

CADMIUM TOXICITY INDUCED MORPHOLOGICAL ALTERATION IN INDIGENOUS FISH *Heteropneustes fossilis* (Bloch.)

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Article History: Received on 01st August 2017, Revised on 5th September 2017, Published on 7th October 2017.

ABSTRACT

The aim of present study was to determine the toxicity (LC₅₀) of cadmium chloride (CdCl₂.H₂O) in freshwater catfish *Heteropneustes fossilis*. Acute toxicity of cadmium on the indigenous fish *H. fossilis* was designed in the fish aquarium in laboratory at room temperature in Department of Zoology, D G P G College at Kanpur. Treated fish *H. fossilis* induced morphological alteration against cadmium chloride toxicity. *H. fossilis* showed morphological alteration such as increased opercula movement, abnormal swimming, and loss of buoyancy and fading of their body colour. Control fishes were also continuously monitored and compared with the changes caused by cadmium concentration. *Heteropneustes fossilis* exposed different concentration of cadmium chloride toxicity i.e. 0 ppm for 24 h, 10 ppm for 48h, 15ppm for 72h and 20 ppm for 96 h. From this present study it seems that the indigenous fish, *H. fossilis* is more susceptible to cadmium toxicity.

Keywords: Indigenous; *Heteropneustes fossilis* LC₅₀, Cadmium chloride, morphological alteration .

INTRODUCTION

Toxicity test has been widely used as a tool to identify organisms as a bio indicator and assessing the effects of toxicant in aquatic ecosystem. Heavy metal toxicity is a global problem in developing country such as India.

Heavy metals, Cadmium have been blacklisted by European community ([Manson, C F 1996](#)). It is a non corrosive and highly toxic metal. It is a nonessential element with no known biological function. It is used in batteries, plastics, metal alloys, dye and metal plating industries. Effluents from such activities are sources of Cadmium in aquatic environment. A higher concentration of Cd in the aquatic environment is lethal to many organisms ([Vankhede, G N et. al 1999](#) and [Bhattacharyya, M H et al., 2002](#)). Cadmium is a non-essential toxic heavy metal, and its bio-accumulating property causes toxicity to aquatic organisms even in minute concentrations. Cadmium heavy metal is a worldwide problem and present in waste water which is released in river, pond or aquatic ecosystem and harmful causes in aquatic organism such as fishes. Fishes are used as a bio indicator because it is very sensitive for changing environment stress and situated in top position of the ecosystem. Fishes have a capacity to accumulated directly contaminated water. Fishes store concentration of heavy metalizes toxicant and exhibit morphological alteration. The morphological behavior of fishes to adjust internal and external challenges for changing the environment.

Cadmium accumulation and physiological alterations were recorded in Rainbow trout on Cadmium exposure ([Hollis L. et. al 1999](#)). Toxicity of Cadmium on behavioral and morphological aspects in *Labeo rohita* was recorded ([Maruthanayagam et. al 2002](#)). Cadmium toxicity effect physical, chemical and biological parameter of water quality. A physical and chemical parameter such as PH, temperature, dissolved oxygen and biochemical oxygen demand and biological parameters such as microorganisms, zooplanktons, and fishes. Fishes are very sensitive organism rapidly affected cadmium toxicity, and cadmium toxicity affects feeding, swimming, and delay maturation period.

Therefore, the present study is aimed to analyze the cadmium induced toxicity of the fish *H. fossilis* exposed to sublethal concentration. Because toxicity studies quantify an organism's response to a biologically active material ([Alderdice d 1967](#)).

RESEARCH PROBLEM

The present research work was aimed to monitor cadmium chloride toxicity , determine health of fish and morphological alteration to evaluate the acute toxicity of sub lethal cadmium heavy metal.

MATERIALS AND METHOD

Collection and acclimatization of test specimen

The experimental fish *H. fossilis* was purchased from the local landing sites and care was taken to minimize stress incurred by the fish during transportation. The fishes were then given a KMnO₄ treatment to avoid any infection before transferring

them into the experimental aquaria. Fishes were acclimatized to laboratory conditions at room temperature (26°C) for a period of 15 days. During this period the fishes were fed with fresh fish food every day.

Experimental Design

Healthy fishes were selected for experimentation. A stock solution of cadmium chloride was prepared with tap water for acute toxicity studies. The cadmium concentration was analyzed double beam uv-v is spectrophotometer (AU 2603). The range of concentration was selected between 0 to 100% mortality. four group of experimental fish were exposed to different concentration of cadmium chloride i.e.0,10, 15 and 20 ppm respectively and for a period of 24, 48, 72 and 96 hrs. 10 fishes were selected for each group, and the experiment was conducted in replicates.

During this experiment, the water in the aquarium was changed every day for maintaining the appropriate concentration of cadmium chloride. The mortality rate of *Heteropneustes fossilis* was recorded at 0 ppm for 24 h, 10 ppm for 48 h, 15 ppm for 72 h, and 20 ppm for 96 hrs. of exposure period of cadmium chloride toxicity. The dead fish were removed from the aquarium, and proper aeration was maintained in test as well as control aquarium by air pumps throughout the experiment.

Physicochemical parameter test of fish water at the time of experiment

Physico-chemical properties of all treatment waters of fishes were studied on the initial day of the experiment. After that water quality parameters, viz. pH, DO (dissolved oxygen), temperature, BOD (biochemical oxygen demand), and TDS (total dissolved solids) were analyzed on a weekly basis following standard method.

pH and temperature determined by pH meter and thermometer. DO of fish water was analyzed by Winkler method and BOD was done after 5 days of DO.

Statistical analysis

Obtained data was calculated by correlation study between concentration and fish mortality using spss software 16. The percentage of corrected mortality was given by ([Abbott W.S. 1952](#)):

$$\text{Control Mortality} = \frac{(\text{Percentage living in control} - \text{percentage living in treatment} * 100)}{\text{Percentage living in control}}$$

RESULTS

Toxicity

The test fish *Heteropneusteus fossilis* were exposed to different concentration of Cadmium chloride (CdCl₂) toxicity for 0 for 24 h, 10 ppm for 48 h, 15 ppm for 72 h and 20 ppm for 96 hrs were recorded the morphological alteration in fish.

Morphological Responses

- **Control fish:** Fishes were active with well-synchronized movements. They mostly settled to the base of the aquarium tub, sometimes came to the surface of the water and actively responded to a slight disturbance. No abnormal changes and mortality were recorded at the time of the experiment.
- **Treated fish:** The treated fishes showed dark body colouration, erratic swimming, and loss of equilibrium, bulging of eyeballs, restlessness, sluggishness, jumping, and opercula movements on acute exposure to Cadmium toxicity. At higher chemical concentration, scale depletion start, skin lesion observed from dorsal to lateral side of the body of fish and these were deepens, copious mucous, clumping of gills increases with the increase of concentration of toxicant. Postmortem examination of dead fish revealed clumping of gills and the effect was concentration dependent.

Table 1. Analyzed physico-chemical parameter of water quality.

[CdCl ₂] (ppm)	pH	Temperature (C°)	(DO) mg/l	(BOD) mg/l
0	7.1	29	6.23	4.5
10	7.4	29	5.21	3.1
15	7.5	27	6.89	5.03
20	7.3	27	4.02	2.1

Table 2. Morphological alteration observed when *H. fossilis* exposed to [CdCl₂] concentrations for 96 h

RESPONSE	EXPOSER PERIOD				
	0(control)	24h	48h	72h	96h
Erratic swimming	Normal response	Abnormal response	Mild response	Moderate response	Maximum response
Clumping of gills	Normal response	Abnormal response	Mild response	Moderate response	Maximum response
Discoloration of skin	Normal response	Abnormal response	Mild response	Moderate response	Maximum response
Lesions on skin	Normal response	Abnormal response	Mild response	Moderate response	Maximum response
Mucus secretion	Normal response	Abnormal response	Mild response	Moderate response	Maximum response
Posturing of pectoral fins	Normal response	Abnormal response	Mild response	Moderate response	Maximum response
Sedimentation of pollutant on body	Normal response	Abnormal response	Mild response	Moderate response	Maximum response
Shedding of scale	Normal response	Abnormal response	Mild response	Moderate response	Maximum response

Table 3: Relation between different concentration of cadmium chloride (CdCl₂) toxicity and the mortality rate of indigenous fish *Heteropneustes fossilis*.

[CdCl ₂] (ppm)	No of exposor fish in CdCl ₂ concentration	Number of dead fishes after exposed in CdCl ₂ concentration	Mortality rate (%) of fishes
0	10	0	0
10	10	2	20
15	10	3	30
20	10	5	50

DISCUSSION

Cadmium chloride showed a toxic effect on the indigenous fish *Heteropneustes fossilis*. The fish mortality may have resulted by absorption and bio-accumulation of cadmium chloride toxicity. When *Heteropneustes fossilis* fish exposed to cadmium treated water, we observed that the treated fish shows abnormal swimming, dark body coloration, mucus secretion and when the increased concentration of cadmium chloride mortality rates also increased. Then plot a graph between cadmium concentration and mortality rates and find a positive correlation coefficient ($r = 0.984$ $p < 0.05$ level 2-tailed). This relation is showing that increased concentration of cadmium chloride then mortality rates of fish also increased.

Sluggishness observed at the end of exposure periods may be due to loss of energy as a result of erratic swimming, jumping, and restlessness. Loss of balance during swimming, observed during this study, might be due to some neurological impairment in the Central nervous system. Similar results were reported by (Lata, S *et al*; 2001, Patro L 2001).

Surfacing and gulping of air might be an attempt to cope with the oxygen deficiency. The increased opercula movement and gulping activity by the treated fish may be an attempt to extract more oxygen to meet the increased energy demand to withstand the Cadmium toxicity (Saxena OP *et al* 1982).

The Physico-chemical parameter of water quality in the fish aquarium was analyzed and observed the effect of cadmium chloride toxicity. pH and temperature of a control group of indigenous fish *Heteropneustes fossilis* was normal but treated a group of different concentration of cadmium chloride was slightly alkaline due to cadmium heavy metal toxicity. pH and temperature is the most important parameter for assessing water quality. Temperature controls the rate of all chemical

reaction and affects fish growth and immunity. Dissolved oxygen was observed in control group as well as treated group and find the result that DO level was normal in control group but treated group of fish *Heteropneustes fossilis* was variable 5.21 DO value observed when fish treated with 10 ppm concentration of cadmium chloride and 4.02 DO value was observed when treated fish with 20 ppm concentration of cadmium chloride toxicity. BOD parameter of water quality measured in *Heteropneustes fossilis* fish aquarium and observed that control group of fish aquarium water was normal. BOD is a measurement of organic material which contaminates with water.

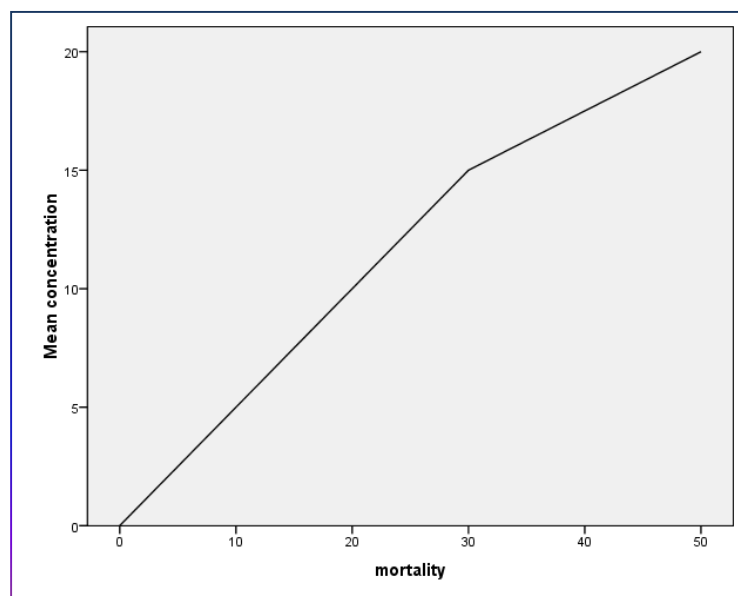


Figure 1. The correlation between cadmium chloride concentration and fish mortality

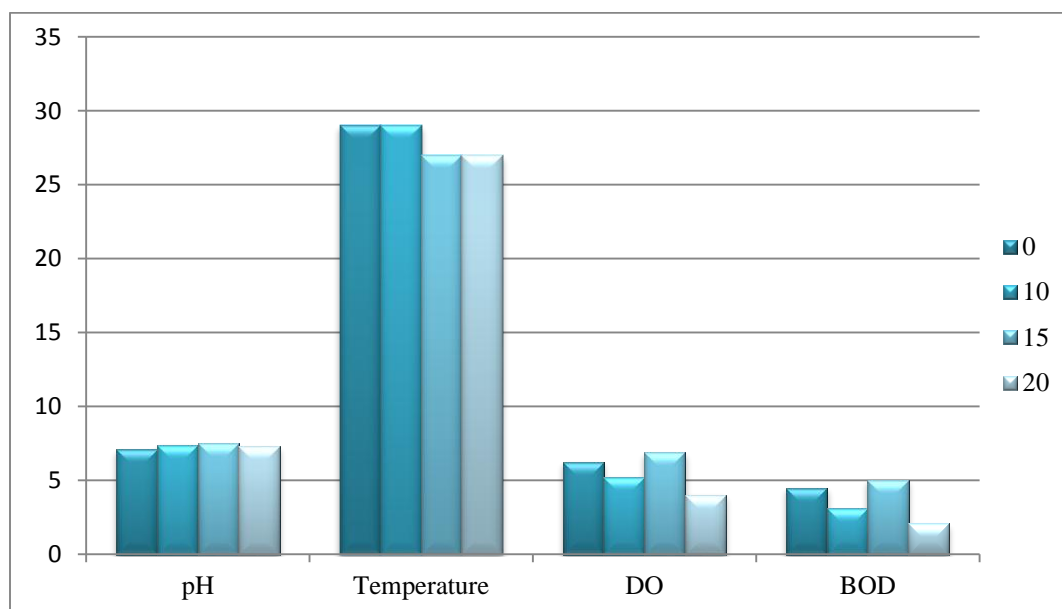


Figure 2. Showing relation graph between different concentration and physico-chemical parameter of aquarium water.

CONCLUSION

The present study was indicated that cadmium chloride toxicity for morphological behavior of *Heteropneustes fossilis* fish a rewarding tool to access the water pollution. If cadmium heavy metals persist in aquatic organism, it can cause harmful effect in aquatic species. It was clearly demonstrated from the LC50 value cadmium chloride harmful to freshwater fish *H. fossilis*. Morphological alteration of *H. fossilis* fish under the influence of cadmium heavy metal toxicity and physical and chemical parameter of water quality can be used to monitor of the health condition of the water.

ACKNOWLEDGEMENTS

The authors are thankful for the encouragement and the facilities provided by the department of zoology D G P G College C S J M University, Kanpur India for carrying out the research work are highly acknowledged.

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