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Impact of Zinc Sulphate on Behavioural Responses in the Freshwater Fish *Channa orientalis* (Sch.)

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ABSTRACT: Static bioassay test was conducted to determine the toxicity of zinc sulphate on the fresh water fish *Channa orientalis.* Fishes were exposed to various concentrations of zinc sulphate for 96 hours and the percent mortality was recorded. Objectives of this study were to understand the relationship between mortality and abnormal behavioural responses of fresh water fish *Channa orientalis* exposed to zinc sulphate. *Channa orientalis* in toxic media exhibited erratic and darting movements with imbalanced swimming activity, which might be due to the malfunctioning of neurotransmitters, followed by hyper and hypo opercular activity, loss of equilibrium, and mucus secretion all over the body were observed. The 96h LC50 for the fish was determined using Interpolation method and found to be 4.72 mg/l.

Key words: Toxicity, behavioral, zinc sulphate, *Channa orientalis*

INTRODUCTION

Heavy metal contamination of aquatic ecosystem has long been recognized as a serious problem. Heavy metal contamination may have lethal effect on ecological balance of recipient environment and diversity of aquatic organism (Charjan, 1997; Farombi *et. al.,* 2007). These heavy metal pollution posses a great threat to fishes. When fishes are exposed to elevated level of metal in polluted aquatic ecosystem, they tend to take these metals up from their direct environment (Hoo *et. al.,* 2004). The fish constitutes a valuable commodity from the stand point of human consumption. So heavy metal contamination of fresh bodies and aquatic biota becomes a serious concern from human health point of view. Heavy metal pollution of aquatic ecosystem poses a serious environmental hazard because of their persistence and toxicity (Joshi 2011).

These heavy metals are available in the water and are further added into aquatic ecosystem as a result of direct input of atmospheric deposition, leaching of mineral and soil erosion due to rain water which causes the hazardous effects on aquatic biota majorly fishes (Mulley *et. al.* 1996). These heavy metal toxicants are accumulated in the fish through general body surface which affect severally their life support system. Once these toxic substance enters into body, they damage and weaken the mechanism concerned leading to physiological, pathological and biochemical disorders (Arasta *et.al*. 1999). Behaviour is considered a promising tool in ecotoxicology. The uses of behavioural changes in fishes are diagnostic end point, for screening and differentiating chemicals according to their mode of action (Drummond *et al.* 1986). Chemicals are categorized to corresponding three general mode of action response syndrome; hyperactivity, hypoactivity and physical deformity (Drummond *et. al.* 1990). Each syndrome or sign of stress was indicative of a different mode of action.

Hence the present study was aimed to investigate behavioral responses in fresh water fish *Channa orientalis* at laboratory condition.

MATERIAL AND METHOD

The freshwater fish *Channa orientalis* were obtained from local sources. They were treated with 0.5 % $KMnO_4$ for five minutes for dermal disinfection. Then they were acclimatized for period of fortnight to laboratory condition. The fishes were of 12-14 Cm in length with weighing 18-30 g were selected for the experiment. The physicochemical parameter of the aged tap water was determined periodically as per standard methods (APHA 1998). The *Zinc sulphate* ($ZnSO_4.7H_2O$) was selected as a heavy metal toxicant for the experiment. Static bioassay was carried out as per Standard Method (APHA 1998) to determine 96 h LC50 (Table 1).

The fishes were exposed to different concentration of zinc sulphate for 96 hours. The acclimatized 10 fishes were transferred to glass aquaria (40 × 20 × 20 cm) containing 15 liters of toxicant treated water. The fish were fed (25 mg / earthworm / gm fish / day) once in a day. After exposure of the fish to various concentrations of the toxicants, observations were made on the behavioral and morphological responses of the fish at 12, 24, 48, 72, and 96 hours. Control fish were monitored along with the toxicant concentrations to provide a reference for assessing any behavioral or morphological changes. Responses were recorded if they differed from the control and occurred in 10% of the fish in each test tank.

The behavioral and morphological indicators observed include; loss of equilibrium, general activity, startle response, hemorrhage, and deformity (including, postural indicators).Each test tank was observed for 10 to 15minutes which allowed sufficient time for an accurate evaluation of each fish. Startle responses were monitored by the following procedures in sequence: passing hand over the test tank (overhead moving visual stimulus), rapping on the tank (vibration stimulus), and lightly touching the fish with a stick (tactile stimulus).

Table 1: Physicochemical Parameters of water.

1.	pH	7.5 ± 0.5
2.	Temperature	23° ± 1°C
3.	Dissolve O_2	6.5 ± 0.3 mg/L
4.	Total Hardness	232 ± 3 mg/l.
5.	Total Alkalinity	243 ± 3 mg/l.

RESULTS AND DISCUSSIONS

The maximum concentration at which zero percent mortality and minimum concentration at which 100% mortality of *Channa orientalis* were observed at 7 mg/ L respectively (Fig. 1). LC50 value obtained through sigmoid curve is 4.72 mg /l (Fig. 1). Behavioral changes are physiological responses shown by the animal, which are often used as the sensitive measure of stress syndrome in the organism experiencing it, consequently the behavioral changes were observed in control and exposed fish.

Control Fish: Control fishes maintained a fairly compact school, covering about one third of the bottom during the first five days of the 15 days experiment.

Table 2: Mortality of *Channa orientalis* in different concentration of zinc sulphate at 96 hrs exposure period.

Conce (mg/L)	Log Conce.	No. of Alive Fishes	Percent Mortality	96 h 50 (mg/L)
01	0.0000	10	00	4.72
02	0.3010	09	10	
03	0.4771	08	20	
04	0.6020	06	40	
05	0.6989	04	70	
06	0.7781	01	90	
07	0.8450	00	100	

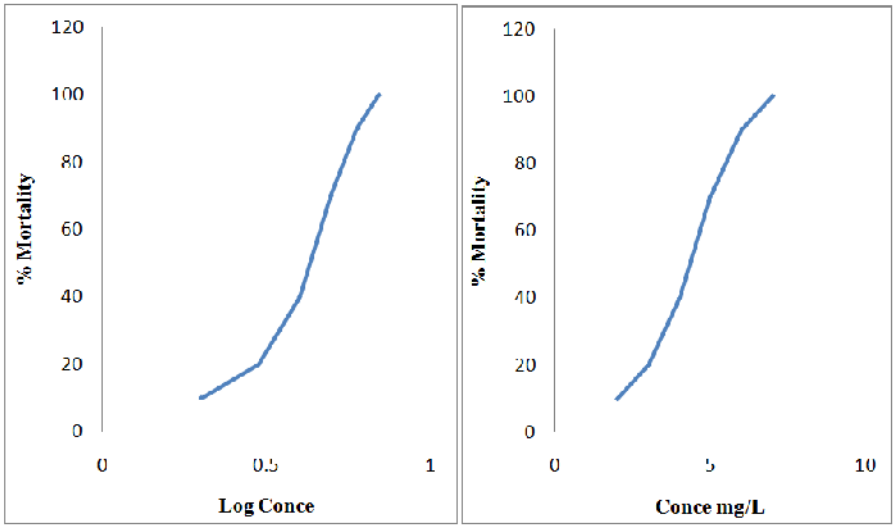

Fig. 1. Graph showing mortality rate to different concentration of zinc sulphate for 96h.

By fifth day, the fishes became less compact covering up to two-third of the tank area. Fishes were observed to scrap the bottom surface. When startled, they instantly formed a tight group that was maintained briefly. They were sensitive to light and moved to bottom of the tank when light was passed into the tank. Except a less response to form a dense group towards the end of the study, no other extraordinary behavior was observed.

Table 3: Diagnostic behavioural and morphological effects of zinc sulphate on fresh water fish *Channa orientalis* (Linn.).

Behavioural and morphological symptoms	**Diagnosis**
Loss of equilibrium	* Yes (occasional) [a]
General activity	* Hyperactive [b]
	* Vertical position [c]
	* Lateral flexure [d]
Startle response	* Under reactive [e]
Hemorrhage	* None [f]
Deformities	* Posturing of pectoral fins [g]
a. Loss of equilibrium	Fish roll over on side or back
b. Hyperactive	Fish swim faster than the control fish: that's around tank without being provoked at initial exposure time.
b. Hypoactive	Fish swim slower than control fish with increased exposure period of more than 48 hours exposure when severely intoxicate.
c. Vertical position	Fish occasionally assumed a vertical position before death.
d. Lateral flexures	Lateral flexure was in the fish in the caudal region.
e. Over reactive	Fish were hyper-excitable: That away from stimuli faster than the control of initial exposure period.
e. Under reactive	Fish that away from stimuli slower than the control fish with increased exposure time.
f. Hemorrhage	No hemorrhage was observed
g. Posturing of pectoral fins	Distinguishable behavioral /morphological change or signs of stress

Experimental fish: The experimental fish exposed to sublethal concentration of Zinc sulphate exhibited abnormal behavioral response. During exposure time, fish initially showed rapid movement, faster opercular activity, surfacing and gulping air. They showed erratic swimming with jerky movements, hyper excitability, convulsions and tendency of escaping from aquaria. These activities were increased initially and subsequently reduced. Beside an interesting observation was noted that there was remarkable reduced body pigmentation along with profuse mucus secretion and its coagulation all over the body. This was followed by loss of equilibrium and fish slowly moved upward in a vertical direction. Thereafter fish became progressively lethargic and lost their sense of equilibrium completely. Ultimately the fish lay down on the bottom of the aquaria with their belly upward before death. In conclusion, the present study proved that the heavy metal salts i.e. Zinc sulphate impacts on behavioral responses in fresh water breathing fish *Channa orientalis.*

These all results were well in agreement with Bhoraskar and Kothari (1997), Drummond (1986), Drummond and Russ om (1990), Bhoraskar and Kothari (1997), Joshi (2011). In the present study the abnormal changes in the fish exposed to lethal concentration of zinc sulphate are time dependent. However, the normal behaviour of the fish at 10, 20 and 30 days on exposure to sub lethal concentrations indicates its adaptability to the sublethal concentration due to long term exposure of zinc sulphate. The fish behavior indicates that the fish has adapted to a compensatory mechanism to derive energy during zinc sulphate exposure. Hence this type of study can be useful to compare the sensitivity of the various species of aquatic animals and potency of chemicals using LC50 values and to derive safe environmental concentration, by which there is no lethality and stress to the animals.

CONCLUSIONS

From obtained results, it is cleared that the 96h LC_{50} of zinc sulphate for the *Channa orientalis* was found to be 4.72 mg/l. The fresh water fish *Channa orientalis* showed the behavioural shift when exposed to the sublethal concentration of zinc sulphate.

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