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A study of lethal concentration (LC_{50}) of zinc sulphate to *Channa striatus* (Bloch)

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Abstract
Industrial effluent containing heavy metals, on entering aquatic environment causes biochemical disturbances in the fish. The present study deals with acute toxicity of zinc sulphate on *Channa striatus* was investigated using toxicity determination of 96 hours LC_{50} values. Fish, *Channa striatus* was exposed to different concentrations of $ZnSO_4$ studied (100,110,120,130 and 140 mg/l) and LC_{50} value was found to be 120 mg/l at 96 hours. All the exposed fishes were daily observed and dead fishes were removed immediately. The mortality was recorded on daily basis. The LC_{50} value at 96 hr was found to be 120 mg/L to *Channa striatus*. While the obtained results were analysed by the Finney's probit analysis method. Survival time decreased with increasing concentration of Zinc Sulphate. Zinc Sulphate concentration was found to be more toxic for Channa striatus. Further study needs the processes by which these chemicals affect haemato-biochemical and histological changes of the fish.

Keywords: LC_{50}, zinc sulphate, acute toxicity, bioassay, *Channa striatus*

Introduction
Industrial contributing to aquatic pollution contain a vast array of toxic substances, which include heavy metals (Kawade S.J and Khillare Y.K 2012) [1]. The aquatic media are contaminated not only from the air but also from the land itself. The major factors contributing to heavy metal contamination are household and industrial waste containing either organic or inorganic matter (Mc Carthy, J.F., Shugart, L.R., (1990) [2]. Biomarkers of Environmental Contamination, Lewis Publishers, FL.

Pollution of the aquatic environment with heavy metals has been 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 pesticide runoff, domestic garbage dumps and mining activities (Merian, 1991) [3]. Increased discharge of heavy metals into natural aquatic ecosystems can expose aquatic organisms to unnaturally high levels of these metals (Van Dyk *et al*., 2007) [4].

Among aquatic organisms, fish cannot escape from the detrimental effects of these pollutants, and are therefore generally considered to be the most relevant organisms for pollution monitoring in aquatic ecosystems (Van der Oost *et al*., 2003) [5].

Some heavy metals are essential elements, while others are non-essential. Zinc is one of the most important trace metals in the body, and participates in the biological function of several proteins and enzymes (Maity *et al*., 2008).

Zinc (Zn) is the second most abundant trace element after Fe and is an essential trace element and micronutrient in living organisms, found almost in every cell and being involved in nucleic acid synthesis and occurs in many enzymes. Additionally, Zn is involved in more complicated functions, such as the immune system, neurotransmission and cell signaling (Niyogi S, and Alabaster JS) [22] [23]. It may occur in water as a free cation as soluble zinc complexes, or can be adsorbed on suspended matter.

Zinc wastes can have a direct toxicity to fish at increased waterborne levels (Nemcsók J, Benedeczky I, Boross L, Asztalos B, Orban L (1981) [24], and fisheries can be affected by either zinc alone or more often together with copper and other metals (Mallat J (1985) [25]. The main target of waterborne Zn toxicity are the gills, where the Ca2+ uptake is disrupted, leading to hypocalcemia and eventual death.

Although the toxicity of Zinc to several fish species has been documented, the toxicity of this metal is not well known for all aquatic organisms (Hogstrand, C. and C.M. Wood, 1996) [7]. Alsop *et al*. (1999) [8], examined chronic waterborne Zinc exposure and the consequences of Zinc acclimation on the gill. Zinc interactions of rainbow trout in hard and soft water. They found that all Zinc-exposed trout had been acclimated to the metal, as seen by an increase of LC_{50} by 2.2 to 3.9 times over that of control fish.

The toxic characteristics of Zinc depend largely on the physicochemical characteristics of water. The principle factors effecting toxicity are the hardness and the pH of water. Decreasing hardness and the increasing pH, increases the lethality of dissolved Zinc (Cusimano, R.F., D.F. Brakke and G.A. Chapman, 1986) [9]. It has also been established that there are marked differences in Zinc sensitivity between various species. For instance the order Perciformes was found to be the most resistant and Cuneiforms the most sensitive (Spear, P.A., 1981) [10].

Materials and Methods
The present study was carried out in the Department of Zoology, UCS, Osmania University, Hyderabad, and Telangana State, India. The acute toxicity of Zinc Sulphate for *Channa striatus* by the determination of 96-hour LC_{50} values of the *Channa striatus* exposure to different concentrations of

Zinc Sulphate.

A short acute toxicity assay (Lethal Concentration to 50% of the population) was designed to assess the toxicity effect of $ZnSO_4$ on fish, *Channa striatus*. Live fishes, *Channa striatus* were collected from the Vijayawada fish market and transported to the laboratory in plastic drums filled with river water. They were allowed to acclimate to the laboratory conditions for 15 days prior starting the experiment. They were treated with 0.5% $KMnO_4$ for five minutes for dermal disinfection. The fish were fed with commercial pelleted food at least once a day.

The physicochemical parameters of the tap water was determined periodically as per standard methods (APHA 2012) [27]. Water quality parameters (temperature, dissolved oxygen (DO), CaCO3 hardness and pH) of aquarium water were periodically determined before the bioassay tests.

The test organisms were subjected to different concentrations such as (100,110,120,130 and 140 mg $ZnSO_4$/litre of water. The amount of zinc sulphate to be added in each aquarium was calculated after the volume of each aquarium was determined. 10 fishes were introduced into 10 litres of tap water with required amount of $ZnSO_4$ aquarium. The average wet weight of the fish was 25 to 30 g and average length of the fish was 12 to 15 cm.

All experiments were carried out for a period of 96 hours. The number of dead fish were counted every day and removed from the aquaria as soon as possible. The mortality rate was determined at the end of the 96 hours.

In this study the effect of Zinc Sulphate on the standard test species, *Channa striatus* was determined by the use of Finney's [28]. Probit Analysis LC_{50} determination Method.

Results and Discussion

In the present investigation, the 96 hours, LC_{50} value for $ZnSO_4$ was found to be 120 mg/L. Results of present studies (Table-2), clearly indicate that the rate of mortality for any fixed time increases 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 shows the physico-chemical analysis of the temperature, hardness, dissolved oxygen (DO) and pH of the water in Zinc Sulphate toxicity tests.Table-2 shows the relation between the zinc sulphate concentration and the mortality rate of *Channa striatus* (bloch). The results obtained for 96 hour toxicity experiments of Zinc Sulphate in *Channa striatus* and estimated LC_{50} values by Finney's probit analysis method.

Table 1: Physico-chemical parameters of the test water

S. No	Parameters	Values of test water
1	Temperature(˚C)-Field method	7.3
2	pH-Electrometric method	28
3	Dissolved Oxygen(mg/l)-Iodometric method	7.9
4	Total HardnessCaCO3(mg/l)- EDTA Titration method	225

Table 2: The relation between the zinc sulphate concentration and the mortality rate of *Channa striatus* (LC50 results for 96 hours).

S. No	Concentration of $ZnSO_4$(mg/l)	Log Concentration	No.of Fishes Exposed	No.of Fishes died at 96hours	Probit Kill (%)	Percent Kill (%)
1	100	2.00	10	1	3.72	10
2	110	2.04	10	3	4.48	30
3	120	2.09	10	5	5.00	50
4	130	2.11	10	8	5.84	80
5	140	2.14	10	10	7.33	100

The observed percentage of mortality of *Channa striatus* for Zinc Sulphate in static tests continuous for different hours and different concentrations were shown in table-2 and figure-1 showing the probit line graph of the $ZnSO_4$ toxicity data and probit kill vs log concentrations.

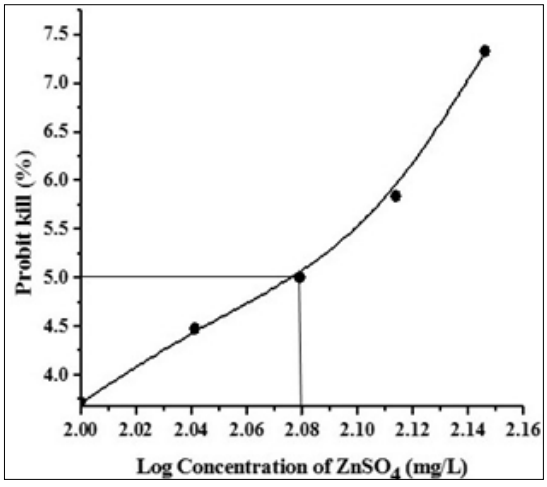

Fig 1: Probit line graph of probit kill vs log concentrations.

Toxicity studies measure a response of an organism to a biologically active substance (Alderdice, 1966) [29] 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 degrade the pollutants (Nagratnamma, Ramamurti, 1981) [14]. The major cause of mortality might be due to respiratory epithelium damage by oxygen accumulation during the formation of a mucus film over the gills of fish (Das and Sahu, 2005) [15].

(Gomez *et al*. 1998) [16]. Studied Zinc toxicity in the fish *Cnesterodon decemmaculatus* in the Parana River and Rio de la Plata estuary. They found 24-h LC_{50} values was 93.2 mg/l for the fish, *Cnesterodon decemmaculatus* and contaminant load in the natural waters tested was similar at both sites, with Zn concentration 40 and 44 mg/l respectively.

(Herrera *et al*. 1995) [17]. Reported that the 96-hr LC_{50} value of $Zncl_2$ on *Chanos chanos* as 25 mg/l. (Finlayson BJ, Verrue KM. 1982) [19]. Were investigated toxicities of copper, zinc and cadmium mixture to juvenile *Chinook salmon*, they found that median lethal concentrations during 4 days (96-hour LC_{50} values) were most variable for zinc (39 to 122 mg/l).

(Spehar RL.1976) [18]. were investigated cadmium and zinc toxicity to flag fish, *Jardanelle floridae*. The 96-hr LC_{50} values for cadmium and zinc to juvenile flag fish were 2.5 mg/l and 1.5 mg/l respectively.
(Gul *et al*., 2009) [20] Found the 96 hrs value for guppies (*Poecillia reticulate* P., 1859) to be 30.826 mg/l. Similarly, (Williams and Holdway 2000) [21] 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. A median lethal concentrations of zinc sulphate have 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, there is need to regulate and control the use of this heavy metal ($ZnSO_4$) to avert possible ecological damage.
Further work with toxicity testing methods directly on fish both in laboratory and in its corresponding natural setting will be very useful in assessing possible ecological risk of heavy metals.

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