ZINC SULPHATE INDUCED HISTOPATHOLOGICAL CHANGES IN ARCHITECTURE OF TRUNK KIDNEY OF THE AIR BREATHING FISH, *HETEROPNEUSTES FOSSILIS* (BLOCH)

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ABSTRACT

Environmental pollution is burning issue at the moment for whole world. Many factors are behind these various types of pollution and varied effects reveal by the pollutants. Heavy metal compounds are the main source of water pollution and are through sewage and industrial effluents in the aquatic environment. Fish is the best indicator of the water body pollutants. Aquatic pollution is mainly concerned with the human life.

In the present investigation the toxic effect of Zinc sulphate was observed on the trunk kidney of the freshwater fish, Heteropneustes fossilis. The effect of 28 days exposure to sublethal concentration of Zinc sulphate (0.07 mg/L) caused various changes which were observed after 7, 14, 21 and 28 days after of the treatment on the histopathology of trunk kidney of the freshwater fish, Heteropneustes fossilis. They assessed noticeable degenerative histopathological changes observed in the trunk kidney were more prominent in the various groups with abnormal behaviour.

Key Words: *Trunk kidney, Zinc sulphate, Heteropneustes fossilis.*

Introduction

Heavy metals have become major environmental pollutant today and are of great biological significance. Pollution has many categories, classes and types. Different sources of pollutants (Industrial, Mixed and Domestic) were found to affect aquatic fauna like fish by variable degrees. Many factors are behind these various types of pollution and varied effects. Aquatic pollution directly affects the human life, as water is main components of living organism. Water requires for our everyday life activities like cleaning, drinking, washing, agriculture purpose, sea food, fish food etc. It is understood that the water is to be clean and pollution free for the sake of healthy life. The harmful effect of any toxicant which was moved to water bodies can be assessed by investigating health of the aquatic fauna.

Fish are the best indicator of the water body pollution and are the sensitive of all the aquatic animals. The accumulation of effluents becomes hazardous to the aquatic organisms and to surrounding human population because, the fish is the most important factor of food chain, which has great nutritive value in the environment. Pollution in the aquatic environment impacts on physiology, development, growth or survival of the fish. It affects humanbeings which is at the top of the food chain, consuming fish in the diet. Therefore it is of great importance to evaluate the effect of pollutant on the fish for the both environmental protection and socio-economic status.

Pollution of aquatic environment with heavy metals is worldwide and under certain conditions aquatic fauna may concentrate large amount of such metals from water in the tissue (Kaoud *et al.*, 2012). Among the various toxic pollutants, heavy metals are particularly severe in their action due to the tendency of biomagnifications in the food chain. Aquatic organisms have the ability to accumulate heavy metals from various sources including sediments, soil erosion and runoff, air deposition of dust and aerosol and discharges of waste water (Labonne *et al.*, 2001; Goodwin *et al.*, 2003).Therefore accumulation of heavy metals in aquatic organisms can pose a long lasting effect on biogeochemical cycling in the ecosphere. Heavy metals can also adversely affect the growth rate in major carps (Hayat *et al*., 2007).

Zinc is an essential mineral in cellular metabolism. It is a cofactor for the activity and folding of proteins. Because of the pleiotropic effects of zinc on every aspects of cell physiology, zinc deficiency or excessive rise in its cellular concentration, can have catastrophic consequences and are linked to major pathophysiologies (Sekler *et al.*, 2007). Zinc is one of the most important trace elements in the body, and participates in the biological functions of several proteins and enzymes (Maity et al., 2008). Despite being an essential trace element, zinc is toxic to most organisms above certain concentrations (Ho, 2004).

Materials and Methods

Live specimens of the freshwater fish, *Heteropneustes fossilis* were selected for the experimental work. The fish were obtained for the experimental purpose from the Adan project (Taluka Karanja, Dist. Washim, M. S.). The fish were brought to the laboratory in well oxygenated bags without any injury. Fish were washed with 1% $KMnO_4$ solution for 5 minutes for dermal disinfection. The fish were allowed to acclimatize to the laboratory condition for period of fortnight. Before conducting the experiments, fish were fed on small pieces of boiled eggs once in a day particularly in morning hours.

The 16 fish including males and females between 70 to 75 gms.(+_2 gm) and length between 16 to 18 cms.(+-2 cms) were selected for experimental work. They were maintained in separate aquaria containing free aged tap water. As per the standard method the physicochemical parameter of used aged tap water were determined periodically (APHA, 1998). The zinc sulphate was selected as heavy metal toxicant for the present investigation. The 96 h LC_{50} of $ZnSO_4$ for the fish, *Heteropneustes fossilis* was estimated as 0.350 mg/L. The sublethal concentration was selected as 0.07 mg/L which is 5 times less than the LC_{50} value which was used to expose the fish for 28 days to study to observe the changes in histological structure of trunk kidney. The acclimatized fish were transferred into glass aquaria containing 40 lit. of toxicant solution of $ZnSO_4$ (sublethal conc. 0.07 mg/l).The fish were fed on pieces of boiled eggs once in a day in morning hours. The set of control fish and experimental fish for 7, 14, 21 and 28 days were run simultaneously. As per microtechnique procedures, fish from each group were dissected for collection of trunk kidney of and the sections were cut at 6 micron thickness and were stained with haematoxylin – Eosin (HE); as per microtomy procedure.

Result and Discussion

The experimental fish exposed to sublethal concentration of $ZnSO_4$ showed abnormal behavioural responses like rapid movement, faster opercular activity, surfacing and gulping of air. Typical observation was noted that there was a remarkable body dispigmentation with more mucus secretion.

Histopathological studies: After exposure of sub lethal concentration of $ZnSO_4$, the trunk kidney of the freshwater fish *Heteropneustes fossilis* showed varied degenerative changes after 7, 14, 21, and 28 days. The remarkable degenerative histopathological changes were observed in the trunk kidney in the $ZnSO_4$ treated fish.

In *Heteropneustes fossilis* the kidney is differentiated into head kidney and trunk kidney. The head kidney of adult fish comprises in mass of pseudolymphoid tissue and is endocrinal elements. The trunk kidney lies behind the head kidney and differentiate from the embryonic mesonephros. In *Heteropneustes fossilis* trunk kidney of two sides are fused throughout their length.

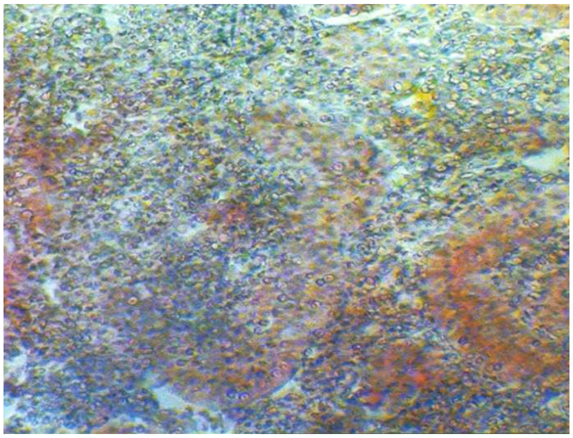

Figure 2: Transverse section through the trunk kidney of fish, *Heteropneustes fossilis, exposed to sublethal concentration of* $ZnSO_4$ 7 days, Haematoxylin-eosin, x 630.

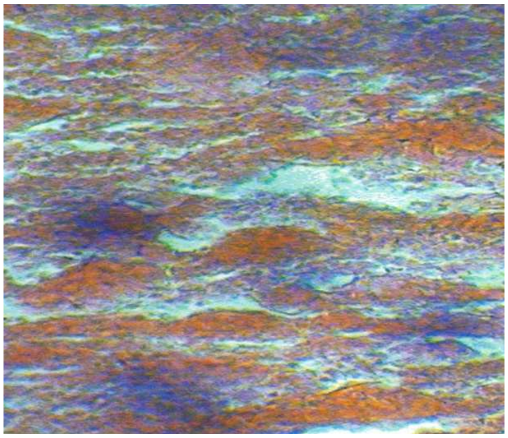

Figure 3: Transverse section through the trunk kidney of fish, *Heteropneustes fossilis, exposed to sublethal concentration of* $ZnSO_4$ 14 days, Haematoxylin-eosin, x 630.

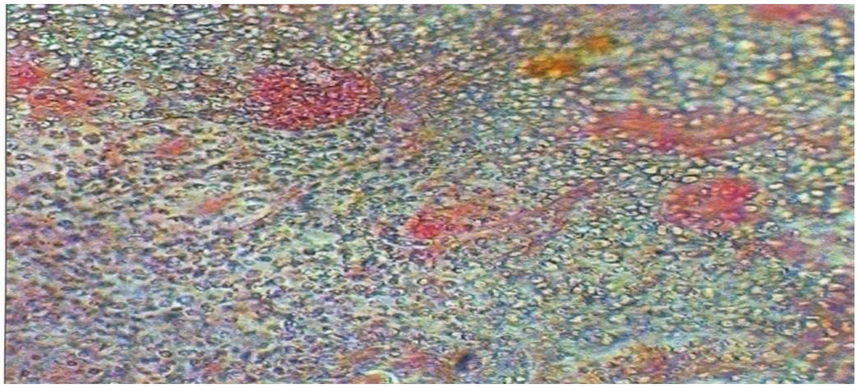

Figure 1: Transverse section through the trunk kidney of fish, *Heteropneustes fossilis* (Bloch), (control). Haematoxylin-eosin, x 630.

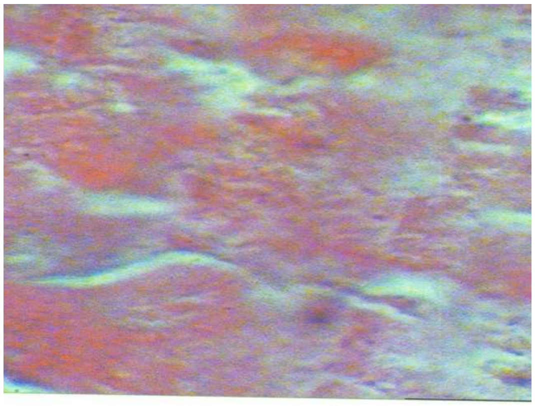

Figure 4: Transverse section through the trunk kidney of fish, *Heteropneustes fossilis, exposed to sublethal concentration of* $ZnSO_4$ 21 days, Haematoxylin-eosin, x 630.

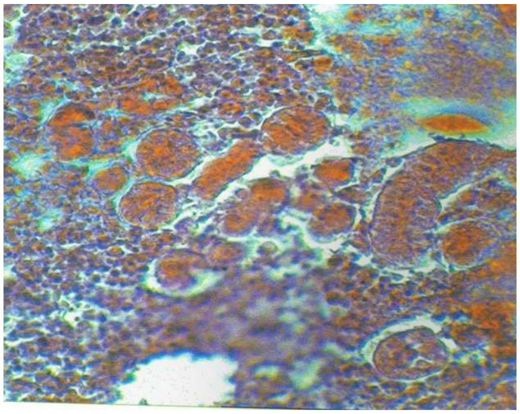

Figure 5: Transverse section through the trunk kidney of fish, *Heteropneustes fossilis, exposed to sublethal concentration of* $ZnSO_4$ 28 days, Haematoxylin-eosin, x 630.

Histologically the trunk kidney is rich in uriniferous tubules and it carries the function of excretion. The tubules are lined with columnar epithelial cells with distinct nuclei. The interstitial tissues in the inter-tubular space have parenchymatus cells with distinct nuclei (fig.1).

After 7 days of exposure to sublethal concentration of toxicant zinc sulphate, proximal tubular lining were destroyed and their cytoplasmic material was disintegrated. The primary site of tissue damage was noticed in the form of loss of interstitial tissue (fig. 2). The fish exposed to sub lethal concentration of $ZnSO_4$ for 14 days exhibited haemorrhage in the glomeruli. The cell lining in uriniferous tubule appeared swollen and vacuolated in nature. Their nuclei were hypertrophied (fig.3). After 21 days of exposure to sublethal concentration of $ZnSO_4$ disintegration of uriniferous tubules, the clumping of nuclei of epithelial cells of uriniferous tubules due to the loss of epithelial membrane of kidney was highly noticed (fig. 4). Severe damaged of renal tubules including distal and collecting tubules was evident at this stage, which resulted into necrosis of the trunk kidney , after the 28 days of exposure to sublethal concentration of zinc sulphate (fig.5).

In the present study, the histopathological damages were observed in the trunk kidney after exposure to the sub lethal concentration of $ZnSO_4$ upto 28 days. The results of the present investigation are in conformity with the results reported by the workers as mentioned later.

Handy and Penrice (1993) found swollen Bowman's capsule and melanomacrophages in the kidney of trout *(Salmo trutta*) and Tilapia (*Oreochromis mossambicus*) exposed to mercuric chloride. Similar alterations were found in fish exposed to organic contaminant (Veiga et al.2002) and mixed environment contaminant (Sehwaiger et al. 1997, Phacheco and Santos 2002).According to Gupta and Srivastava (2006) the most remarkable histopathological change was the expansion of the renal tubules to such an extent that it covers the area of lumen. Further, the cell linings and the lumen were also ruptured causing tubular necrosis in lumen of the renal tubules. The occurrence of cellular debris was also noticed. According to Camergo and Martinez (2007), kidney of fish often showed cloudy swelling in tubular cells of the Neotropical fish caged in a contaminated urban stream.

According to Avinashe and Patil (2012) the trunk kidney of freshwater fish, *Channa punctatus*, showed uniform thickening, tubular degeneration with loss of nuclei from lining cells and compensatory dilation. Nephrosis and vacuolation was also observed in advance stages after 28 days exposure of fish to the Selenium dioxide as toxicant.

In the present study the various histopathological degenerative changes of trunk kidney were recorded in all the experimental fish exposed to sub lethal concentration of toxicant $ZnSO_4$ and these results support the views of the earlier researchers.

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