Acute Toxicity of Heavy Metal, Zinc in Fresh Water Fish, *Catla Catla*

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Abstract- Industrial effluent are the major sources of heavy metal pollution and it is released into fresh waterbodies. Heavy metals cause several ill effects to aquatic ecosystem and organisms including fish. The acute toxicity (LC_{50}) of Zinc against fresh water food fish, Catla catla for 96 hr was found to be 15.0196 mg/L for Zinc. Furthermore, the exposed fish showed behavioural changes include hyperactivity, loss of equilibrium, rapid swimming, disturbed opercular movements, increased surface activity and loss of equilibrium. The result also revealed that mortality rate depends upon concentrations of heavy metals and duration of exposure.

Indexed Terms- Probit analysis, $LC_{50, Zinc}$ chloride, Catla catla

I. INTRODUCTION

Pollution of aquatic ecosystem with heavy metals has become a serious health concern in recent years. These metals are introduced into the aquatic ecosystem through various routes such as industrial effluents and wastes, agricultural runoff, domestic garbage dumps and mining activities (Srivastava and Prakash, 2018a). The introduction of many relatively toxic heavy metal cations in small amounts into an aquatic environment causes various changes in the internal dynamic of aquatic organism, even at sublethal levels (Srivastava and Prakash, 2018b). Under certain environmental conditions like the metals can accumulate to toxic concentrations and cause ecological damage (Srivastava and Prakash, 2018c). Thus, the heavy metal in the aquatic environments has been as a potential threat to the aquatic organisms including fishes. Metals are known to inhibit the several biochemical and physiological mechanism vital for fish metabolism. Among the heavy metals, cadmium, lead, mercury, copper, zinc, chromium and nickel are comparatively notorious toxicants and most of their compounds are water soluble and non-degradable (Bose *et al*., 2013). Increased discharge of heavy these metals into natural aquatic ecosystems can expose aquatic organisms to unnaturally high concentrations of metals. These excess amounts in addition to naturally occurring levels gradually build up to toxic levels causing damage to the biota of the aquatic ecosystem.

The presence and concentration of any metals varies between fish species; depend on age, developmental stage and other physiological factors. Although many metals are essential but all metals are toxic at higher concentrations because they cause oxidative stress by formation of free radicals or they can replace essential metals of pigments (haemoglobin or haemocyanin) or enzymes disrupting their function.

Toxicity tests are experiments designed to predict the concentrations of toxicant and its duration of exposure required to produce an effect. Toxicity is species-specific because individuals have different levels of response to the same dose of a toxic substance (Smith and Stratton, 1986). The toxicity bioassays are used to detect and to calculate the potential toxicological effects of chemicals on organisms. These tests provide a data base that can be used to assess the risk associated with a situation in which the organisms live. A variety of methods have been developed to evaluate the hazard and potential toxicity of chemicals to organisms, such as acute toxicity test, sub-acute toxicity test or chronic toxicity test. LC_{50} is the estimation of the dose or concentration necessary to kill 50% of a large population of the test species. Experimentally, this is done by administrating a toxicant at different concentration to a group of organisms and then observing the resulting mortalities in a set time periods like 24, 48 72 and 96 hr. The acute toxicity data are important and beneficial in the fixation of sub lethal concentrations for chronic toxicity tests.

Probit analysis is a type of regression used to analyze binomial response variables. Probit analysis is commonly used in toxicology to determine the relative toxicity of toxicant or pollutant to living organism (Singh and Zahra, 2017). This is done by testing the response of an animal at different concentrations of toxicant and then comparing the concentrations at which a response occurs. Probit method is widely accepted and most accurate method for calculating LC_{50}. Therefore, the present investigation aimed to evaluate the acute toxicity bioassay of heavy metals, Zinc against water fish, *Catla catla.*

II. MATERIALS AND METHODS

Indian major carp, *Catla catla* fingerling (average length 7.0-8.0 cm and average weight 5.5-6.2 gm) was collected from local fish form and dip in 0.1% of potassium permanganate solution for 2 minutes. The fishes were acclimatized in laboratory conditions for 7 days. During acclimatization the fishes were fed with commercial diet, egg albumin and small insects. The feeding of Fishes was stopped before experiment. The mortality was recorded after a period of 96 h and dead fishes were removed immediately after death during observation. Stock solution of both heavy metals of various concentrations were prepared and 10 fishes was kept in each rectangular glass aquaria separately to estimate mortality between 0% and 100%. For 96h LC_{50} test, separate 12 concentrations both heavy metals were taken to find out the narrow range of concentrations.

III. RESULT AND DISCUSSION

The percent mortality observed for each dose was calculated and converted to probits by means of a SPSS software. Acute toxicity test *i.e.* LC_{50} values show susceptibility of fish to particular toxicant or pollutant and reflect their survival potential. In the present study, the percent mortality, and probit mortality of heavy metals, Zinc chloride for fish, *Catla catla* at and 96 hrs are presented in table 1. However, fishes exposed to dechlorinated tap-water were observed to be healthy and normal.

Table-1. Relationship between concentration of Zinc chloride and percentage of mortality of fish

S.N.	Conc. in mg/l	Log Conc.	No of fish exposed	No of fish dead up to 96 hr	Percent mortality	Probit mortality
1	0	0	10	0	0	0
2	9.0	0.9542	10	1	10	3.72
3	12.0	1.0792	10	2	20	4.16
4	15.0	1.7610	10	4	40	4.75
5	18.0	1.2553	10	7	70	5.52
6	21.0	1.3222	10	8	80	5.84
7	24.0	1.3802	10	9	90	6.28
8	27.0	1.4314	10	10	100	8.03

The toxicity tolerance of freshwater fish *Catla catla* to $ZnCl_2$ in the present study are depends upon concentrations of heavy metals and duration of exposure. It was noticed that percent of mortality increased with an increase in concentration and duration of expose. LC_{50} values of the heavy metal zinc showed the susceptibility of major carp to lethal concentrations in acute short-term exposure. The *Catla catla* are very sensitive than other fish for both heavy metals as evident from the reported values of 96h LC_{50} of $CdCl_2$ for fish, *Scorpaena guttata* which is 25 mg/l (Brown *et al*., 1984), 30.4 mg/L for fish, *Poecili reticulate* (Mehnet Yilmaz *et al*., 2004) and 8.13 ppm (Selvanathan *et al*., 2011). as well as 35 mg/l (Gandhewar *et al*., 2014) for fish, *Clarias batrachus* as well as 96h LC_{50} of $CuSO_4$ for fish, *Clarias batrachus* which is 15 mg/l (Gandhewar *et al*., 2014). The death of fish could be due to the lethal action of pollutant that causes alterations in physiological and biochemical process related to cellular metabolic pathway. However, sublethal concentrations of heavy metals also induce substantial changes in the biological organization of fish (Srivastava and Prakash, 2018). In the present study the surfacing activity and opercular activity (number of beat / min) of zinc exposed *Catla catla* increases with increasing the concentrations of heavy metal, copper and duration of exposure.

Today, heavy metals are introduced into aquatic ecosystem with industrial effluent, soil leaching, mining activities, sewage disposal and rainfall. The heavy metals are relatively toxic, even at fairly low concentrations and affect the survival of aquatic organisms. Stebbing and Fandino (1983) reported that, the adverse biological effects of heavy metals in the aquatic environment are mainly due to their complex nature. When the toxicant concentration in the water body is very high, it results in the death of fish. So, the death of an organism was taken as the end point of toxicological studies previously (Jones and Reynolds, 1997).

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