VOLUME 8 ISSUE 2 2022

ISSN 2454-3055

INTERNATIONAL JOURNAL OF ZOOLOGICAL INVESTIGATIONS

Forum for Biological and Environmental Sciences

Published by Saran Publications, India

International Journal of Zoological Investigations Vol. 8, No. 2, 279-283 (2022)

International Journal of Zoological Investigations
Contents available at Journals Home Page: www.ijzi.net
Editor-in-Chief: Prof. Ajai Kumar Srivastav
Published by: Saran Publications, Gorakhpur, India

ISSN: 2454-3055

Histopathological Changes in the Liver of Indian Major Carp, *Catla catla* Caught from Uppanar River Water, Cuddalore, India

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Received: 28th June, 2022; **Accepted:** 7th August, 2022; **Published online:** 18th August, 2022

https://doi.org/10.33745/ijzi.2022.v08i02.035

Abstract: Heavy metal contamination of Uppanar River aquatic ecosystem has been recognized as a serious pollution problem. When fish are exposed to elevated levels of heavy metals in a polluted aquatic ecosystem, they take these metals from their environment. In the present investigation, adult live specimens of edible Indian major carp, *Catla catla* were procured from Uppanar River, Cuddalore District from January to December 2020, Liver were processed for heavy metals estimation and histopathological studies. Liver showed accumulation of heavy metals in *Catla catla*. In liver the content of toxic heavy metals were found in the order-- zinc > lead > copper > cadmium > manganese> chromium > nickel > arsenic.

Keywords: Uppanar River, *Catla catla*, Pollution, Histopathological, Heavy metals, Liver

Citation: Rajmohan K. and Vijayan P.: Histopathological changes in the liver of Indian major carp, *Catla catla* caught from Uppanar River water, Cuddalore, India. Intern. J. Zool. Invest. 8(2): 279-283, 2022.

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Introduction

Environmental pollution has become a major concern in the developed as well as under-developed countries (Kazi *et al.*, 2009; Ozden 2010). Contamination of aquatic bodies with a vast array of pollutants has seriously increased the worldwide attention. Anthropogenic activities resulting from modern agricultural practices, rapid urbanization and industrialization involve the increased release of various chemical pollutants and toxicants, such as industrial effluents, biocides, pesticides, heavy metals etc. These pollutants/toxicants ultimately reach the aquatic environments and become responsible for their degradation (Wang, 2002; Dautremepuits *et al.,* 2004). Among these pollutants, heavy metals have been recognized as strong biological poisons because of their persistent nature, toxicity, tendency to get accumulated in organisms and undergo biomagnification (Kamble and Muley, 2000; Dinodia *et al.,* 2002). Among the aquatic fauna, fishes are valuable organisms for the study of heavy metal pollution, because they explore freely among the different trophic levels in an aquatic environment (Chopra *et al.,* 2001;

Palaniappan *et al.,* 2009). Fish assimilate heavy metal contaminants by different ways like intake of particulate matter suspended in water, ion-exchange of dissolved heavy metals across lipophilic membranes (gills) and adsorption on surface of tissues and membrane. Heavy metal distribution among different fish tissues also depends upon the mode of exposure (dietary or aqueous) (Alam *et al.,* 2002).

Catla catla is a common food item and commercially an important cyprinid species. It is cultured along with other indigenous major carps and exotic Chinese carps (Lone *et al.*, 2009). The aim of the present study was to investigate the effects of heavy metals on histology of liver of major carp, *Catla catla* which is caught from Uppanar River at Cuddalore, India.

Materials and Methods

Live specimens of adult freshwater cyprinid, *Catla catla*, irrespective of size, weight and sex were procured from Uppanar River at Cuddalore (11º43'N latitude and 79º46'E longitude) from January to December 2020. Similarly, control fish (*Catla catla*) was procured from fish culture ponds (having almost no pollution), Annamalai University, Parangipettai, Cuddalore.

Adult fish samples were dissected and liver were removed, excised of fat and adhering tissues. The liver was fixed in aqueous Bouin's fixative for 24 h. The tissues thus fixed were dehydrated in ascending grades of alcohol and cleared in xylene. The fixed tissues were embedded in paraffin wax and sectioned at 5 µm using Euromex Holland microtome. Sections were stained following Saad *et al.* (2012) method with Hematoxylin and Eosin and were studied under the microscope. The photomicrographs of selected section of liver were taken by microscopic camera.

Heavy metals in fish liver were estimated by using Inductively Coupled Argon Plasma Atomic Emission Spectrophotometer (ICAP-AES, Thermo iCAP-6300) (Yousafzai *et al*., 2010). The sample of liver was processed for the estimation of eight heavy metals i.e. lead, cadmium, copper, chromium, arsenic, zinc, nickel and manganese.

Results and Discussion

Histopathological investigation is a useful tool for determining effects of different anthropogenic pollutants on organisms. Histopathalogical biomarkers reflect the overall health status of population in an ecosystem (Khoshnood *et al*., 2010). Fish liver from control group showed normal architecture (Fig. 1). The hepatocytes were normal in appearance, arranged in cords around central vein with central nuclei. Cords of hepatocytes were separated by sinusoids. Liver of fish inhabiting Uppanar River, which is polluted by heavy metals, showed dilated and congested central vein, ruptured hepatocytes with eccentric nuclei, degeneration of hepatocytes, vacuolization and necrosis (Fig. 1). Massive number of macrophage infiltration was noted in liver of fish procured from Uppanar River. Many cells were degenerated and transformed to eosinophilic patches with no nuclei or deeply stained nuclei. The present observation is in conformity with the studies of Patnaik *et al.* (2011) who have reported hypertrophy of hepatocytes, vacuolation and severe necrosis in liver of cadmium exposed *Cyprinus carpio.* Complete disintegration of liver tissue and marked necrosis was detected in lead exposed *Cirrhinus mrigala* (Mary *et al*., 2014). Fish liver is the main organ for detoxification of xenobiotics, including BPA. Therefore, the changes in liver of aquatic fauna such as fish are reflective of aquatic pollution of their habitat (Moon *et al.,* 2012). Similar changes were noticed in hepatocytes of *Oreochromus spilurus* exposed to nonylphenol (endocrine disrupting chemical) (El-jawaher, 2012). Change in normal liver architecture with dilated sinusoids may be due to loss of structural proteins (El-jawaher, 2012). Abnormal liver architecture of *Siganus rivulates* exposed to heavy metals (Abdel-aziz *et al.,* 2006). Vacuolation of hepatocyte is a nonspecific response of fish due to toxic conditions (Roberts, 1978; Abdel-aziz *et al.,* 2006). In liver, BPA caused

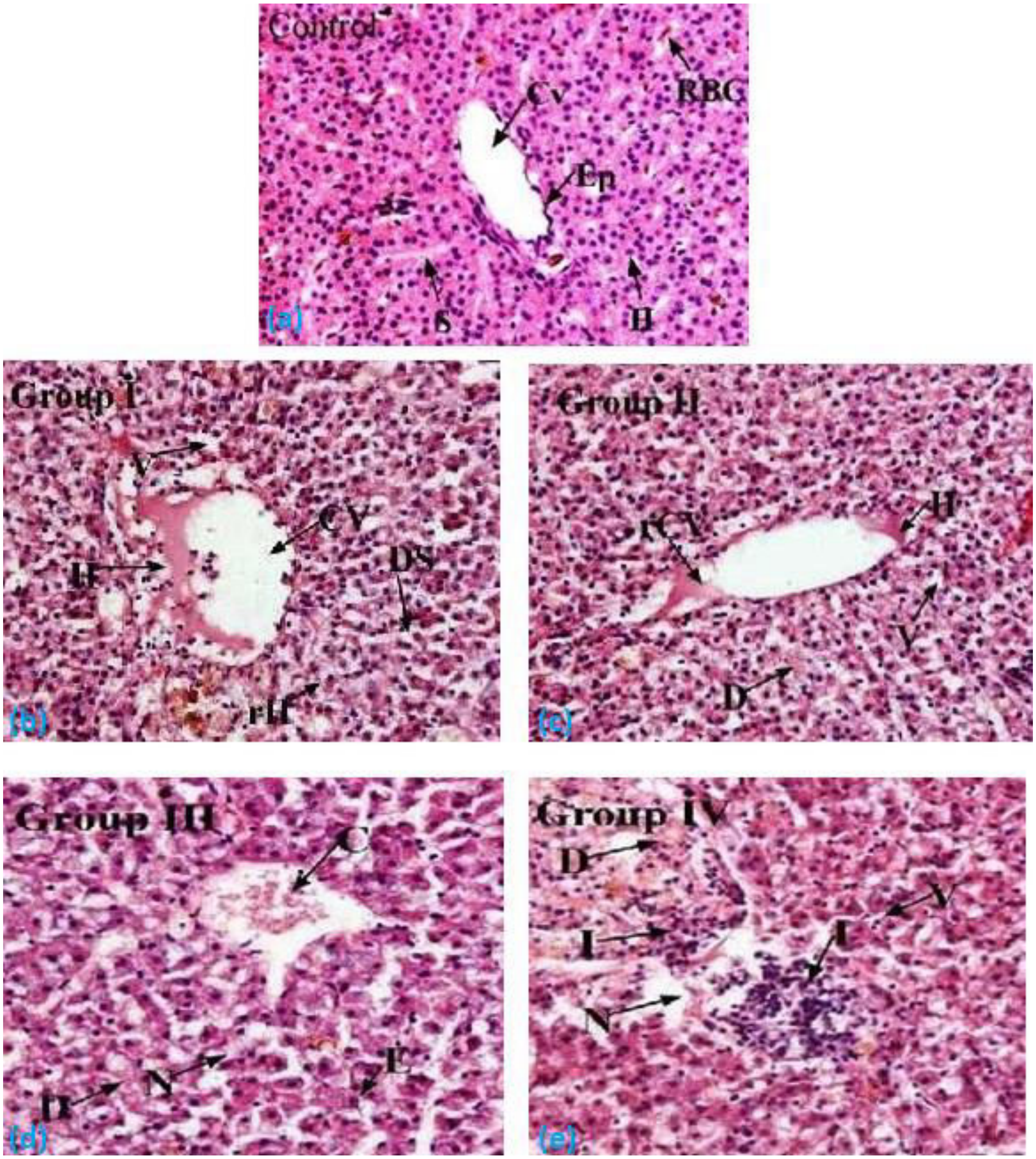

Fig. 1: (a) *Catla catla* liver from control group and (b-d) fish caught from Uppanar river. CV- Central vein, EP- Epithelial layer, H- Heatocytes with central nucleus, RBC- Red blood cells, S- Sinusoids; H- Hemoklysis, DS- Dilated sinusoids, rH- Ruptured hepatocytes, V- Vacuolization, rCV- Ruptured central vein, C- Congestion, N- Necrosis, D- Degeneration, E- Edema of hepatocytes, I- Inflammation. HE x 400.

central vein congestion, inflammation, edema, degeneration and necrosis of hepatocytes (Faheem *et al.,* 2016).

The analysis of heavy metals in liver of *Catla catla* caught from the Uppanar River showed presence of heavy metals. The distribution of heavy metal in fish liver was in the order-- zinc > lead > copper > cadmium > manganese> chromium > nickel > arsenic (Table 1). The distribution of heavy metal in the fish organs analyzed were in the order of Zn > Cu > Pb > Ni and Cd (Marcy and Mary, 2016). The average mean concentrations of Cd ,Cu, Pb, Zn and Mn were reported to be higher in the untreated effluents than the treated effluents (Usha Damodharan, 2013). In particular, cestodes and acanthocephalans have an increased capacity to accumulate heavy metals, where for example,

Table 1: Level of heavy metals in liver of *Catla catla*

Elements	Liver	
	Control	Fish caught from Uppanar river
Lead	3.67±0.19	10.12±1.71*
Cadmium	1.03±0.07	3.24±0.18*
Copper	6.17±0.42	5.14±0.56*
Chromium	0.08±0.04	2.02±0.14*
Arsenic	0.87±0.23	1.56±0.52*
Zinc	40.25±1.78	59.12±2.46*
Nickel	0.37±0.15	1.78±0.48*
Manganese	0.27±0.67	2.75±1.06*

Values are Mean±SE; * indicates difference at $p<0.05$ between fish caught from Uppanar river and control

metal concentrations in acanthocephalans were many times higher than in host tissues (El-Sayed *et al.*, 2020). The hepatic lesions after pesticide exposure were in the form of hepatocytes degeneration and necrosis, with a congested central vein, mononuclear infiltration, and melanomacrophage center aggregations (Sabra and Mehana, 2015).

Conclusion

Fish are the most important aquatic organisms that can accumulate heavy metals in their organs. Heavy metals induce significant damage to the physiologic and biochemical processes of the fish and subsequently to fish consumers. In conclusion, severe histopathological lesions and cellular alterations were observed in liver of the fish *Catla catla* which were procured from Uppanar river water. These alterations in liver of the fish could be attributed to the significant accumulation of several heavy metals in this tissue.

Acknowledgements

The authors are grateful to the Professor and Head, Department of Zoology, Annamalai University, Annamalainagar for providing the laboratory facilities.

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