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Assessment of some heavy metals in the selected freshwater fish species collected from Veeranam Lake Cuddalore District, Tamil Nadu, India

G. Ambedkar[1,*], **J. Kmalakkannan**[2] and **M. Muniyan**[3]

[1]PG and Research Department of Biotechnology, Sri Vinayaga College of Arts and Science, Villupuram, India

[2]PG and Research Department of Chemistry, Sri Vinayaga College of Arts Science, Villupuram. India

[3]Departments of Zoology, Periyar Arts College, Cuddalore, India

*E-mail address: gambedkar1984@gmail.com

ABSTRACT

The present study was conducted to assessment the some heavy metals, chromium, cadmium, copper, lead, iron, zinc and manganese concentrations in gill, liver, kidney, intestine and muscle of the selected freshwater fish *Tilapia mossambica*, *Claris batrachus*, *Labeo rohita*, *Mystus vittatus* and *Cyprinus carpio communis* of the Veeranam Lake Cuddalore district, Tamilnadu, India collected between January 2010- December 2010. Heavy metals concentrations varied in significantly depending upon the type of fish tissues and locations. In the selected freshwater fish, liver tissues appeared to have significantly highest level of chromium followed by Cd, Cu, Pb, Fe, Zn and Mn. The maximum level of chromium in liver tissue followed by the gill, kidney and intestine was found in the of *Tilapia mossambica*, *Claris batrachus*, *Labeo rohita*, *Mystus vittatus* and *Cyprinus carpio communis* while the minimum level of manganese was observed in the muscle tissue of *Tilapia mossambica*, *Claris batrachus*, *Labeo rohita*, *Mystus vittatus* and *Cyprinus carpio communis.* These levels of metals higher in the fish tissue may be due to increased fertilizers, agricultural wastes, industrial effluents and some anthropogenic activities high in the investigated area.

***Keywords*:** Freshwater Fish, Heavy metals, Veeranam Lake

1. INTRODUCTION

Water is the universal solvent required for all the living beings. Fresh water resource is becoming day-by-day at the faster rate of deterioration of the water quality is now a global problem. Discharge of toxic chemicals, over pumping of aquifer and contamination of water bodies with substance that promote algae growth are some of the today's major cause for water quality degradation. The natural aquatic resources are causing heavy and varied pollution in aquatic environment leading to water quality and depletion of aquatic biota. In order to manage aquatic ecosystem it is important to know the biological status of the system, especially when evaluating the impact of a chemical stressor on the biota (Ebrahimpour and Mushrifah, 2009). Heavy metals can enter the aquatic ecosystem by atmospheric deposition, by weathering from the geological matrix, or from anthropogenic sources, such as industrial effluents and mining wastes (Alam et al., 2002). Today, even after knowing these realities, aquatic ecosystems are being severely altered or destroyed at a greater rate than at any other time in human history.

Contamination of aquatic ecosystems (e.g., Lakes, Rivers and streams, etc.) with heavy metals has been receiving increased worldwide attention due to their harmful effects on human health and other organisms in the environment (Abdul et al., 2010). The main sources of heavy metals in aquatic ecosystems are of the anthropogenic activities. Metals after entering the water may precipitate or adsorb on the surface of solids, remain soluble or suspended in it or may be taken up by fauna and flora. One of the most important properties of a toxic pollutant is its ability to accumulate in the tissues of organisms. Over a long period, the pollutants present in the environment at very low levels may accumulate within the body of aquatic species by various mechanisms to the extent that they exert toxic effects. The heavy metals are not biodegradable and can accumulate in the environment make them deleterious to the aquatic environment and consequently to humans who depend on aquatic products as sources of food (Rauf and Javed, 2007). Heavy metals from natural and anthropogenic sources are continually released into aquatic ecosystems, and they are a serious threat because of their toxicity, long persistence, bioaccumulation, and biomagnifications in the food chain (Vosyliene and Jankaite, 2006*)*. The ecological services become costly and many times impossible to replace/sustain when aquatic ecosystems are indiscriminately contaminated or degraded. Fish bioaccumulation may be used to elucidate the aquatic behavior of environmental contaminants, to identify certain substances present at low concentrations, and to assess exposure of aquatic organisms (Van der Oost et al., 2003) Among pollutants that could accumulate in fish, metals are great interest because it has been shown that they could trigger oxidative stress in fish and affect their growth. When heavy metals enter the aquatic ecosystems, their presence can cause stress effects in biota due to their ability to accumulate (Oence et al., 2000). Significance in ecotoxicological is highly persistent and all have the potential to be toxic to living organisms (Storelli et al., 2006).

In the body organs of both herbivorous- and carnivorous fish species, the accumulation of Cd, Cu, Cr, Mn and Zn were accumulated significantly in gill, liver, kidney, intestine and muscle. The mechanism of trace metals bioaccumulation in fish is complex and diversified, varying with their chemistry, mode of action and metal species. The function and ability of specific organs to regulate metals are the factors to affect the accumulation differences in various tissues. The differences in various tissues for the accumulations of Cd, Cu, Cr and Zn might be the result of their capacity to induce metal-binding proteins such as metallothioneins

(Canli and Atli, 2003; Magelsir, Draszawka-Bołzan, 2016; Kulkarni, Ibraheem, Wirnkor, Ganiron, Battacharyya, Anbuselvan, 2017).

Heavy metals are the serious aquatic pollutants and their uptake and accumulation in the aquatic ecosystems, beyond safe limits, would cause direct consequences to the aquatic food chain and ultimately to the man (Iwegbue et al., 2007). Heavy metals concentrations in fish samples and consider its potential impacts on the food chain and its human health risks. Pollutants are transferred in the liver it is stored there or excreted in bile or passed back to the blood for possible excretion via gills or kidney or stored in fat (Heath, 1991). These dynamic processes, which take place simultaneously within the body of the fish, eventually, determine the concentrations of the pollutants in the fish. As fish constitute an important link in the food chain its contaminations by toxic metals causes a direct threat, not only to the entire aquatic environment, but also to humans that utilize it as food. The analysis of metals in the fish tissues in River and Lakes were reported by many authors (Malik et al., 2010; Gupta et al., 2009; Vindothini and Narayanan, 2008). Hence the present study was carried out to investigate the assessment of heavy metals such as, chromium, cadmium, copper, lead, iron, manganese and zinc in the selected tissues of available five freshwater fish *Tilapia mossambica*, *Claris batrachus*, *Labeo rohita*, *Mystus vittatus* and *Cyprinus carpio communis* collected from Perumal Lake Cuddalore district, Tamil Nadu, India.

2. MATERIALS AND METHODS

Description of the study area

The Veeranam Lake is located 14 km away from the university campus of Chidambaram in Cuddalore District, in the State of Northern Tamil Nadu in South India (Coordinates 11° 20' 10"N and 79°32'40" E). The lake type is reservoir, intermittent, the total catchment area of the reservoir is 25 km2 (9.7 sq.mile) and it is about 16 km (10 mile) long and 4 km (2.5 mile) width. The source to supply water to Veeranam Lake is the surplus water from Keelanai (Lower Anaicut) and water coming from surrounding area. From where water is planned to be supplied to Chennai for drinking purpose, Ayacut area of 48,000 acres irrigation in Chidambaram Town.

Collection of fish samples and analysis of heavy metals

The selected freshwater fish *Tilapia mossambica*, *Claris batrachus*, *Labeo rohita*, *Mystus vittatus* and *Cyprinus carpio communis* of Veeranam Lake Cuddalore district, Tamilnadu were caught by the local fishermen using gill net of various sizes. The fish species were ice-packed and transported to the laboratory and identified with the help of fishes of India (Day, 1978). The selected fish organs were removed and put it in Petri dishes to dry at 120° until reaching a constant weight. The dried tissue was placed into digestion flask and ultra pure concentrated nitric acid and hydrogen peroxide [1: I V/V] [SD fine chemicals] were added. The digestion flask was heated to 130 °C until all the material was dissolved. Digest was diluted with double distilled water appropriately (Yilmaz, 2003). The elements like cadmium, chromium, copper, lead, manganese, iron and zinc were assayed using ELICO's SL-176 Double Beam Atomic Absorption Spectrophotometer.

3. RESULTS AND DISCUSSIONS

The determination of metals concentration in the selected organs of Liver, gill, kidney, intestine and muscle of the selected freshwater fish *Tilapia mossambica*, *Claris batrachus*, *Labeo rohita*, *Mystus vittatus* and *Cyprinus carpio communis* were presented in Figure 1-5. The distribution of heavy metals in selected organs analyzed were in the order of magnitude as liver > gill > kidney > intestine > muscle. The distribution of heavy metal in the all fish organs analyzed were in the order of Cr > Cd > Cu > Pb > Fe > Zn and Mn.

The bioaccumulations of metal concentration in the freshwater fish *Tilapia mossambica* are presented in Figure 1. In the gill tissue they were Cr 1.58 ± 0.071, Cd 1.30 ± 0.036, Cu 1.24 ± 0.043, Pb 1.04 ± 0.049, Fe 0.76 ± 0.029, Zn 0.64 ± 0.029 and Mn 0.50 ± 0.024 mg/kg dry weight. In the liver tissue they were Cr 1.62 ± 0.070, Cd 1.44 ± 0.046, Cu 1.32 ± 0.059, Pb 1.20 ± 0.038, Fe 0.80 ± 0.027, Zn 0.78 ± 0.030 and Mn 0.62 ± 0.026 mg/kg dry weight. In the kidney tissue they were Cr 1.50 ± 0.039, Cd 1.28 ± 0.054, Cu 1.10 ± 0.030, Pb 0.90 ± 0.029, Fe 0.70 ± 0.032, Zn 0.50 ± 0.019 and Mn 0.48 ± 0.010 mg/kg dry weight. In the intestine tissue they were Cr 1.42 ± 0.050, Cd 1.20 ± 0.043, Cu 0.94 ± 0.035, Pb 0.80 ± 0.037, Fe 0.62 ± 0.016, Zn 0.42 ± 0.016 and Mn 0.30 ± 0.011 mg/kg dry weight. In the muscle tissue they were Cr 1.34 ± 0.050, Cd 1.08 ± 0.049, Cu 0.80 ± 0.037, Pb 0.70 ± 0.029, Fe 0.60 ± 0.021, Zn 0.38 ± 0.011 and Mn 0.26 ± 0.009 mg/kg dry weight. The highest level of Cr 1.62 ± 0.070 mg/kg dry weight were found in the liver tissue of *Tilapia mossambica*, while the least concentrations level of Mn 0.26 ± 0.009 mg/kg dry weight were detected in the muscle tissue of the *Tilapia mossambica*.

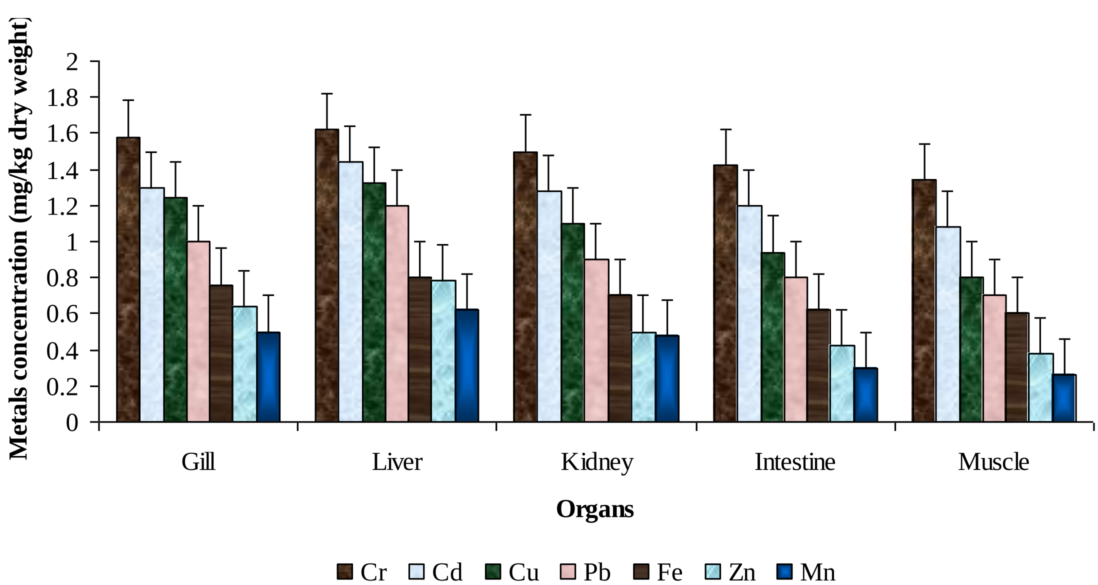

Figure 1. Mean concentrations of metals in the selected organs of freshwater fish *Tilapia mossambica* caught at Veeranam Lake from January 2010- December 2010

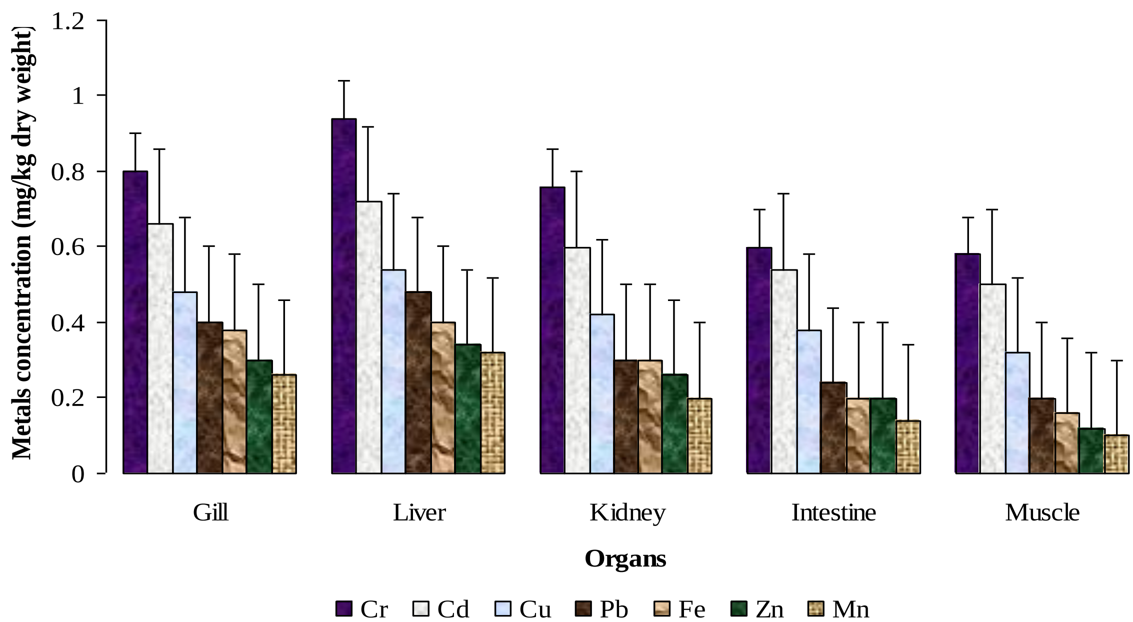

Figure 2. Mean concentrations of metals in the selected organs of freshwater fish *Claris batrachus* caught at Veeranam Lake from January 2010 - December 2010

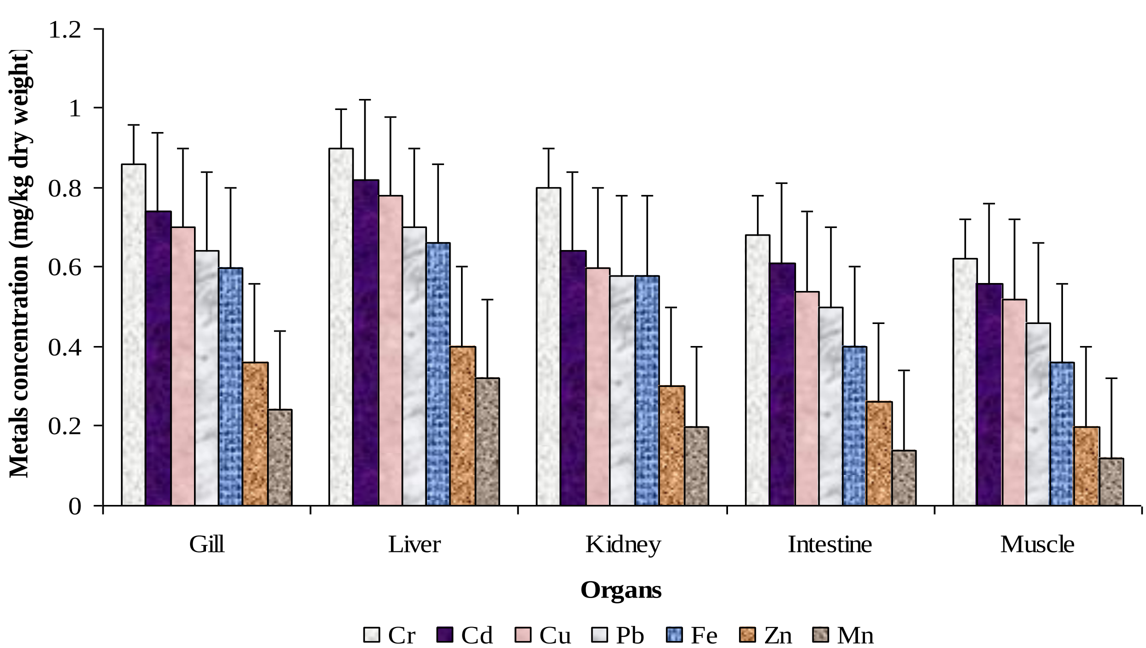

Figure 3. Mean concentrations of metals in the selected organs of freshwater fish *Labeo rohita* caught at Veeranam Lake from January 2010 - December 2010

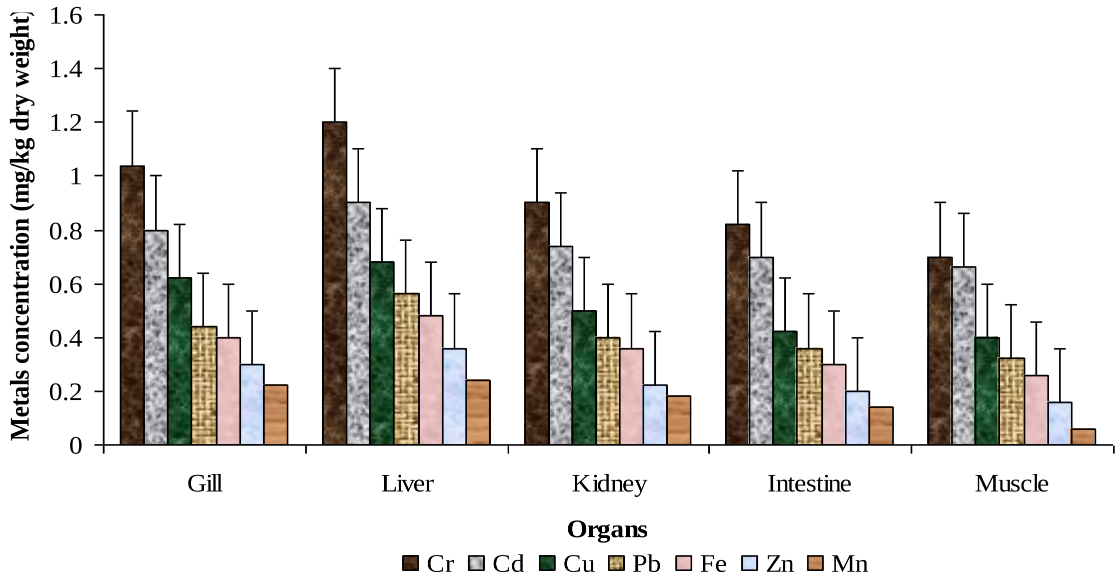

Figure 4. Mean concentrations of metals in the selected organs of freshwater fish *Mystus vittatus* caught at Veeranam Lake from January 2010 - December 2010

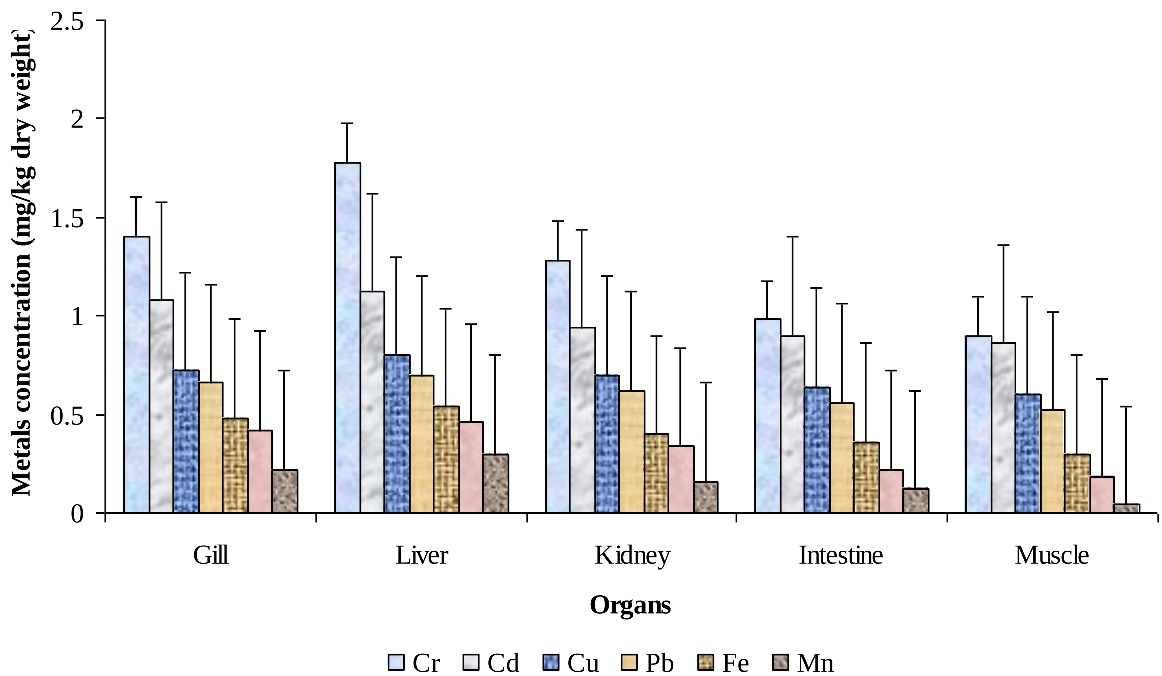

Figure 5. Mean concentrations of metals in the selected organs of freshwater fish *Cyprinus carpio communis* caught at Veeranam Lake from January 2010 - December 2010

The analysis of metal concentration in the freshwater fish *Claris batrachus* are presented in Figure 2. In the gill tissue they were Cr 0.80 ± 0.037, Cd 0.66 ± 0.018, Cu 0.48 ± 0.023, Pb 0.40 ± 0.015, Fe 0.38 ± 0.014, Zn 0.30 ± 0.014 and Mn 0.26 ± 0.008 mg/kg dry weight. In the liver tissue they were Cr 0.94 ± 0.038, Cd 0.72 ± 0.020, Cu 0.54 ± 0.013, Pb 0.48 ± 0.018, Fe 0.40 ± 0.017, Zn 0.34 ± 0.012 and Mn 0.32 ± 0.011 mg/kg dry weight. In the kidney tissue they were Cr 0.76 ± 0.028, Cd 0.60 ± 0.020, Cu 0.42 ± 0.014, Pb 0.30 ± 0.012, Fe 0.30 ± 0.012, Zn 0.26 ± 0.009 and Mn 0.20 ± 0.007 mg/kg dry weight. In the intestine tissue they were Cr 0.60 ± 0.020, Cd 0.54 ± 0.019, Cu 0.38 ± 0.017, Pb 0.24 ± 0.009, Fe 0.20 ± 0.023, Zn 0.20 ± 0.007 and Mn 0.14 ± 0.005 mg/kg dry weight. In the muscle tissue they were Cr 0.58 ± 0.019, Cd 0.50 ± 0.020, Cu 0.32 ± 0.014, Pb 0.20 ± 0.009, Fe 0.16 ± 0.006, Zn 0.12 ± 0.005 and Mn 0.10 ± 0.004 mg/kg dry weight. The Figure 2 showed the elevated level of Cr 0.94 ± 0.038 mg/kg dry weight were detected in the liver tissue of selected fish, while the declined level of Mn 0.10 ± 0.004 mg/kg dry weight were found in the muscle tissue of *Claris batrachus*.

The bioaccumulations of metal concentration in the freshwater fish *Labeo rohita* are presented in Figure 3. In the gill tissue they were Cr 0.86 ± 0.041, Cd 0.74 ± 0.028, Cu 0.70 ± 0.032, Pb 0.64 ± 0.027, Fe 0.60 ± 0.028, Zn 0.36 ± 0.009 and Mn 0.24 ± 0.010 mg/kg dry weight. In the liver tissue they were Cr 0.90 ± 0.038, Cd 0.82 ± 0.030, Cu 0.78 ± 0.020, Pb 0.70 ± 0.025, Fe 0.66 ± 0.030, Zn 0.40 ± 0.014 and Mn 0.32 ± 0.014 mg/kg dry weight. In the kidney tissue they were Cr 0.80 ± 0.021, Cd 0.64 ± 0.024, Cu 0.60 ± 0.022, Pb 0.58 ± 0.027, Fe 0.58 ± 0.020, Zn 0.30 ± 0.013 and Mn 0.20 ± 0.006 mg/kg dry weight. In the intestine tissue they were Cr 0.68 ± 0.024, Cd 0.60 ± 0.028, Cu 0.54 ± 0.021, Pb 0.50 ± 0.021, Fe 0.40 ± 0.014, Zn 0.26 ± 0.009 and Mn 0.14 ± 0.005 mg/kg dry weight. In the muscle tissue they were Cr 0.60 ± 0.017, Cd 0.56 ± 0.026, Cu 0.52 ± 0.014, Pb 0.46 ± 0.020, Fe 0.36 ± 0.008, Zn 0.20 ± 0.008 and Mn 0.12 ± 0.004 mg/kg dry weight. Figure 3 showed the maximum level of Cr 0.90 ± 0.038 mg/kg dry weight were observed in the liver tissue *Labeo rohita,* while the minimum concentration of Mn 0.12 ± 0.004 mg/kg dry weight were detected in the muscle tissue of selected fish *Labeo rohita*.

The assessment of metal concentration in the freshwater fish *Mystus vittatus* are presented in Figure 4. In the gill tissue they were Cr 1.04 ± 0.047, Cd 0.80 ± 0.021, Cu 0.62 ± 0.016, Pb 0.44 ± 0.019, Fe 0.40 ± 0.015, Zn 0.30 ± 0.014 and Mn 0.22 ± 0.003 mg/kg dry weight. In the liver tissue they were Cr 1.20 ± 0.050, Cd 0.90 ± 0.030, Cu 0.68 ± 0.029, Pb 0.56 ± 0.020, Fe 0.48 ± 0.018, Zn 0.36 ± 0.012 and Mn 0.24 ± 0.011 mg/kg dry weight. In the kidney tissue they were Cr 0.90 ± 0.034, Cd 0.74 ± 0.027, Cu 0.50 ± 0.014, Pb 0.40 ± 0.013, Fe 0.36 ± 0.015, Zn 0.22 ± 0.010 and Mn 0.18 ± 0.008 mg/kg dry weight. In the Intestine tissue they were of Cr 0.82 ± 0.028, Cd 0.70 ± 0.032, Cu 0.42 ± 0.021, Pb 0.36 ± 0.017, Fe 0.30 ± 0.013, Zn 0.20 ± 0.007 and Mn 0.14 ± 0.006 mg/kg dry weight. In the muscle tissue they were 0.70 ± 0.022, Cd 0.66 ± 0.022, Cu 0.40 ± 0.012, Pb 0.42 ± 0.015, Fe 0.26 ± 0.011, Zn 0.16 ± 0.007 and Mn 0.06 ± 0.004 mg/kg dry weight. Figure 4 showed the elevated level of Cr 1.20 ± 0.050 mg/kg dry weight were observed in the liver tissue of selected fish *Mystus vittatus*, while the declined level of Mn 0.06 ± 0.004 mg/kg dry weight were detected in the muscle tissue *Mystus vittatus*.

The analyses of metals concentration in the freshwater fish *Cyprinus carpio communis* are presented in Figure 5. In the gill tissue they were Cr 1.40 ± 0.036, Cd 1.08 ± 0.038, Cu 0.72 ± 0.027, Pb 0.66 ± 0.030, Fe 0.48 ± 0.015, Zn 0.42 ± 0.012 and Mn 0.22 ± 0.010 mg/kg dry weight. In the liver tissue they were level of Cr 1.78 ± 0.075, Cd 1.12 ± 0.036, Cu 0.80 ±

0.033, Pb 0.70 ± 0.026, Fe 0.54 ± 0.021, Zn 0.46 ± 0.019 and Mn 0.30 ± 0.011 mg/kg dry weight. In the kidney tissue they were Cr 1.28 ± 0.052, Cd 0.94 ± 0.034, Cu 0.70 ± 0.027, Pb 0.62 ± 0.026, Fe 0.40 ± 0.013, Zn 0.34 ± 0.013 and Mn 0.16 ± 0.005 mg/kg dry weight. In the intestine tissue they were Cr 0.98 ± 0.037, Cd 0.90 ± 0.023, Cu 0.64 ± 0.017, Pb 0.56 ± 0.021, Fe 0.36 ± 0.015, Zn 0.22 ± 0.005 and Mn 0.12 ± 0.005 mg/kg dry weight. In the muscle tissue they were Cr 0.90 ± 0.031, Cd 0.86 ± 0.033, Cu 0.60 ± 0.017, Pb 0.52 ± 0.024, Fe 0.30 ± 0.014, Zn 0.18 ± 0.006 and Mn 0.04 ± 0.002 mg/kg dry weight. The highest level of Cr 1.78 ± 0.075 mg/kg dry weight were recorded in the liver tissue of *Cyprinus carpio communis*, while the least concentration of Mn 0.04 ± 0.002 mg/kg dry weight were detected in the muscle tissue of *Cyprinus carpio communis* (Figure 5).

The highest levels of copper in the different tissues of selected fish species may be Among the metal analyzed in Figure 1-5 showed the highest mean concentration level of Cr 1.78 ± 0.075 mg/kg dry weight were observed in the liver tissue of selected freshwater fish *Cyprinus carpio communis* (Figure 5) while the lowest concentration of manganese 0.04 ± 0.002 mg/kg dry weight were recorded in the muscle tissue of *Cyprinus carpio communis* (Figure 5). Chromium bioaccumulation in fish has been reported to cause impaired respiratory and osmoregulatory functions through structural damage to gill epithelium [11]. The high concentration of chromium levels in the different organs of the freshwater fish and their presence could be attributed to waste water discharge from the agricultural related activities that take place high in the investigated area due to the presence of domestic waste, agricultural and industrial waste in the study area. Zn is necessary element for embryo development and is important to reproductive organs (Carpen et al., 1994).

Fish liver and kidney accumulated significant quantities of all metals while these accumulations were significantly lowest in muscle. Fish kidney as its role to detoxify metals has also accumulated significant amounts of heavy metals (Vindothini and Narayanan, 2008). The liver is expected to be a target of toxic action since it contains metal binding proteins (metallothioneins) (Bendell – Young and Harvey, 1986). These proteins are responsible for the accumulation of significant levels of metals. Fish liver, kidney and gill tissues showed significant ability to accumulate metals as observed during present investigation. The gills are directly in contact with water. Therefore, the concentration of metals in gills reflects their concentration in water where the fish lives, whereas the concentrations in liver represent storage of metals in the water (Romeo et al., 1999). Gills are the most likely sites of metal uptake from the ambient environment due to their large surface area and close proximity with the external and internal environment.

It was also observed that the heavy metals in muscle tissue were at low levels compared with other organs [Saglamtimur et al., 2003; *Karadede- Akin and Unlu, 2007*). Fishes are affected by pollutants both directly and indirectly in various ways. Some of the effects produced are as given below: An increase in the osmotic pressure, violent alteration in the pH of water, reduction of oxygen content of in water by substances with a high oxygen demand, specific toxic ingredients, which may injure the gills and other external structures, cause death either from anorexia or by intake and absorption. Fishes are affected indirectly when its habitual food organisms are destroyed. The covering of the bottom of a water body by a coating of waste matter greatly reduces the food supply of the fish.

4. CONCLUSION

In this study given valuable information on the heavy metals in the selected freshwater fish from Veeranam Lake. *Cyprinus carpio communis* liver tissue exhibited maximum tendency to accumulate chromium and minimum accumulation of manganese in the muscle tissues *Cyprinus carpio communis*. The high level of metals not safe for human consumption might be representing a risk for human health.

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