changes. The control kidney's histological structure revealed a large number of nephrons, which were made up of renal tubules and renal corpuscles with a well-developed glomerulus. Bowman's capsule encircles the blood capillaries that make up the germerulus tuft.

Treated fish: Group II^{nd} [lower dosage] fish's kidneys showed substantial damage with vacuolation and loss of glomerular structures, as well as tubular degeneration in the glomerular tufts. The fish in the III^{rd} group (higher dose) have undergone significant changes such as renal tubular epithelium destruction accompanied by necrosis and total loss of hematopoietic organs. (Figure- 2).

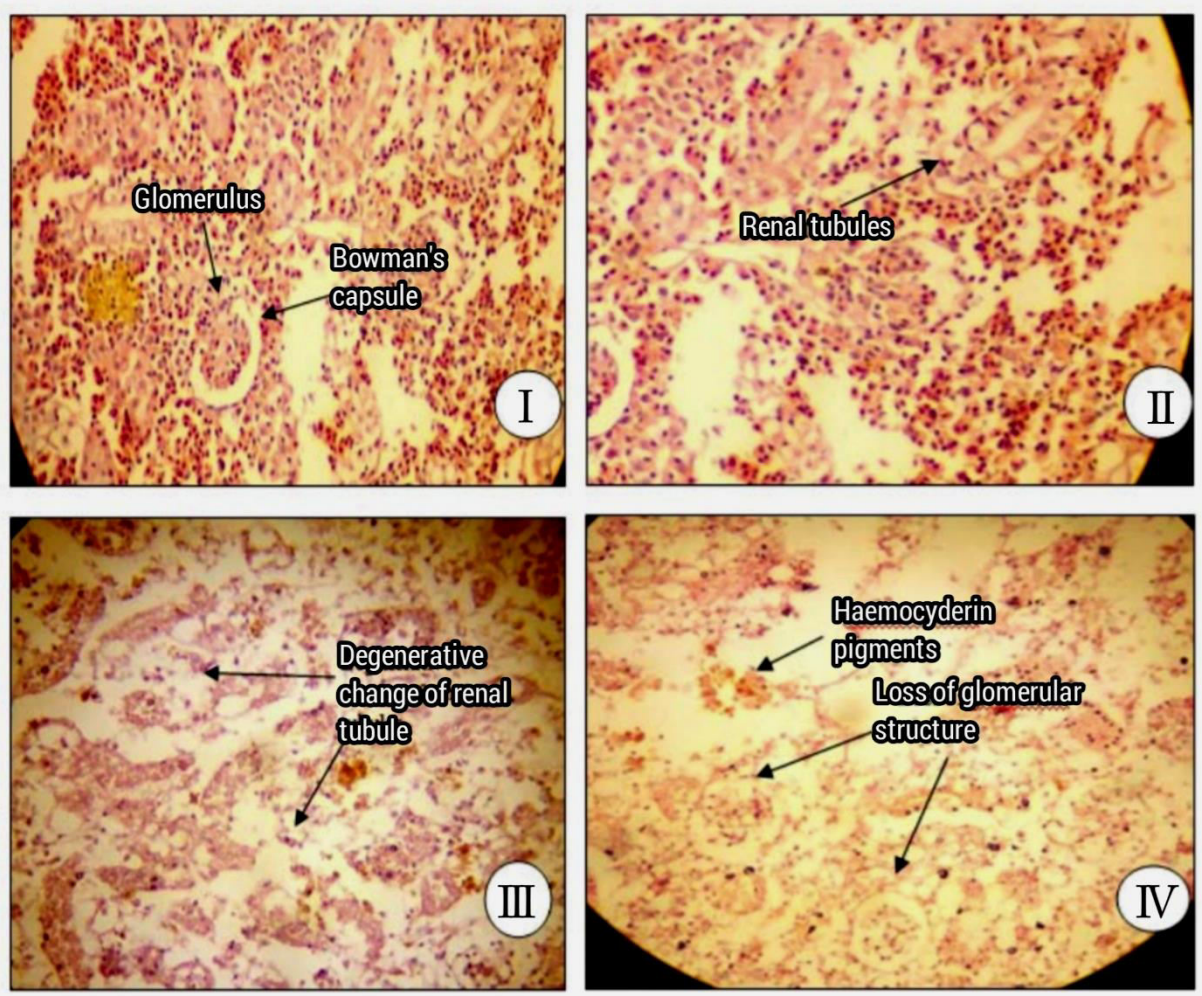

Figure-2 *(I) Kidney of untreated fish, (II) Kidney of untreated fish showing the renal tubules, (III) 1.42 ppm (1/10th of LC50) exposed group kidney and (IV) 0.28 ppm (1/50th of LC50) exposed group kidney (100X).*

Discussion

The findings of current study showed that substantial histopathological alterations are produced in the kidneys of treated fish by sublethal concentrations of chlorpyrifos. Pandey and Dubey (2015) reported damage to hematopoietic tissue in the kidney, disintegration of glomeruli, increase in Bowman's space, and tubule elongation, following a 21-day pentachlorophenol (PCP) treatment. In catfish, H. fossilis, exposed to chlorpyrifos at a concentration of 2 mg/litre, glomeruli declined and nephritic tubules greatly expanded (Srivastava et al., 1997). Numerous fishes exposed to pollutants have been reported to exhibit the dilatation of the kidney tubule lamina and necrosis of the tubules following treatment with chlorpyrifos (Kumar and Pant, 1984, Gill et al. 1988, Fanta et al., 2003, Cengiz, 2006). The impairment of renal function or net electrolyte influx at the gill could be the cause of H. fossils. Chlorpyrifos-exposed H. fossilis has

been linked to degenerative changes in the kidney (Srivastava et al. 1997) and gills (Tripathi and Srivastava, 2010).

Conclusion

According to the current study, chlorpyrifos significantly alters the histomorphology of the kidney at various concentrations. When chlorpyrifos was administered at a higher dose, the histopathological alterations observed in all the tissues were more noticeable in sublethal concentrations. The sublethal concentration of chlorpyrifos caused histopathological changes at different level, and these changes were more noticeable at higher sublethal concentrations than at lower dose levels. Vacuolation, glomerular structure loss, extensive renal tubular epithelium damage with necrosis, and total loss of hematopoietic tissues were the changes that were found. Therefore, the current study's result shows that though higher dose levels were found to be more significant to damage tissue architecture but, minimum dose is also effective in inducing degenerative changes.

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