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Histopathological Alterations in Kidney and Liver of *Oreochromis mossambicus* (Peters, 1852) Collected from Mallapura Lake, Chitradurga District, Karnataka, India

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Abstract: The present study was performed to investigate the histopathological changes in liver and kidney of Tilipia fish, *Oreochromis mossambicus* caught from Mallapura lake of Chitradurga district. The study indicates the toxic effect of untreated sewage water on fish organs like liver and kidney. The hepatocytes show focal lipid deposition with focal areas of degeneration. There are focal aggregates of melanomacrophages and mild mixed inflammation. In tubular region of kidney foci of infiltration of inflammatory cells or inflammation were noticed. The present findings indicate that untreated sewage is acutely toxic to the fish.

Keywords: Histopathology, *Oreochromis mossambicus*, Mallapura lake, Liver, Kidney

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Introduction

Wastewater disposal has become a problem in recent years due to the rapid pace of industrialization and rapid population growth. Heavy metals, pesticides, and a variety of organic compounds, in addition to domestic waste and industrial effluents that have not been treated at all, have greatly contributed to the widespread effects on fish in aquatic ecosystems. There are several reports indicating that these toxic metals and chemicals have altered the quality of the water, which has an effect on fish and other aquatic organisms (Dhasarathan *et al.*, 2000; Pazhanisamy and Indra, 2007; Shankar Murthy *et al.*, 2013).

Over the past two decades, the use of various pesticides in agriculture to prevent pests from damaging crops has increased, particularly in developing nations (Santhakumar and Balaji,

Fig. 1: Mallapura lake.

2000). Through surface runoff, these pesticides reach unrestricted areas like ponds and rivers, affecting aquatic organisms by altering the physico-chemical properties of the water (Kamble and Muley, 2000; Bhachandra *et al.*,2001; Madhab Prasad and Aditya, 2002; Sindhe *et al.*, 2007; Muthukumaravel *et al.*, 2013).

The most significant single source of contaminants for the aquatic environment comes from industrial effluents (Bryan and Langston,1992). Depending on the dose and time spent exposed, some toxicants in industrial effluents have been reported to be harmful (Yusuff and Sonibare, 2004), and they have the potential to cause significant harm to aquatic life (Vinodhini and Narayanan, 2009). The discharge of industrial effluents from multiple industries into the receiving water bodies has been linked to a number of fish mortality cases (Das, 2003; Adewoye and Lateef, 2004; Adewoye *et al.*,2005; Amte and Mhaskar, 2012)

Since records of the documented use of pesticides even in developed nations reveal that less than 1% of pesticides applied to crops reach the target organisms, indiscreet and unpredictable use of agrochemicals has raised significant concerns among researchers. However, Chapman *et al*. (1998) and Manimekalai *et al*. (2022) have reported that more than 99 per cent pollute the air, water, and land. These pesticides can get into the natural environment either by spreading on target organisms or by transferring the synthetic compounds from the soil. Apart from horticulture, aquaculture is widely practiced in India. Pesticides that are used to control insects are exposed to non-target organisms like fish and other organisms. The fish's reproduction, fecundity, and survival rate are directly affected by the pesticides.

Oreochromis mossambicus, belongs to order Cichliformes and included under family-Cichlidae that is native to southeastern Africa. It is a freshwater fish that can be found in a variety of aquatic habitats, including rivers, lakes, and swamps. Like other tilapia, *Oreochromis mossambicus* is commonly farmed for food due to its hardiness, rapid growth, and adaptability to a variety of environments. It is also a popular game fish and is sometimes used for biological control of aquatic weeds and invertebrates.

The purpose of this study was to investigate the histopathology of liver and kidney of *Oreochromis mossambicus* collected from Mallapura Lake, Karnataka, India which receives untreated sewage water, pollutants, chemicals, hospital wastes, pesticides, etc. This study has provided information for both hazard assessment and for hazard classification purposes.

Materials and Methods

Study Area:

Chitradurga is a taluk city and the head quarter of Chitradurga district which is located on the valley of the Vedhavathi river in the central part of the Indian state of Karnataka. Chitradurga is a place with historical significance which is located to the

North west about 200 kms from the state capital Bengaluru. Chitradurga is a tourist place of Karnataka. The area lies in between longitude 76° 24' to 76°28'5" E and latitude 14°11' to 14°17' N.

Mallapura lake (Fig. 1) is a perennial, natural fresh water body situated 2 km away from Chitradurga city. Gonuru is the Gram panchayath of this lake. Total water spread area is 91.84 hectares and the depth of the water body is about 2.5 meters. The water storage capacity is about 189 million cubic feet. This lake receives water from rainfall, municipal sewage and also agricultural runoff. The colour of water is bluish green.The water of this lake is used to cultivate the crops like Arecanut, Coconut, Jowar, Ragi and Maize, Green leaves and vegetables. Besides this, water is also used for washing of clothes, cattle bathing and other domestic purposes.

Mallapura lake receives major sewage water especially from urban places of the city. The entire city sewage water is directly released to the water body, which consists of pollutants, chemicals, hospital wastes, pesticides, and heavy metals.

The freshwater fish *O. mossambicus*, (N=30) were collected from Mallapura lake Chitradurga. This study was performed at Department of Zoology, Kuvempu University. Fish weigh approximately 850 to 1000 g. after collection, the liver and kidney of the fish were extirpated and fixed in Bouin's fixative for 24 h. Then the tissues were dehydrated, cleared in xylene and embedded in paraffin. The sections were cut at 6 µm and stained with hematoxylin-eosin (HE).

Results and Discussion

The hepatocytes show focal lipid deposition (Fig. 2) with focal areas of degeneration. There are focal aggregates of melanomacrophages (Fig. 3) and mild mixed inflammation. The sinusoids are intact. The hepatocytes exhibits subcentral to peripheral round to oval nucleus and degenerating hepatocytes (Fig. 4). There are moderate mixed inflammation (Fig. 5). In kidney tubular hemorrhages were noticed (Fig. 6). Foci of infiltration of inflammatory cells or inflammation in tubular region of kidney was also recorded (Fig. 7).

Due to the presence of enzymatic machinery, fish liver becomes the active site of storage and metabolism in response to the pesticide's passage through the portal circulation and becomes the first organ to experience its effects (Jagadeesan, 1994). According to Jones *et al*. (1987) toxic substances are less harmful to normal physiological processes when eliminated by the liver.. Toxic metabolites are also metabolized and excreted by the muscle, kidney, and gills (Arora *et al*., 1971). In the present study there was histological alterations in the liver of the fish *O. mossambicus* which are caught from Mallapura lake. This can be attributed to the effects of various pollutants which are received by this lake through sewage water which is directly released to the water body which contains various pollutants. In past, it has been reported that several pesticides/pollutants can cause adverse effects on fish liver/liver enzymes (Srivastava *et al*., 1990a; Kumar *et al*., 2013; Raza *et al.*, 2016; Mohebbi *et al.*, 2020; Zanaty *et al*., 2020; Kothekar *et al.*, 2022; Manimekalai *et al.*, 2022; Topić Popović *et al.*, 2023).

The kidney plays a crucial role in maintaining a stable internal environment and maintaining the electrolyte and water balance in fish and other higher vertebrates. Ammonia, urea, and creatinin are examples of nitrogen-containing metabolic waste products that are excreted by the kidney. According to Takashima and Hibiya (1995), tubule degeneration and changes in the corpuscle, such as dilation of capillaries in the glomerulus and reduction of Bowman's space, are the most common alterations found in fish kidneys exposed to water contaminants.

Histological alterations are noticed in the kidney of the fish *O. mossambicus* which are caught from Mallapura lake. The histological alterations in kidney may be due to the effects of various pollutants present in sewage water which is directly received by this lake. In past, it has been

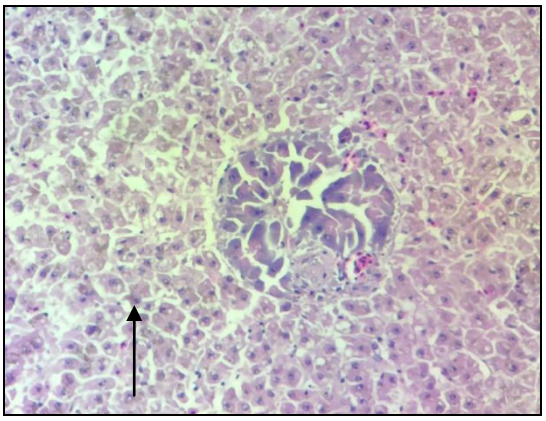

Fig. 2: Lipid deposition in liver. HE x400.

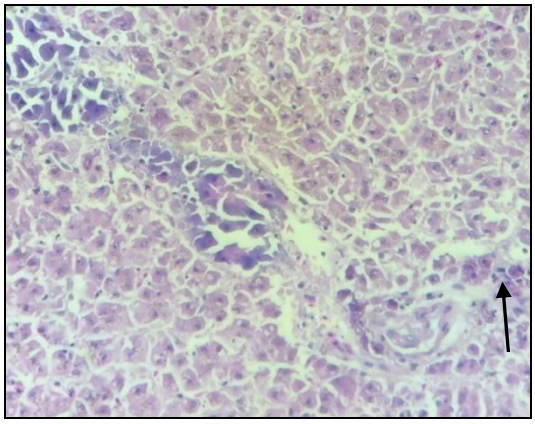

Fig. 3: Melanomacrophages in liver. HE x400.

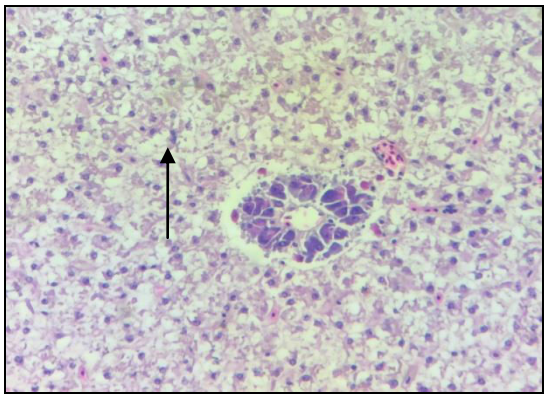

Fig. 4: Degenerating hepatocytes. HE x400.

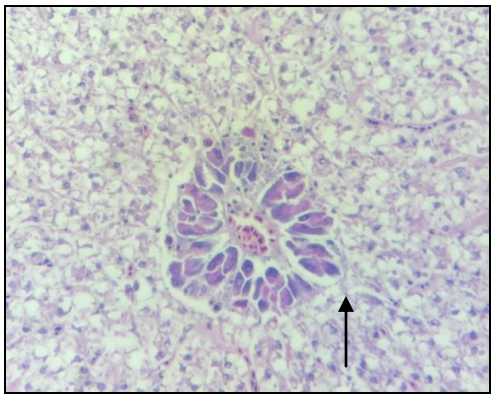

Fig. 5: Liver inflammation. HE x 400.

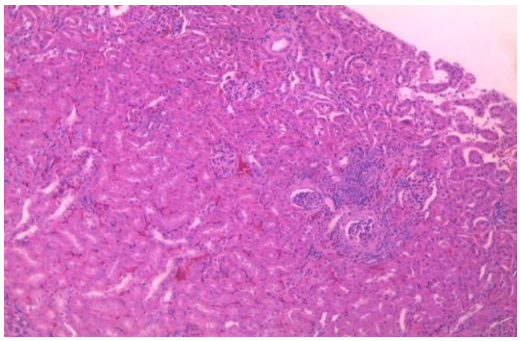

Fig. 6: Tublar haemorrhages in kidney. HE x100.

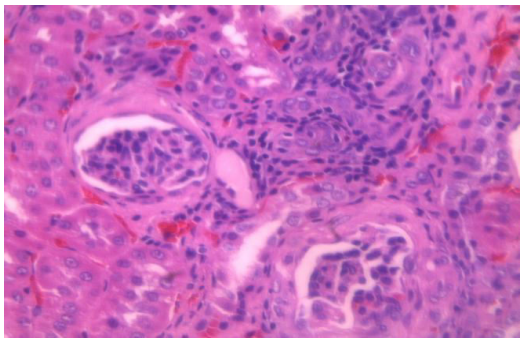

Fig.7: Inflammation in tubular region of kidney. HE x400.

reported that several pesticides/pollutants can cause adverse effects on fish kidney (Srivastava *et al*., 1990b; Hussain *et al*., 2019; Al-Otaibia *et al*., 2019; Shahid *et al*., 2020; Risna *et al*., 2020; Obaid *et al*., 2022; Hasan *et al*., 2023).

Conclusion

Histopathological assessment of *Oreochromis mossambicus* fish in Mallapura lake exposed sewage waste water revealed remarkable alterations in the kidney and liver and thereby it may also affect the physiological functions such as excretion and metabolic processes of the fish. Long term exposure of organisms to waste water in a lake means a continuous health hazard for the population. So, human population is at high risk by

consuming these fishes. With reports of toxicants usage and its adverse effects on non-target organisms like fish, it has become essential to formulate stringent rules against indiscriminate use of pesticides.

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