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Research Article

ASSESSMENT OF HEAVY METALS CONCENTRATION IN WATER AND FISH FROM KRISHNA RIVER, VIJAYAWADA, INDIA

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ABSTRACT

The present study was conducted to assess the levels of heavy metals for Mercury (Hg), Cadmium (Cd), Zinc (Zn) and Lead (Pb) in water and fish (*Labeo rohita)*. Water and various tissues (liver, kidney and muscle) of fish were analyzed Metals for using flame atomic absorption spectrophotometer. The assessment showed Zn (1.64 mgL^{-1}) and Pb (0.05 mgL^{-1}) highest followed metal in water and average mean of Cd (1.28 mg/kg^{-1}) were found to be high in the total three organs of fish were above the permissible limits than recommended benchmarks by WHO and the Food Safety Authority of Ireland (2009) and therefore, not safe for human consumption. So, there is need for a constant monitoring of the heavy metals concentrations in fresh water ecosystem.

Keywords: Krishna river, Heavy metals, *Labeo rohita*, Toxicity.

INTRODUCTION

The main source of fresh water pollution can be attributed to discharge of untreated waste, dumping of industrial effluent, atmospheric deposition, mining, erosion and runoff from agricultural fields (Ambedkar and Muniyan, 2011). Metal are not biodegradable and their presence in the food chain through a number of pathways becomes accumulated in different organs of animal (Staniskiene *et al.,* 2006). The accumulation could also depend on the concentration of the metals and exposure periods (Nyirenda *et al.,* 2011). According to world health organization (WHO, 1991), metals occurs less than 1% of the earth's crust, with trace amount generally found in the environment and when these concentrations exceed a stipulated limit, they may toxic to the surrounding environment.

Benthic organisms which are under direct contact with sediments are more prone to such exposures. Some of the metals such as Pb and Cd are nonessential and are harmful even at very low concentrations (Pehlivan *et al.,* 2009). The increasing demand of food safety has accelerated research regarding the risk associated with food consumption contaminated by heavy metals (Mansour *et al.,* 2009). Moreover, the use of large quantities of agrochemicals such as metal-based pesticides and fertilizers plays an important role in the contamination of foodstuffs by heavy metals (Loutfy *et al.,* 2012).

The last three decades were witness to several reports on the toxicity of heavy metals in human beings, due to the contamination in the fish and fishery organisms (Mohamad and Osman, 2014). Heavy metals cause damage by enhancing the production of free radicals in several organs (liver, kidney, muscles, and heart) and interfering with cellular mechanisms against oxidation, leading to oxidative stress which has been implicated in the etiology of several diseases (Castro-Gonzalez and Mendez-Armenta 2008). The predominant pathways for heavy metal uptake, target organs, and organism's sensitivity are highly variable and are dependent of factors such as metal concentrations, age, site, physiological status, habitat preferences, feeding behavior and growth rates of fish (Chapman *et al.,* 1996). The liver is highly active in the uptake and storage of heavy metals; hence it is a good monitor of water pollution with metals since their concentrations are proportional to those present in the environment (Dural *et al.,* 2007).The heavymetals in aquatic ecosystem are transferred through food web into human beings. Some of heavy metals can cause health problems to fish consumers (Uysal *et al.,* 2008; Taweel *et al.,* 2011). Therefore, in the present study attempts the fish have been found as a good indicator for heavy metal concentration in water and fish.

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MATERALS AND METHODS

Study Area

Vijayawada is a commercial city located on the bank of Krishna river in Krishna district of Andhra Pradesh, India. It is the third largest city in Andhra Pradesh, with an area of 261.88 km^2. Located at 16.52° north latitude 80.62° east longitude and the average elevation of the land of the city of Vijayawada is about 39 feet above the sea level engineering firms, automobile parts manufacturers, health care facilities, educational institutions, hospitality and for its Vijayawada, Andhra Pradesh. They are the main water resource for the nearby villages mostly for various domestic activities. The area is somewhat prone to cyclones which have resulted in the place being nicknamed as "Blazewada".

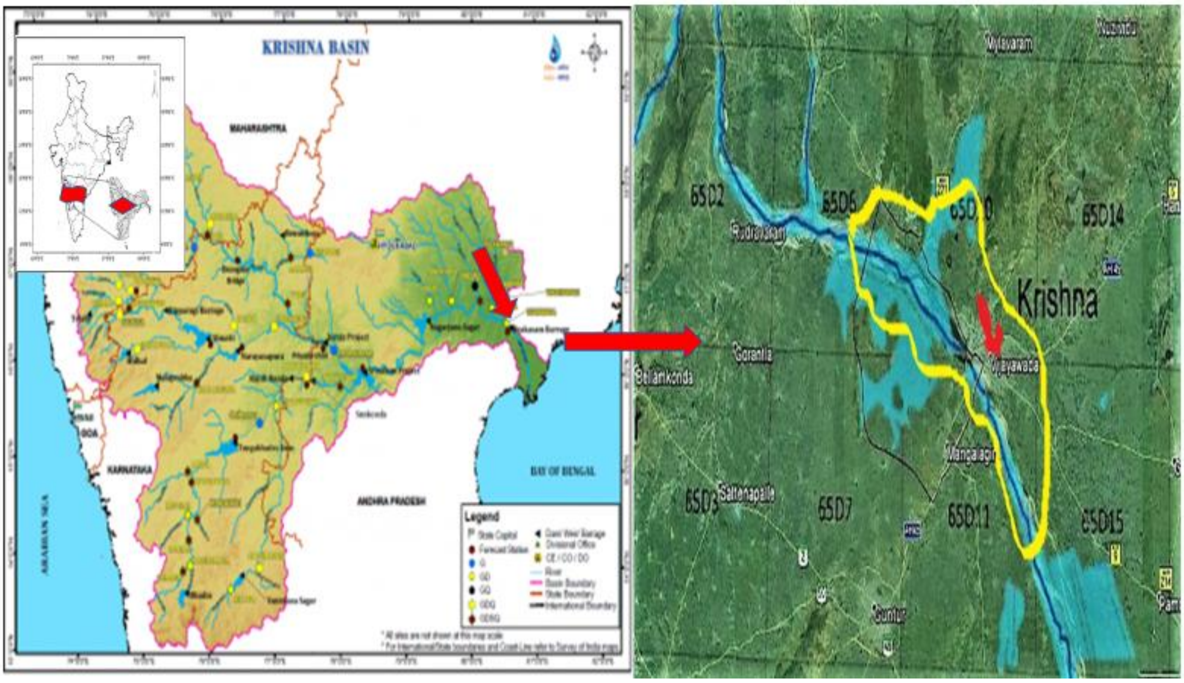

Figure 1. Location of the studied area.

Heavy metal analysis in fish samples

Fish samples (*Labeo rohita*) were caught from the Krishna river region, Vijayawada city and transported to the laboratory in ice boxes and stored at -10°C until subjected for future analysis. They were brought to the laboratory and dissected the organs viz. liver, kidney, and muscles. They were removed with clean sterilized instruments. Tissues organs were washed with double distilled water and put in sterilized Petri dishes to dry at 120°C in oven until they reached a constant weight. One gram of each dried tissue of liver, kidney, and muscles were then digested with diacid (HNO3 and HClO4 in 2:1 ratio) on a hot plate set at 130°C until all materials were dissolved. Digested samples were diluted with double distilled water appropriately in the range of the standards, which were prepared from the stock standard solutions of the metals (Merck). The metal concentration in the samples was measured using a flame atomic absorption spectrophotometer. The results were expressed as mg/kg-^{1}dry weight and mg L-^{1} for fish and water, respectively. Physico-chemical parameters of the water were analyzed as per the procedures described in APHA (1998).

Heavy metal analysis in water

Water samples of heavy metals analysis were collected in L bottles pre-rinsed with distilled water. A 0.25L of the water samples was transferred into a 500 cm^3 beaker. It was filtered and evaporated to dryness. The residue was redissolved in 0.1M nitric acid in 100cm^3 volumetric flask ready for analysis after labeling. Aqueous stock solutions were prepared for Hg, Cd, Zn and Pb, using the appropriate salts. Five working standard solutions were prepared for each metal by serial dilution of stock solution. These and blank solution were aspirated into flame Atomic Absorption Spectrophotometer. A calibration curve of absorption versus concentration was measured in the samples using standard calibration plot.

Statistical Analysis

Mean and Standard deviation of the measured parameters were estimated and comparison of heavy metal in fish tissues were statistically analyzed by using one-way analysis of variance (ANOVA) with the 5% level by DMR Tusing the SPSS (Version 17.0 for Window) computer program.

RESULT

In the water sample, the mean concentration of metal Pb, Zn, Cd and Hg were 0.05,1.64,0.02 and 0.001mg L^{-1}, respectively (Table 1, Figure 1). The concentration of Zn was the highest followed by Pb,Cd and Hg.

The mean values of metal in fish organs Pb in liver, kidney and muscle goes to 0.2, 0.1 and 0.2 mg/kg-^{1} respectively, the maximum accepted limit was 0.3 mg/kg for food fish. The present study indicated that the concentration of lead levels was within the permissible limits. The present study Zn was observed in fish liver, kidney and muscle average mean value of 0.87, 0.44 and 0.92 mg/kg-^{1} respectively. The maximum accepted limit was Zn 5mg/kg for food fish. The average mean value of Hg recorded in total three organs 0.2 mg/Kg-^{1} of fish the maximum accepted limit was 0.5 mg/Kg-^{1}, the value is indicated within the permissible limits by FSAI 2009. The average level of Cd in all three organs of fish liver goes 1.05 kidney 1.01 and muscles 1.03 mg/kg-^{1}. According to WHO, Food Safety Authority of Ireland 2009**,** the maximum accepted limit was Cd 0.05 mg/kg-^{1} for food fish. The present study indicated out of four metals in fish samples Cd constituted the major portion of concentration the total metal ions determined (Table 2).

Table 1. Mean heavy metal concentration in water from Krishna river, Vijayawada.

Heavy Metals (mg L-$^{1)}$	Mean concentration (mg l-^{1}) present study	Drinking water standard by WHO, BIS 2012
Pb	0.050	0.010
Zn	1.640*	5.000
Cd	0.002	0.003
Hg	0.001	0.001

*higher concentration value recorded total four metals.

Table 2: Mean heavy metal concentration in*labeo rohita* in Krishna river, Vijayawada.

Heavy Metals (mg/kg-$^{1)}$	Mean concentration (mg/kg) present study			Food Safety Authority of Ireland 2009
	Liver	Kidney	Muscle	
Pb	0.20	0.10	0.20	0.30
Zn	0.87	0.44	0.92	5.00
Cd	1.03*	1.01*	1.03*	0.05
Hg	0.20	0.20	0.30	0.50

* Levels higher than permissible limit.

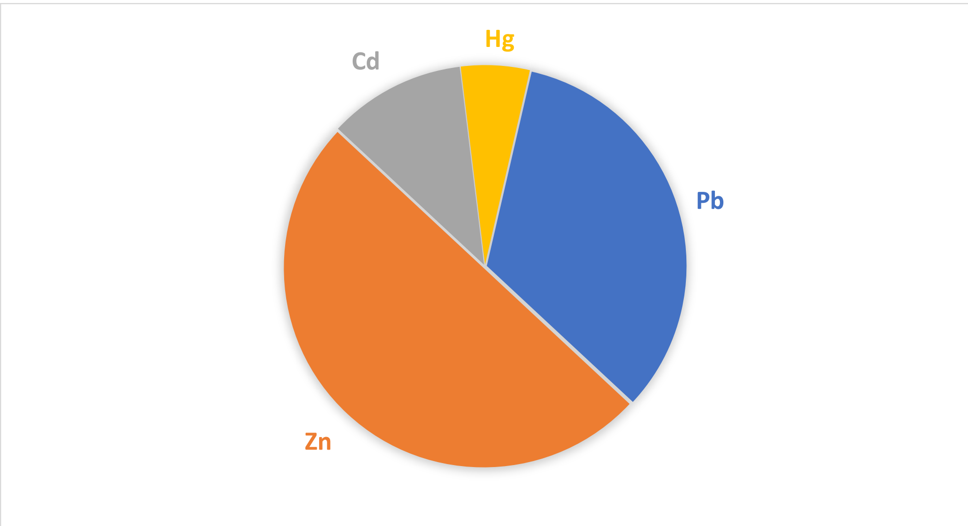

Figure 1. Order of higher occurrences of toxic metal in Krishna river.

DISCUSSION

Heavy metal contamination in aquatic ecosystem exerts an extra stress on biota, fish, which tend to accumulate the heavy metals in metabolically active tissues and organs are usually monitored by measuring their accumulation level in various organs like brain, muscle, gills, liver, kidney and blood (Dhanalakshmi, 2016). The efficiency of metal up take from polluted water may different ecological need, metabolism and contaminated level, food and sediment as well as other environmental factors such as temperature, salinity and interacting gent (Rauf *et al.*, 2009).The present study in water concentration of Zn was the highest followed by Pb, Cd and Hg. Zinc is an essential trace metal for both retarded growth, loss of taste and hypogonadism, leading to decreased fertility (Sivapermal *et al.,* 2007). Zn toxicity is rare, but at concentrations in water up to 40 mg/kg, may induce toxicity, characterized by symptoms of irritability, muscular stiffness and pain, loss of appetite, and nausea (NASNRC, 1974).

The average level of Cd in all three organs of fish was 1.02 mg/kg-^{1}. The maximum accepted limit was Cd 0.05 mg/kg-^{1} for food fish. The present study indicated out of four metals in fish samples Cd constituted the major portion of concentration the total metal ions determined. The source of Cd in humans is through food consumption. Severe toxic symptoms resulting from Cd ingestion are reported between 10 to 326 mg (Sivapermal, 2007). Fatal ingestions of Cd, producing shock and acute renal failure, occur from ingestions exceeding 350 mg/g (NASNRC, 1982).

The concentrations of Cd in all the fish samples, however, fell below the NCBP concentration of 2.1 μg/g threshold considered harmful to fish and predators (Robertson *et al.*, 1991). The concentration of heavy metals in liver and gills of *L. rohita* and *C. straitus* was found to be higher than the other organs, because liver acted as an important organ for storage and detoxification and gills acted as depot tissue there was significant accumulation of metals in these organs, as also reported by (Yilmaz *et al*., 2005; Malik *et al.,* 2010; Taweel *et al.,* 2011). The International Agency for Research on Cancer has classified Cd as a human carcinogen (Group 1) on the basis of occupational studies (EFSA, 2009). Cd was also listed as endocrine disturbing substance and may lead to the development of prostate and breast cancer (Pan *et al*., 2010). Among the metal analyzed in water and fish the highest concentration level of Zn and Cd respectively, the minimum concentration level of Hg in water and fish from Krishna river region Vijayawada pose to health hazards to the consumers.

CONCLUSION

It was observed that the concentrations of four metals in water and fish organs the concentration of Zn was the highest followed by Pb, Cd and Hg in water. In all three organs of fish samples Cd constituted the major portion of concentration than out of four metal ions determined by FSAI, 2023). Overall data of this research states that bioaccumulations of heavy metals found in Krishna river region Vijayawada like Zinc and Cadmium in water and fish tissues respectively. It is an indication of severe toxicity which will cause ill health in human beings.

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