Acute toxicity of aluminium to zebra fish, Brachydanio rerio (Ham.)

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Abstract

A critical appraisal of existing water becomes significant for assessment of sustainable development of any resource. The present research work is oriented to find out toxic effects of aluminium on a freshwater fish Brachydanio reri . By following standard procedures for toxicity determination, it was found that 61.66ppm, 59.57ppm, 57.94 ppm and 56.92ppm of aluminium toxicity for 24h, 48h, 72h and 96hours LC_{50} doses, whereas LC and LC_{100} doses were 52 ppm and 65ppm respectively. Erratic swimming, hyperactivity changes in opercular movement, loss of equilibrium, mucus secretion all over the body and chromatic changes on skin were observed. All these observations can be considered to monitor the quality of water contaminated with chemicals.

INTRODUCTION

The pollution of the ecosystems by metals is a worldwide problem and ecologists try to identify various ways to control and monitor metal pollution in order to maintain the natural equilibrium of the ecosystem [1] . Humans have long interfered in nature by extracting natural resources and discarding residues into the environment. This impact has been intensified since the Industrial Revolution with many chemicals now being released into aquatic and terrestrial ecosystems as well as the atmosphere [2] . Acute toxicity is a major subject of research in all research institutes for evaluating the metal toxicity test for assessing the potential hazard of chemical contamination to aquatic organisms are well documented by various authors [3,4] . Data on toxicity by bioassay tests of heavy metals and their effects on aquatic organisms are basic for determination of environmental toxicological risks of heavy metals for the aquatic ecosystems. Aluminum toxicity has been recognized in many settings where exposure is heavy or prolonged, where renal function is limited, or where a previously accumulated bone burden is released in stress or illness. Toxicity may include: encephalopathy (stuttering, gait disturbance, myoclonic jerks, seizures, coma, abnormal EEG) osteomalacia or aplastic bone disease (associated with painful spontaneous fractures, hypercalcemia, tumorous calcinosis) proximal myopathy, increased risk of infection, increased left ventricular mass and decreased myocardial function microcytic anemia with very high levels, sudden death. Different industries like distilleries, cotton mills, tanneries, paper mills, jute mills, fertilizers pass out their effluents in adjoining rivers, ponds, ditches and other water resources. All these chemical threaten the exixtence of flora and fauna and adversely affect the ecological balance leading to unwanted mortality of aquatic biota including fishes [5,6] . Though, the survey of literature reveals that a lot of work has been carried out on various aspects of toxicity of different chemical to fishes, there is little information on the toxicity of aluminium. Some toxic effects in aquatic biota are reversible, whereas some others are not, leading the organisms to mortality. Hence, in the present study, an attempt has been made to assess the acute toxicity of aluminium on zebra fish Brachydanio rerio (Ham.)

MATERIALS AND METHODS

The zebra fish(Brachydanio rerio) of length 4± 0.5 cm and 5±1 g of body weight were purchased from Devi aquarium, Cuddalore district, Tamilnadu and were confined to large plastic aquaria bearing tap water for a period of two weeks in the laboratory for acclimation. Twenty five to fourty individuals were used for the experiment. They were kept in batches in 20L glass tanks filled with dechlorinated tap water under constant filtration. The fish were fed with artificial fish pellet on every day for a period of three hours and the water was renewed on every day by routine cleaning of aquaria to remove unconsumed food, faecal matter or death fish (if any). Feeding was allowed 3hours before the

renewal of the medium. Prior to the commencement of the experiment 96hours LC_{50} for aluminium chloride (E-merck India) was calculated following probit analysis [7,8] and was found to be 56.92 ppm (Fig.1). The physico–chemical characteristics of the normal water and water dissolved with aluminum for calculating LC_{50} dose was analysed as per standard procedures [9] (Table 1).

Figure 1

Table 1: Physico-chemical characteristics of the normal water and water dissolved with aluminium

Parameters	Normal water	Water dissolved with aluminium
Odour	Odourless	Unpleasant
Temperature°C	27	28
pH	7.2	6.8
DO, mg/L	6.09	5.96
Total hardness ,mg/L	240	234

The toxicity determination was carried out in round bottom glass jars [10,11] . The fish in healthy condition and almost of same age group and average body weight of 5±1 g were used in the experiment. For estimating the degree of toxicity of aluminium, a batch of 10 test fish were released at a time in each container. Experiments for each dose of the chemical were repeated ten times to get average of mortality from a sample test of 100 test specimens. A control experiment with 10 fish was set simultaneously without toxicant to have a comparative idea. Mortality was noted and dead fish were removed immediately. The test solutions were renewed every 24 h to maintain the dissolved oxygen concentration at optimum level [12] . All the experiments were conducted at room temperature.

RESULT AND DISCUSSION

The results of acute toxicity test with aluminium as toxicant and Brachydanio rerio as test specimen clearly show the toxic nature of the neurotoxic, leading to alteration in the physico–chemical quality of water and occurrence of mortality of the test fish at varying rates. The mortality percentage of Brachydanio rerio with the toxicant aluminium is given in Table 2and 3.

Figure 2

Table 2: Mortality percentage of exposed to different concentrations of aluminium

Concentration (ppm)	No. of Specimens	Mortality Percentage				Remarks
		24hr	48hr	72hr	96hr	
52	100*	0	0	0	0	LC_0
53	100*	0	0	0	10	
54	100*	0	0	10	20	
55	100*	0	0	20	40	
56	100*	0	10	40	50	LC_{50}**
57	100*	0	20	50	60	
58	100*	10	30	60	70	
59	100*	20	50	70	80	
60	100*	40	60	80	90	
61	100*	50	70	90	100	LC_{100}***
62	100*	60	80	100	100	
63	100*	70	90	100	100	
64	100*	90	100	100	100	
65	100*	100	100	100	100	

*Total number of test specimens tested in 10 sets of experiments; LC_0/96hr dose, **Incipient LC_{50}/96 hr dose. ***Incipient LC_{100}/96hr dose.

Figure 3

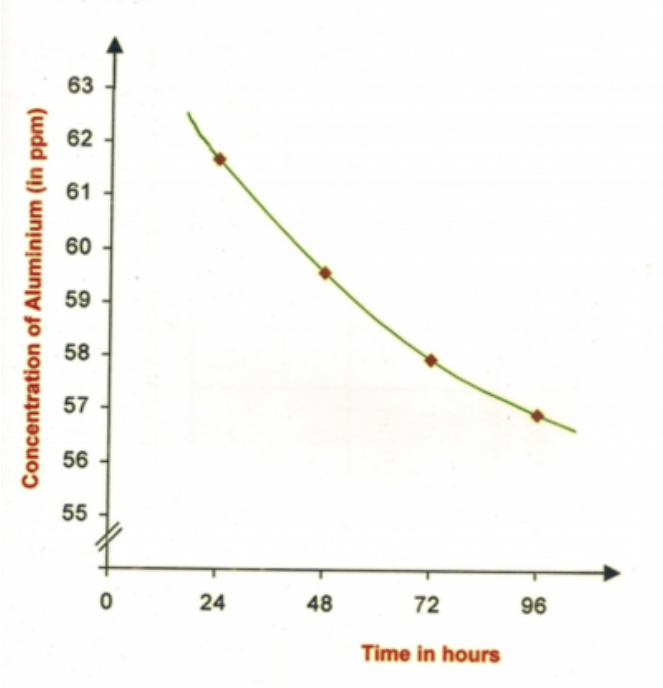
Table 3. LC values for aluminium (with 95% confidence limit) estimated by Trimmed Spearman – Karber method

Test duration(hr)	LC_{50} values mg/lit	95% lower confidence limit	95% upper Confidence limit
24	61.66	61.65	61.67
48	59.57	59.42	59.72
72	57.94	57.08	58.80
96	56.92	56.81	57.03

The LC_{50} values for 24, 48, 72 and 96 hours exposure durations were estimated 61.66, 59.57, 57.94 and 56.92ppm were as LC and LC_{100} doses were 52 and 65 ppm respectively (Fig –1).

Figure 4

Fig - 1. Toxicity curve for aluminium



The study on toxicity impact deals, in general, with the reaction of a living organism in an aquatic environment and there is a generalized view that the toxicity of a chemical of the individual sp. To detoxify the compound; factors like DO, free CO_2, pH, temperature etc., and size, length and weight of the test species, as has been expressed [13,14] . Susceptibility of the aquatic biota to other chemical has been investigated by many workers [16,17,18,19] .

The behavioural response of the fish towards the toxicant was also investigated in the present study. As released in the toxic media, the fish showed abnormal behavior. When exposed to higher concentrations hyperexcitability, increased opercular movement were observed as immediate response of fish towards the toxicant. Fish were often seen swimming with jerky movements on the surface of water and tried to jump out of the container. The higher concentration of aluminium exposure showed white wound patches on the skin surface at the side of the body. The fish tried to remain almost in vertical position perpendicular to the base of the container with the mouth facing upward. Finally, the fish lost balance, settled to bottom and died. Similar behavioural changes in fishes due to pesticidal pollution or other types of pollution have been studied [20,21,22] . On analyzing different factors involved in behavioural changes, it appears that immediately after facing the unfavourable toxic media, the test specimen have to exert maximum efforts but due to limitation of energy required and downward trend of opercular movement, the effort lasted for a limited period; finally meeting death end.

It is concluded from the present study on aluminium toxicity reveals the Brachydanio rerio is very sensitive to the toxicity as evident from the behavioural responses such as erratic swimming, attempt to jump out of water, fall in opercular activity, copious secretion of mucus all over the body and increased gulping of air to meet out the respiratory distress of fish.

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