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Research article

PATHOLOGICAL EFFECTS OF PCB 126 ON KIDNEY TISSUE OF *PUNTIUS TICTO* (HAM.)

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ABSTRACT: Chronic exposure of the fish *Puntius ticto* to sub lethal concentration of the compound PCB 126 for a prolonged period of 30 days showed visible and serious effects on the kidney tissues. A comparative histological study of the extent of pathology was carried out by collection of tissue samples on every 10th day of exposure.
Key words: Puntius ticto, PCB 126, chronic exposure, kidney pathology.

INTRODUCTION

PCBs (Polychlorinated Biphenyls) are ubiquitous compounds found in the environment. The major PCB use today is as a dielectric in electrical equipment servicing industries with large electrical power distribution and consumption where they continue to pose potential threats to the environment in the event of releases. PCBs have been found in air and in solid waste and solid waste-related materials [2]. These may eventually enter water by deposition or run off. This threat is particularly prevalent in the mining industry because mines generally penetrate the water table. When PCBs are spilled or PCB equipment is abandoned underground, the PCBs can be expected to be released into the ground water with no possibility of source retrieval. This can result in water pollution for which there may be no solution [3]. These substances are highly lipophilic [4] and hence tend to affect tissues of organisms that are exposed to these compounds.

The toxic nature of PCBs have raised great concern, leading to study of different aspects of the congeners in relation to the environment and living organisms [5].

Recent emphasis on the source of the toxicity of commercial PCB formulations has increased the need for more complete details of the properties of PCB congeners, especially with respect to their structure, which can cast light upon their functions and effects [6]. A detailed study of all 209 congeners has been carried out [7]. In the aquatic phase, PCBs tend to dissolve in water in minute quantities and adversely affect the aquatic organisms. PCBs have been shown to be toxic to organisms in general, as reported in several instances in literature [8, 9, 10, 11] etc. They have been shown to bioaccumulate up through various food chains and have been detected in birds of prey (David J. Hoffman et al, 1996) and even in human populations [12].

In fish, the kidneys are the sites of removal of excretory. Contaminants are seen to enter fish bodies primarily through gills and cause lesions in kidneys and other organs [13]. Various environmental pollutants have been found to affect the histology of the kidney, which is the site of nitrogenous waste excretion by fishes. Kidney pathologies are common symptoms of toxic effects on fishes of a wide variety of aquatic pollutants. The morphological anomalies commonly include thickening of glomeruli and tubules, necrosis and haemorrhages [14, 15]. The present study attempts to study the histopathological effects of the congener PCB 126, i.e. 3,3',4,4'5-pentachlorobiphenyl on the kidney tissues of the local freshwater fish, *Puntius ticto* (Ham.). The PCB congener 126 is considered to be one of the most toxic, on account of its coplanar nature and high lipophilicity. The fish are eaten sun-dried or fried, generally by poor communities.

MATERIALS AND METHODS

Fish were procured from local freshwater bodies and acclimatized using dechlorinated tap water. PCB 126 of Dr. Ehrenstorfer make was imported from Germany. Active and healthy individuals were selected for the experiment. Attempt was made to determine the acute toxicity and calculate a safe sub-lethal dose for chronic exposure. Based on observations of acute toxicity assay, a sub lethal dose of 12.5 µl l^{-1} was arrived at.

Fish in aquaria were exposed to the above concentration through a daily dose which was fed through an indigenously designed constant dosing device adjusted to maintain a flow of 10 litres of dilution water over 24 hours. The characteristics of dilution water are given in Table 1.

Fish were collected at the 10^{th}, 20^{th} and 30^{th} day of exposure. They were dissected and kidney tissue fixed in Buoin's fixative. The kidneys so obtained were dehydrated through increasing concentrations of ethyl alcohol and embedded in paraffin blocks for histopathological study. Sections of thickness 5-8 µ were obtained on a rotary microtome of Weswox make and subjected to Haematoxylin – Eosin Staining for histological study.

Appropriate controls were maintained in parallel.

Table 1: Characteristics of Dilution Water

S. No.	**Parameters**	**Values ***
1	Temperature º C	25-27
2	pH	7.5-8.2
3	Total Alkalinity as $CaCO_3$	156-190
4	Total Hardness as $CaCO_3$	142-172
5	Ca Hardness as $CaCO_3$	80-94
6	Mg Hardness as $CaCO_3$	62-78
7	Dissolved Oxygen	6.9-7.3
8	Calcium as Ca	32-38
9	Magnesium as Mg	14-18
10	Sodium as Na	36-38
11	Potassium as K	2-4
12	Chloride as Cl	126

*All the values are expressed as mg/L except temperature and pH.

The Control Kidney

The general histological structure of the kidney of *Puntius ticto* (Plate I) shows a large number of uriniferous tubules composed of cuboidal epithelial cells having central or marginal nuclei, and eosinophilic cytoplasm. A renal corpuscle comprises a glomerulus, enclosed in a single layered Bowman's Capsule. Many blood capillaries can be seen in a transverse section. Intertubular spaces are packed with haemopoietic tissue, showing a large number of erythrocytes, lymphocytes and immature blood cells.

PCBs are known to have histopathological effects on fish tissues. Literature reports that there is enlargement of the glomerulus, reduction of Bowman's space, occlusion of the tubular lumen, cloudy swelling and hyaline droplet degeneration in the kidneys of fish (Marina M. P. Camargo and Cláudia B. R. Martinez, 2007).

Observations

Exposure of Puntius for 10 days to PCB 126 showed histopathological changes in the kidney tissue. The glomerular patches and tubules were seen to be more dense and closer together (Plate II).

In case of a 20 days' exposure, the kidneys of Puntius showed evidences of degeneration of connective tissue, necrosis in certain areas (Plate III) and increased presence of interstitial blood.

An exposure of Puntius to PCB 126 for 30 days further showed similar conditions of tissue degeneration (Plate IV).

The observed pathological effects are in agreement with observations put forth in literature by Camargo and Martinez (2007). The gradual increase in the degree of pathological effects over 10, 20 and 30 days also indicates that the compound must be accumulating within the fish body. Since the fish species studied in the present work is eaten by marginalized communities near the fresh water bodies, detection of the presence of PCBs in aquatic biota, their possible sources and remediation becomes an important requirement to prevent any deleterious effects of the pollutant on the fish itself, as well as on other organisms of the food chain, including man.

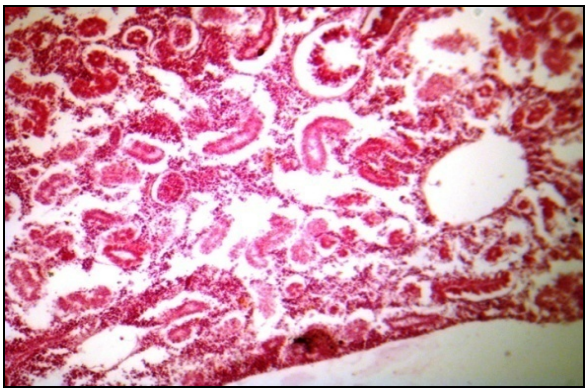

Plate I: T.S. Kidney of *Puntius ticto* (Control) (Magnification: 10X)

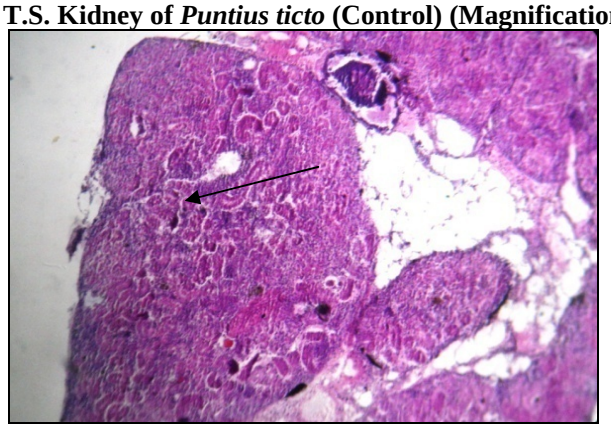

Plate II: T.S. Kidney of *Puntius ticto* exposed to PCB 126 for 10 days (Magnification: 10X) (Arrow shows dense kidney tissue)

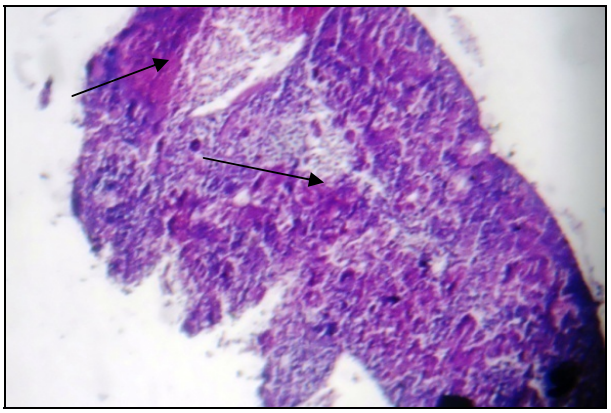

Plate III: T.S. Kidney of *Puntius ticto* exposed to PCB 126 for 20 days (Magnification: 10X) (Arrows indicate blood in interstices and thickening in tubular cells)

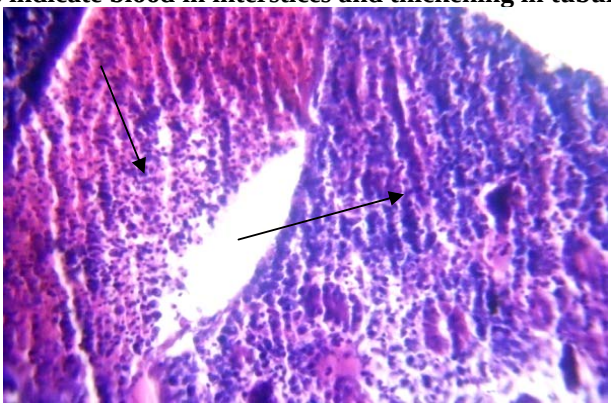

Plate IV: T.S. Kidney of *Puntius ticto* exposed to PCB 126 for 30 days (Magnification: 40X) (Arrows indicate blood in interstitial spaces and presence of necrotic patches)

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