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Behavioral and Structural Alterations in fresh water fish *Catla catla* exposed to zinc chloride

Blessy Graciah^{*1}, Viji Margaret I², Jeya Praba. L³

1. Research Scholar, Zoology Department and Research Centre, Sarah Tucker College (Autonomous), Affiliated to Manonmaniam Sundaranar University, Abishekapatti, Tirunelveli-627 012, Tamil Nadu, India.

2. Assistant Professor, Zoology Department and Research Centre, Sarah Tucker College (Autonomous), Affiliated to Manonmaniam Sundaranar University, Abishekapatti, Tirunelveli-627 012, Tamil Nadu, India.

3. Assistant Professor, Zoology Department and Research Centre, Sarah Tucker College (Autonomous), Affiliated to Manonmaniam Sundaranar University, Abishekapatti, Tirunelveli-627 012, Tamil Nadu, India.

Abstract

The acute toxicity of zinc chloride was evaluated in *Catla catla* over a 96-hour exposure period. The LC₅₀ value was calculated utilizing the Finney method (1971). Comprehensive monitoring of behavioral and morphological alterations was conducted throughout the 96 hours. Behavioral manifestations included erratic swimming, surface gulping, increased opercular activity, decreased activity, restlessness, and loss of equilibrium. Morphological changes recorded comprised scale detachment, ocular recession, conjunctival hyperemia, profuse mucous secretion, branchial hemorrhage, and dermal hemorrhages. The concentration of zinc chloride demonstrated significant toxicity. Control organisms were concurrently monitored for comparative analysis. The empirical data indicates the potential of *Catla catla* as a reliable bio-indicator for heavy metal contamination in lotic and lentic freshwater environments.

Key words: Acute toxicity, zinc chloride, equilibrium, restlessness, haemorrhages, bio-indicator.

Introduction

Now a day's freshwater bodies such as rivers, lakes and ponds are being polluted. These water bodies are not only being polluted but also become the disposal sites of domestic and industrial wastes by recent advances in industrialization, urbanization, agricultural and other developmental activities. Due to these activities, discharge of metals into the aquatic body has caused eco toxicological effects. However, metals are unique among pollutants in that they occur naturally, but may cause adverse health effects as well. Kakade *et al.* (2020) reported the status of heavy metals in aquatic organism.

Material and Methods

Healthy *Catla catla* were collected from the Bhavani river at Erode (TN) . Only healthy, uninjured and uninfected fish specimens (Length: 15-20 cm, Weight: 50- 60 gm) were taken for experiment. Fishes were acclimatized in tank containing tap water for 15 days in the laboratory. The fishes were fed with fish food and water in the aquaria was changed at every 24 hrs, leaving no fecal matter, unconsumed food or dead fish. Proper aeration was maintained in test as well as control aquaria by aerators throughout the experiments. The 96hrs LC₅₀ value of cadmium chloride was determined by static renewal bioassay following probit analysis (Finney, 1971). The behavioral and morphological changes were recorded simultaneously at different exposure period.

Morphological and Behavioral Studies:

Throughout the experiments, fish was observed meticulously for their morphology and behavior. To facilitate comparison, a parallel control experiment was run with an identical number of fish and volume of water. Within the 96-hour experimental period, each group of fish was examined for any alterations in morphology or behavior.

Result and Discussion

Due to anthropogenic activities, fish represent a vertebrate group that exhibits early responses to environmental contamination by pollutants (Sehonova et al., 2017). Their role as significant indicators of water pollution stems from their continuous direct contact with water for sustenance and respiration, rendering them highly susceptible to alterations in the aquatic environment.

Given their importance as a protein source, the consumption of fish contaminated with heavy metals poses a risk of heavy metal accumulation in the human body. Consequently, thorough screening for heavy metal contamination in fish is essential prior to consumption.

Upon exposure to zinc chloride-treated water, the test fish initially displayed subtle signs of excitability, increased opercula movement, and fin flickering within the first 24 hours. Notably, they did not exhibit imbalanced swimming, alterations in pigmentation, or mucus secretion throughout the entire 96-hour exposure period. As the exposure progressed, the fish showed signs of acclimation, with reduced excitability, opercula movements, and fin flickering, and an absence of significant pigmentation changes. By the conclusion of the 96-hour observation period, the behavioral patterns of the test fish were largely comparable to those of the control group. At the median lethal concentration (10 ppm) of zinc chloride, approximately fifty percent mortality was observed among the fish by the end of the exposure period.

Effect of sub lethal dose of Zinc Chloride exposure on morphological changes of fresh water fish *Catla catla*

SN	Morphological changes	Control	Exposure (Zinc Chloride) Period					
			AcuteTest				ChronicTest	
			24 hrs	48 hrs	72hrs	96hrs	15 day	30day
1.	Patches on body	-	++	++	++	+++	++++	++++
2.	Discoloration of skin	-	++	++	+++	+++	+++	++++
3.	Shedding of scale	-	++	++	++	++	+++	++++
4.	Mucus secretion	-	++	++	++	+++	+++	++++
5.	Sedimentation of chemical On the body	-	++	++	++	+++	+++	++++
6.	Clumping of Gill	-	++	++++	++++	++++	+++	+++

(-)Normal, (+)Nil, (++)LessChange, (+++) Moderate Change (+++++) Prominent Change

Effect of sub lethal dose of Zinc Chloride exposure on behavioral responses of fresh water fish *Catla catla*

SN	Behavioural Changes	Control	Exposure(Zinc Chloride)Period					
			AcuteTest				ChronicTest	
			24 hrs	48hrs	72hrs	96 hrs	15day	30 day
1.	Loss of Equilibrium	-	++	++++	++++	++++	+++	++
2.	Gulping air at Surface	-	+++	+++	++++	++++	+++	++
3.	Erratic Swimming	-	++	+++	++++	++++	++	++
4.	Opercular Movements	-	++	+++	+++	++++	++	++
5.	Restlessness	-	++++	+++	++++	++++	+++	++
6.	Jumping	-	++++	++++	++++	++++	+++	++
7.	Sluggishness	-	++	++	+++	++++	+++	++

(-)Normal, (+) Nil, (++) Less Change, (++++) Moderate Change (+++++) Prominent change

Behavioural Changes

This study investigated the effects of varying zinc chloride concentrations on *Catla catla*. Increasing concentrations of zinc chloride resulted in increased mortality and induced both behavioral and morphological changes. Observed behavioral alterations included loss of balance during swimming, potentially indicating neurological impairment in the central nervous system, consistent with findings by Kawade and Khillare (2014). Fast opercula movements, air gulping, and surfacing were also noted. Surfacing and air gulping may be a response to increased oxygen demand following exposure (Katja *et al.*, 2005). Similar behavioral and morphological changes in *Catla catla* exposed to increasing concentrations of cadmium compounds were reported by Maruthanayagam *et al.* (2002) and Laovitthayanggoon (2006). While discomfort was observed consistently every 24 hours, the fish showed reduced activity and some degree of adaptation to the toxic environment over several days. The effects of toxicity are typically manifested as behavioral and morphological responses, which can lead to genetic and subsequently cytological changes in tissues. Fish behavior is highly sensitive to environmental changes, and behavioral alterations are well-established as indicators of chemically induced stress in aquatic organisms (Suedel *et al.* 1997; Remyla *et al.* 2008).

Morphological Changes

This study investigated the morphological alterations in fish subjected to varying exposure durations of zinc chloride. The observed changes included dermal discoloration, the deposition of a thin chemical film on the integument, diminished mucous secretion (potentially contributing to a chemical layer on the aquarium substrate), and squamation. These findings are consistent with the reports of Gupta and Dua (2015) concerning *Catla catla* exposure to zinc chloride. Additional pathological changes documented were branchial clumping, fin hyperextension, fin splitting and necrosis, cutaneous lesions, ocular deformities, and muscular tetany. The incidence of all documented deformities demonstrated a positive correlation with the duration of exposure, aligning with the observations of Halappa and David (2009) and Anita *et al.* (2010). Specifically, branchial clumping intensified with increasing toxicant exposure. Furthermore, the test subjects exhibited a loss of natural pigmentation, becoming predominantly pale yellow, a phenomenon also reported by Brraich and Kaur (2015). The profuse mucous secretion observed in this study is hypothesized to represent a defensive mechanism aimed at neutralizing and preventing the effects of the toxicant.

Conclusion

In present study, results showed that when fishes exposed to sub lethal concentration of zinc chloride, they showed a marked change in their behavioral and morphological changes. These changes show direct response of the animals to the pollutants. The results revealed that the mortality was observed over 96 hours in test species *Catla catla*.

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