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RESEARCH ARTICLE

TOXICITY OF THE HEAVY METAL IN THE FISH, *Cyprinus carpio* ON EXPOSED TO MUNICIPAL SEWAGE WATER

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ABSTRACT

This investigation examines uptake of heavy metals, Zinc and Nickel in the tissues of the fish, *Cyprinus carpio* exposed to lethal and sublethal concentrations of Singanallur waste water for 3,10 & 20 days. The concentration of zinc varied from 0.29mg / gm to 0.72mg / gm (Liver), 0.56mg / gm to 0.58mg / gm (Kidney), 0.33mg / gm to 0.52mg / gm (Muscle) and Nickel concentration was varied from 0.54mg / gm to 1.60mg / gm (Liver), 10.81mg / gm to 3.63mg / gm (Kidney) and 0.75mg / gm to 1.31mg / gm (Muscle). Accumulation of Zinc was increased progressively on 3,10 & 20 days in the following order: Muscle> Kidney>Liver. In the case of nickel the order was: Liver>Muscle>Kidney. Zinc and Nickel were found to be toxic to the fish, which will biomagnify up the foodchain and will ultimately be toxic to human beings.

INTRODUCTION

Heavy metal concentration in aquatic ecosystem poses an environmental hazard because of their toxicity and persistence measurements of accumulated metal toxicant concentrations are vital to the interpretation of impact of metals overall aquatic biota (Weiner and Giesy, 1979). Indiscriminate discharge of metals from industrial effluents and other sources into aquatic media affect non-target organisms such as fishes and prawns which are of great economic importance to man. Heavy metals can affect the aquatic organisms as toxic substance of water, sediment are as a toxicant in the food chain (Zyadan, 1995). Heavy metals constitute the most widely distributed group of highly toxic and long retained substances. Almost all metals are toxic in higher concentration and some are severally poisonous even at low concentrations. Hence this study reports the accumulation of zinc and nickel in the tissues of fish, *Cyprinus carpio*.

MATERIALS AND METHODS

The fresh water fish, *Cyprinus carpio* was selected as test animals and healthy specimens of fishes were procured from a local fresh water pond at Coimbatore. The fish were acclimated to laboratory conditions for a period of fifteen days at room temperature. During this period fishes were fed regularly with conventional food diet (Rice bran & oil cake, 1:1 ratio). Feeding was stopped one day prior to the start of the experiment.

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The municipal sewage water was collected from Vellalore and analyzed for physico-chemical parameters as per the APHA (1998). By conduction static bioassay test, LC_{50} value at 72 hour was determined by rearing experimental fish in different concentrations of municipal sewage water. LC_{50} value was found to be 50% well acclimated *Cyprinus carpio* were selected from the stock and allowed to survey in control and diluted waste water concentrations separately for 3,10 and 20 days after the stipulated period, the test *C. carpio* were sacrificed. The tissues namely liver, kidney and muscle were subjected to acid digestion [nitric acid is to perchloric acid, (3:1)] cooled and made up to 100 ml in a volumetric flask and the level of heavy metals (zinc & nickel) were determined by Atomic Absorption Spectrophotometer (Riley and Segan, 1970).

RESULT AND DISCUSSION

Temperature of the sewage water at the time of analysis was found to be 30^0C. and pH value was 7.55. (Table 1) The electrical conductivity was 2.94 mmhos/cm. the total solids (TS) and total dissolved solids (TDS) were 1466.7 mg/l and 1266.7mg/l. DO was found to be 4.22 mg/l. The BOD and COD are 63.33 mg/l and 128 mg/l. The chloride level was 220.10mg/l. The sulphate, phosphate and nitrate were found to be 10.00mg/l, 9.57 mg/l and 17.86 mg/l respectively. The zinc content 0.110 mg/l and nickel content was below the detectable level. Analysis of heavy metal in fish is an important aspect, as the fish if ingested as food; the impact of

heavy metal in man may get biomagnified leading to disastrous health effects. The present investigation was taken up to study the distribution of zinc and nickel in different part of the fishes (liver, kidney and muscle) exposed to the lethal and sublethal levels of Singanallur municipal sewage water for 3, 10 and 20 days (Table 2). Maximum zinc accumulation in liver was 0.72 mg/g when the fish was exposed for 20 days when compared to the control the percentage increase was 288. Similarly the nickel content was found to be maximum (1.6 mg/g) in the liver on exposure of 20 days and the percentage increase is 814. The zinc accumulation in kidney was maximum (0.58 mg/g) on exposure for 20 days and the increase is 422.7% as compared to the control. Similar trend was noticed in nickel and maximum accumulation of nickel is 3.63 mg/g on exposure to 20 days which is about 5 times. The accumulation of zinc in muscle was maximum (0.52 mg/g) in the fish which was exposed to sublethal concentrations of sewage water for 20 days. When compared to the control the percentage increase was 900%. In exposed fish, the accumulation of nickel in muscle was found to be 1.3mg/g and the percentage increase amounted to 184.8%.

Table 1. Physico-chemical characteristics of the vellalore municipal sewage water

Parameters	Values	Tolerence limit	ISI Tolerance limit
Temperature	30.00	Less than 40^0C	40^oC
pH	7.55	5.50-9.00	5.5 to 9.0
EC	2.94	-	-
TS	1466.67	-	500
TDS	1266.67	2100.00	-
DO	4.22	-	30.00
BOD	63.33	30.00	250.0
COD	128.00	250.00	1000.0
Chloride	220.00	1000.00	1000.0
Sulphate	10.00	1000.00	5.0
Phosphate	9.57	-	-
Nitrite	17.86	-	-
Zinc	0.110	-	-
Nickel	Bdl	-	-

All values in mg/l except pH and EC (mmhos/cm). Bdl – Below deductible level

Table 2. Heavy metal concentrations (mg/g) in different tissues of *Cyprinus carpio*

Sample (mg/g wet tissue)	Metals	Control	Lethal 72 hours	Sublethal 10 days	Sublethal 20 days
Liver	Zinc	0.19	0.29 (55↑)	0.62 (235.1↑)	0.72 (288↑)
	Nickel	0.18	0.54 (210.9↑)	0.72 (312.6↑)	1.60 (814.3↑)
Kidney	Zinc	0.11	0.56 (408.2↑)	0.56 (410.9↑)	0.58 (422.7↑)
	Nickel	0.62	10.81 (30.5↑)	0.96 (54.4↑)	3.63 (484.7↑)
Muscle	Zinc	0.05	0.33 (536.5↑)	0.41 (688.5↑)	0.52 (900↑)
	Nickel	0.46	0.75 (62.6↑)	1.05 (128.3↑)	1.31 (184.8↑)

↑- Percentage increase

Accumulation of nickel is more pronounced than zinc, *Cyprinus carpio*. Bioaccumulation of metal toxicants depend on availability and persistence of the contaminants in water and food, physico-chemical properties of the toxicant, quality of holding water, uptake and transport of xenobiotics, biotransformation as reported by Part and Svangberg (1981) and Norey *et al.* (1990). The heavy metals accumulated predominantly in gill, liver, intestine and kidney (Brown *et al.,* 1986 ; Thomas *et al.,* 1985). In micropogan undulates, zinc was initially taken up from the gut into the blood followed by a rapid accumulation in the liver and kidney and then a slow protected accumulation in bone, integument and muscle (Chipman *et al.,* 1998). Mohammed and Al-Mohanna (1994) reported that the accumulation of zinc in liver and kidney tissues was maximum, while minimum accumulation was found in the muscle tissue. This study confirms with the above observations with least concentration of zinc in muscle tissue. Fluctuations seen between tissues over the time cources of the experiment may be due to considerable differences in the accumulation of toxic metals by different organs (Vincent and Ambrose, 1994). In this study liver and kidney bioaccumulated zinc and nickel to a higher level than the muscle tissue. Bremner and Davies (1976) have pointed out an increased synthesis of metallothioneins and their storage as a constituent of liver and kidney cytoplasm might have resulted in the increased accumulation of metals in liver and kidney. Least accumulation was reported in the muscle (Lockhart *et al.,* 1972). In the present study there was no correlation between the metals present in the environment and metals accumulated in the tissues.

It has been reported that there is a direct correlation between metals accumulated by organisms and the amount of metals present in the environment (Bryan and Uysal, 1978). Bryan (1979) reported that absorption of pollutants from food is often the most important route for bioaccumulation. From this investigation, it may be said that uptake and accumulation of heavy metals, zinc and nickel may thus depend on availability and persistence of the contaminant in the medium. It may be further deduced that the uptake and persistence of the heavy metal in tissues of fish directly or indirectly alter the physiology of fish under the toxic stress.

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