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Original Research Paper

Bioaccumulation of Aluminium in Selected Tissues of Zebra Fish *Brachydanio rerio* (Ham.)

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ABSTRACT

The aim of the study was to investigate the bioaccumulation of aluminium in tissues such as gill, liver, muscle and brain, and possibility to use these organs as quantitative bioindicators in polluted aquatic environment. Therefore, the experiment has been designed to provide conditions as close as possible to those found in nature. For this, two sublethal concentrations of aluminium were selected and the fish were exposed for a period of 7, 14, 21 and 28 days. The pattern of accumulation varied significantly among fish organs (liver > gill > muscle). In brain the accumulation was below the detection limit. The study showed that the bioaccumulation rate depends on concentration of the toxicant and length of the exposure period.

INTRODUCTION

Metals are considered major aquatic pollutants, which accumulate in the fish tissues influenced by the factors like species (Turkmen et al. 2005) and living environment (Romeo et al. 1999). Tam & Wong (1995) stated that heavy metal contamination in aquatic environments is of critical concern due to toxicity of metals and their accumulation in aquatic habitats. Among the aquatic fauna, fish is the most susceptible to heavy metal toxicants (Nwaedozie 1998) and so, are more vulnerable to metal contamination than any other aquatic fauna. Fish are at the higher level of food-chains and may accumulate large amounts of metals from water. Accumulation patterns of contaminants in fish and other aquatic organisms depend both on uptake and elimination rates (Hakanson 1984, Guven et al. 1999). Heavy metals are taken up through different organs of fishes. In this process, many of the heavy metals are concentrated at different levels in different organs of the body (Rao & Padmaja 2000, Bervoets et al. 2001).

Heavy metals cannot be destroyed by biological degradation and have the ability to accumulate in aquatic organisms and consequently to humans who depend on aquatic products as source of food (Kalay et al. 1999, Ashraf 2005). Many industrial and agricultural processes have contributed to the contamination of freshwater systems by heavy metals, thus, causing adverse effects on aquatic biota and human health (Dautremepuits et al. 2004). One of the most serious consequences of their persistence is biological amplification through food chains (Unlu & Gumgum 1993). Therefore, it is important to consider the influence of biotic and abiotic factors on the mechanisms affecting accumulation, elimination or biotransformation of heavy metals. The zebra fish (*Brachydanio rerio*) has ability to accumulate and concentrate aluminium to the levels several orders of magnitude above those found in the environment. Two sublethal concentrations were selected for the present study to understand the level of accumulation of aluminium in tissues such as liver, gill, muscle and brain.

MATERIALS AND METHODS

The zebra fish (*Brachydanio rerio*) of length 3 ± 0.5 cm and 5 ± 1g of body weight were acquired from Devi Aquarium, Cuddalore district, Tamil nadu and confined to large plastic aquaria having tap water for a period of two weeks in the laboratory for acclimation. Twenty five to forty individuals were used for the experiment. They were kept in batches in 20 L glass tanks filled with dechlorinated tap water under constant filtration. The fish were fed with fish feed 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 and death fish, if any. Feeding was allowed 3 hours before the renewal of the medium. Prior to the commencement of the experiment, 96 hours LC_{50} for aluminium chloride was determined by bioassay technique following probit analysis (Finney 1971). The 96 hours LC_{50} was found to be 56.92 ppm. The experimental individuals were exposed to two sublethal concentrations (5.69 ppm and 17.08 ppm) of aluminium, i.e., 10 % and 30% of 96 hrs LC_{50} value of aluminium, for a period of 28 days. Parallel groups of control were also kept. Brain, gill, liver and muscle tissues were removed after specific period (7, 14, 21 and 28 days) of the experiment. The organs of the fish were digested in nitric acid and perchloric acid for aluminium determination through standard methods (APHA 1989). Data were analysed for statistical significance using Duncan's Multiple Range Test. In the control tissues, the aluminium accumulation was not detected.

RESULTS AND DISCUSSION

The results of the study are given in Table 1. Significant differences occurred in accumulation of aluminium among the fishes after 7, 14, 21 and 28 days of exposure. However, after 28 days fish showed significantly high accumulation of aluminium than rest of the groups. The order of aluminium accumulation was liver > gill > muscle, but the brain does not show any aluminium accumulation (below detection limit). The liver showed a continuous increase in aluminium accumulation in both the sublethal concentrations. This can be correlated with the metabolism, as liver is the centre of detoxification. Moreover, high concentrations of enzymes and proteins are present in liver, which help to bind the metal. The gills showed a high concentration of aluminium in the initial stages of exposure, but gradually decreased after 28 days in both the sublethal concentrations. The gills, in general, showed the highest metal concentration due to their intimate contact with the water and their

Table 1: Bioaccumulation of aluminium (ppm) in various tissues of *B. rerio* after 7, 14, 21 and 28 days of 5.69 ppm and 17.08 ppm of sublethal aluminium exposure.

Concentration of aluminium	Tissues	Control	Days of exposure			
			7	14	21	28
5.69 ppm	Brain	0.00 ± 0.00	Below detection limit			
	Gill	0.00 ± 0.00	**1.00 ± 0.01	**1.16 ± 0.01	**1.19 ± 0.01	**1.20 ± 0.01
	Liver	0.00 ± 0.00	**1.12 ± 0.00	**1.65 ±0.00	**1.68 ± 0.02	**1.95 ± 0.01
	Muscle	0.00 ± 0.00	**0.16 ± 0.01	**0.19 ± 0.01	**0.20 ± 0.01	**0.21 ± 0.06
17.08 ppm	Brain	0.00 ± 0.00	Below detection limit			
	Gill	0.00 ± 0.00	**1.50 ± 0.05	**1.78 ± 0.04	**1.97 ± 0.01	**2.01± 0.01
	Liver	0.00 ± 0.00	**2.25 ± 0.51	**2.28 ± 0.55	**2.45 ± 0.54	**2.58 ± 0.45
	Muscle	0.00 ± 0.00	**0.25 ± 0.14	**0.32 ± 0.25	**0.38 ± 0.17	**0.45 ± 0.22

Note: Values are ± SEM; Experimental values are compared with control values; Based on Duncan's multiple range test; * = $p < 0.01$; ** = $p < 0.05$.

importance as an effecter of ionic and osmotic regulations. The highest accumulation of aluminium in the gills may also be due to the fact that they serve as respiratory organs in fishes through which metal ions are absorbed (Bebianno et al. 2004). The gills are in direct contact with the contaminated medium and have thin epithelium, through which metals can penetrate easily. The muscle recorded the least amount of aluminium among the tissues. This is due to indirect contact with the medium, i.e., through circulatory system. According to Muhammad (2005), while studying the growth responses of *Catla catla, Labeo rohita* and *Cirrhina mrigala* for bioaccumulation of zinc during chronic exposure, the muscle and skin accumulated significantly less amount of metals. The results showed that whatever the concentration (low or high) of aluminium, it will produce adverse effect on Zebra fish.

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