Acute toxicity of mercuric chloride and zinc sulfate on *Catla catla* and *Labeo rohita*

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ABSTRACT

Heavy metals can accumulate in the tissues of aquatic organisms and cause a range of hazardous effects to all organisms through biomagnifications. The aim of this study was to investigate the acute toxicity effects of mercuric chloride and zinc sulfate on the freshwater fishes Catla catla and Labeo rohita. Fish samples were exposed to different concentrations (10, 20, 30, 40 and 50 mg/L) of mercuric chloride and zinc sulfate for 96h and their cumulative mortality was calculated in 12 hours intervals. Results were analyzed by SPSS 20 to obtain number of cumulative mortality and lethal concentrations. LC_{50} *of Catla catla at 96hr was 11.358 and 17.505 mg/L for mercuric chloride and zinc sulfate while* LC_{50} *of Labeo rohita at 96 hours was 10.518 and 14.340mg/L for mercuric chloride and zinc sulfate respectively. Relatively mercury had the higher toxicity to Catla catla and Labeo rohita than zinc. Mortality rate was increased with the increase in metal concentrations and time.*

Keywords: *Catla catla and Labeo rohita,* LC_{50}*, mercuric chloride, zinc sulfate, acute toxicity, heavy metal pollution.*

INTRODUCTION

Metals are substances with high electrical conductivity, malleability and luster that voluntarily lose their electrons to form cations. They found naturally in the earth's crust and their compositions vary among different localities, resulting in spatial variations of metal concentrations. Metal distribution in atmosphere is determined by the properties of the given metal and by various environmental factors (Khlifi and Hamza-Chaffai, 2010). Heavy metals enter the surroundings by natural means and through human activities. The contamination of natural aquatic resources with heavy metals released from industrial, domestic and other anthropogenic activities has become a matter of concern over the past few decades (Waqar *et al.*, 2013). Harmful effects of these heavy metals on aquatic organisms can be detected by performing toxicity tests that allow establishing a dose-response relationship (Akter *et al.*, 2008; Javed, 2013) which help us in predicting acute and chronic effects on aquatic fauna as well as in regulating toxic chemical discharges into the water bodies (APHA, 2005). Fish being the top consumer in the aquatic food chain accumulate large amounts of heavy metals in their body (Chezhian *et al.*, 2010). This work was aimed to find out the acute toxicity of mercuric chloride and zinc sulphate on *Catla catla* and *Labeo rohita* using 96 hours LC_{50} values.

MATERIALS AND METHODS

Collection and acclimation of experimental fishes

Catla catla with an average weight of 3.28 g and fork length of 56.04 mm and *Labeo rohita* weighed 5.60 g and fork length of 74.05 mm were procured from a fish farm located at Orathanadu, Thanjavur District, Tamil Nadu. Fish were acclimatized under laboratory conditions for 7 days prior to start of this experiment. Fish were fed with pelleted feed and water was renewed every day. Glass aquaria of 10 liter water capacity were used in this experiment. Fresh air was supplied to each aquaria through air pump fitted with capillary system.

LC_{50} determination

After acclimation healthy fish of *Catla catla* and *Labeo rohita* were chosen for the LC_{50} determination of mercury and zinc by static renewable bioassay. Fish were not fed during the experimental period. Various concentrations (10, 20, 30, 40 and 50mg/L) of the test solutions were prepared from $HgCl_2$ and $ZnSO_4$ stock solutions. A group of 10 laboratory acclimatized fish of a particular species having the same weight, size and age were introduced into each test concentration of $HgCl_2$ and $ZnSO_4$. Triplicates and appropriate controls were maintained for each concentration. LC_{50} values were calculated as per Speeman-Kerbers methods (1831). Toxicity tests were conducted in accordance with the method recommended by Sprague (1973). Median lethal concentrations of 96 hrs were calculated by Finney's (1974) probit analysis using SPSS Ver.20 Log_{10} Base calculation.

RESULTS AND DISCUSSION

To determine the LC_{50} value graphs were plotted between % mortality and log concentrations of toxicant. The concentrations obtained by drawing a perpendicular line against 50% mortality and calculated their antilog value. In the present investigation, LC_{50} of *Catla catla* at 96h was 11.358 and 17.505 mg/L for mercuric chloride and zinc sulfate while LC_{50} of *Labeo rohita* at 96h was 10.518 and 14.340 mg/L for mercuric chloride and zinc sulfate respectively. Results of present studies (Table 1-4), clearly indicated that the rate of mortality for any fixed time increased with increase in concentration and for a particular concentration with increase in exposure time and a regular mode of toxicant due to accumulation up to dangerous level leading to death. Table-1-4 show the relation between the mercury chloride and zinc sulphate concentration and the mortality rate of *Catla catla* and *Labeo rohita* respectively. The results obtained for 96 hour toxicity experiments of mercuric chloride and zinc sulfate on fishes were estimated by Finney's probit analysis method.

The observed percentage of mortality of *Labeo rohita* for mercuric chloride and zinc sulfate for different hours and different concentrations were given in table 1 and 3. Figure 1 and 3 showed the probit line graph of the mercuric chloride and zinc sulfate toxicity data and probit kill vs log concentrations. The observed percentage of mortality of *Catla catla* for mercuric chloride and zinc sulfate for different hours and different concentrations were shown in table-2 and 4. Figure 2 and 4 showed the probit line graph of the mercuric chloride and zinc sulfate toxicity data and probit kill vs log concentrations. The 96-hr LC_{50} study observed that *Labeo rohita* was significantly more susceptible to Hg and Zn toxicity than *Catla catla*.

Table.1: Mortality record of *Labeo rohita* fingerlings exposed to $HgCl_2$ for 96 hours

Concentrations (mg/L)	Log Concentration (mg/L)	Exposed fish	Mortality	% of Mortality	Probit
10	1	10	5	50	5.00
20	1.30103	10	8	80	5.84
30	1.477121	10	9	90	6.28
40	1.60206	10	10	100	7.33
50	1.69897	10	10	100	7.33

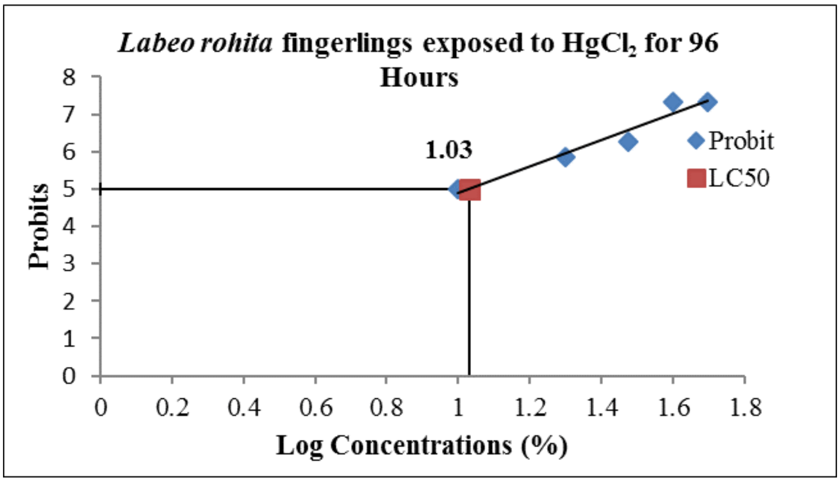

Fig.1: LC_{50} Value of Log concentration for 96 hours *Labeo rohita* fingerlings exposed to $HgCl_2$

Table.2: Mortality record of *Catla catla* fingerlings exposed to $HgCl_2$ for 96 hours

Concentrations (mg/L)	Log Concentration (mg/L)	Exposed fish	Mortality	% of Mortality	Probit
10	1	10	5	50	5.00
20	1.30103	10	7	70	5.52
30	1.477121	10	8	80	5.84
40	1.60206	10	10	10	7.33
50	1.69897	10	10	10	7.33

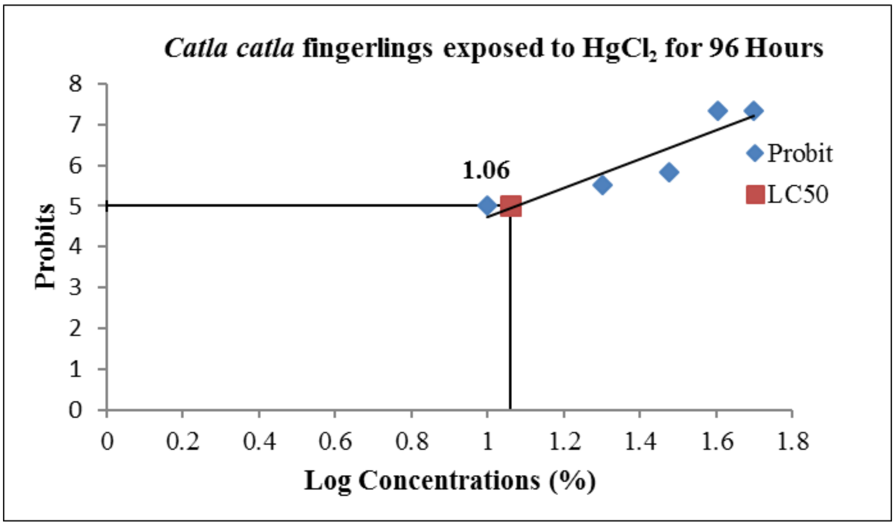

Fig.2: LC_{50} Value of Log concentration for 96 hours *Catla catla* fingerlings exposed to $HgCl_2$

Table.3: Mortality record of *Labeo rohita* fingerlings exposed to $ZnSO_4$ for 96 hours

Concentrations (mg/L)	Log Concentration (mg/L)	Exposed fish	Mortality	% of Mortality	Probit
10	1	10	4	40	4.75
20	1.30103	10	6	60	5.25
30	1.477121	10	7	70	5.52
40	1.60206	10	9	90	6.28
50	1.69897	10	10	100	7.33

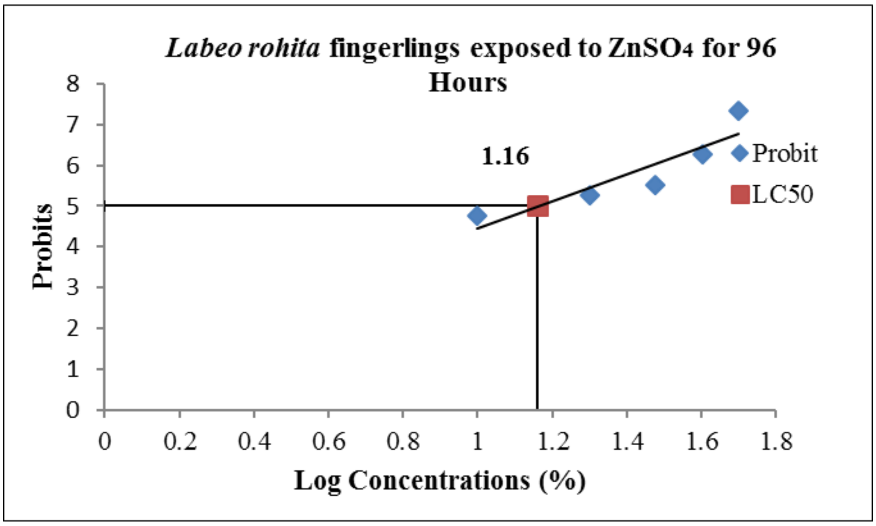

Fig.3: LC_{50} Value of Log concentration for 96 hours *Labeo rohita* fingerlings exposed to $ZnSO_4$

Table.4: Mortality record of *Catla catla* fingerlings exposed to $ZnSO_4$ for 96 hours

Concentrations (mg/L)	Log Concentration (mg/L)	Exposed fish	Mortality	% of Mortality	Probit
10	1	10	3	30	4.48
20	1.30103	10	5	50	5.00
30	1.477121	10	7	70	5.52
40	1.60206	10	8	80	5.84
50	1.69897	10	10	10	7.33

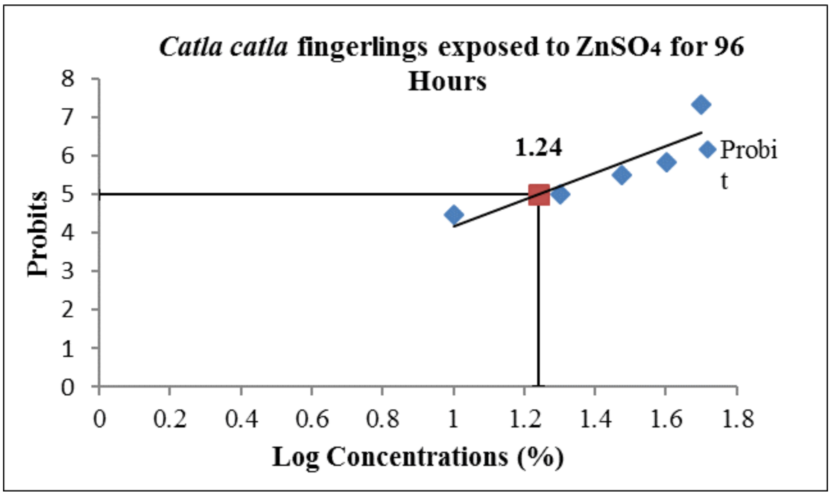

Fig.4: LC_{50} Value of Log concentration for 96 hours *Catla catla* fingerlings exposed to $ZnSO_4$

Table.5: Lethal concentrations 50% for 96 hours

Exposed Toxicity	LC_{50} Estimate Value (mg/L)	LCL for %	UCL for %
***L. rohita* exposed to $HgCl_2$**	10.518	3.697	14.961
***C. catla* exposed to $HgCl_2$**	11.358	3.647	16.453
***L. rohita* exposed to $ZnSO_4$**	14.340	5.839	20.323
***C. catla* exposed to $ZnSO_4$**	17.505	9.507	23.972

Acute toxicity caused by various toxicants on freshwater fish can be evaluated by quantitative parameters like survival or mortality of test animals and sensitivity of different fish species to toxicants. Toxicity in fish is the culmination of a series of events involving various physical, chemical and biological processes. Toxicity studies measure a response of an organism to biologically active substances (Spear, 1981) and are useful in determining water quality. The wide variation in sensitivity of different species to different heavy metals depends on various factors like age, sex, weight, physical stage of the animal and presence or absence of enzyme system that can detoxify the pollutants (Nagaratnamma and Ramamurti, 1981). The major cause of mortality might be due respiratory epithelium damage by oxygen accumulation during the formation of a mucus film over the gills of fish (Das and Sahu, 2005).

Mercury and its compounds have not part take any role in biological functions. The presence of mercury in any form in living organisms cause cytochemical and histopathological effects. The organic mercuric compounds and mercuric vapour affects central nervous system. Whereas, mercuric chloride damage liver, digestive tract and kidney (Vahter *et al.,* 2000; Ghosh and Sil, 2008). Fish may absorb mercury directly from contaminated water or indirectly from feeding on organisms living in the contaminated water (Javed, 2005; Martins *et al.,* 2004). Although several studies have been conducted to assess the toxicity of heavy metals to algae, the number of studies dealing with the toxic effect of heavy metal on aquatic animals is limited (Harmon *et al.,* 2005)

Zinc is an essential element occurs in the enzyme carbonic anhydrase that catalyses the formation of carbonic acid from carbon dioxide in the blood. Therefore, small amount of zinc in the water or in the diet is essential. All organisms have internal mechanisms to transport zinc around the body in order to manufacture such vital enzymes. When the zinc in water rises to a level, the amount entering the organism through the gills exceeds the requirement. In fish this condition cause precipitation of the layer of mucus on the gill surface causing suffocation (Andres *et al.,* 2000; Papagiannis *et al.,* 2004).

Srinivasa Naik Banavathu *et al.,* (2016) study the acute toxicity of mercuric chloride on the survival and behavioural responses of freshwater fish *Labeo rohita*. The acute toxicity of mercuric chloride to *L. rohita* for 24, 48, 72 and 96 hours based on the mortality percentage has been calculated as 0.41, 0.35, 0.30, and 0.25 mg/L respectively adopting Finney's probit analysis method.

Williams and Holdway (2000) examined that the effects of pulse-exposed cadmium and zinc on embryo hatchability, larval development and survival of Australian crimson spotted rainbow fish, *Melanotaenia fluviatis*. The LC_{50} values of Zinc were found to be 0.51, 0.56 and 1.57 mg/l for 24 hr, 3-4 day and 9-10 day old larval rainbow fish. Median lethal concentration of zinc sulphate has been widely narrated for different aquatic organisms and exposure routes. Since this metal is an important constituent in municipal wastes discharged into freshwater and marine environment, there is a need to regulate and control the use of zinc sulphate to avert possible ecological damage.

CONCLUSION

The present study was an attempt to find the toxicity of mercuric chloride and zinc sulfate on the freshwater fish, *Catla catla* and *Labeo rohita.* In the acute toxicity test to these toxicants, *L. rohita* exhibited relatively higher toxic response than *C. catla,* hence *L.rohita* can be suggested as a candidate species to monitor the toxicity of mercury and zinc. The toxicity study on fishes will be very useful to provide a future understanding of ecological impact.

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