MONITORING OF HEAVY METAL (COPPER, ZINC, IRON, LEAD AND CADMIUM) ACCUMULATION IN FRESH WATER FISH SPECIES OF TAMMILERU RESERVOIR, WEST GODAVARI DISTRICT

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***ABSTRACT:** The concentrations of heavy metals viz., Cu, Zn, Fe, Pb and Cd were detected in the edible part of selected fresh water fishes i.e., Labeo rohita, Channa striata and Mastacembelus armatus collected from the Tammileru reservoir, West Godavari District. Analyses were carried out in penta replicates using F-AAS, since March 2016 to February 2018. Irrespective of species, the magnification order of metal accumulation was Fe>Zn>Cu>Pb>Cd, Zn>Cu>Fe>Cd>Pb and Cu>Zn>Fe>Pb>Cd in the species of Labeo rohita, Channa striata and Mastacembelus armatus. Significance (p<0.05) was observed within the species but not between the species. This study revealed that the range of the metal accumulation of three fresh water fish species of Tammileru reservoir.*

***Keywords:** Heavy metal; freshwater fish; Tammileru reservoir; human health*

INTRODUCTION

Pollution and its effects on the living resources, especially the fishery resources, have assumed considerable interest as well as importance in the recent times. Pollution from metals is a vital problem affecting the estuaries and inshore regions (Rushinadha *et al* 2016). These pollutants released into air, water or soil is eventually carried into estuarine and coastal water systems. The concentration of metals in the organisms living in such environment is found to be higher than the concentration of pollutants in the surrounding media. Some of these metallic elements have no apparent biological function but affect uptake or excretion. Metallic elements from natural and anthropogenic sources are environmentally ubiquitous, readily dissolved in and are transported by water. They are taken up by aquatic organisms due to bio-accumulation and bio-magnification in the food chain as elements or their metabolites, thus causing a concern for the potential concentrations in animals at the top of the food chain (Papagiannis *et al*. 2004).

Heavy metals are non-biodegradable persistent and are known to cause deleterious effects on animal and human health (Davydova, 2005; Javed and Usmani 2011, 2012). Both acute and prolonged exposures to heavy metals cause various diseases (Jarup, 2003; Javed and Usmani 2013a, 2015). Dietary intake of toxic elements is the main route of exposure for most people (Calderon *et al*. 2003; Powers *et al*. 2003). Owing to industrialization, heavy metal pollution of aquatic ecosystems has become topic of concern worldwide. Fishes are on top of aquatic food chain and hence accumulate significant amount of heavy metals become the source of heavy metal for consumers (Javed and Usmani 2013b, 2015). Primarily fishes are consumed as they are one of the best sources of protein and polyunsaturated fatty acids (PUFA). According to American Heart Association (AHA) fishes are recommended twice a week to the adults with no history of heart attack (Kris-Etherton *et al*. 2002).

Aquatic organisms have ability to accumulate heavy metals from various sources including sediments, soil erosion and runoff, air depositions of dust and aerosol, and discharge of waste water (Goodwin *et al* 2003). Many factors including season, physicochemical properties of water, habitat, age and physiological conditions of fish play a vital role in accumulation of metals in fish (Rao et al., 2016). Gills are directly in contact with water; therefore the concentration of metals in gills reflects metal concentration in water where the fish lives (Rushinadha and Sreedhar, 2017). The accumulation of heavy metals within the fish varies depending on route of metal uptake, type of heavy metal, and fish species (Begum *et al* 2009).

Labeo rohita is the indigenous species of south Asia and dominate the natural waters as well as cultivated in public and private sector (Hussian *et al*., 2011; Khan *et al*., 2012). However these fish maintained in the breeding stations are highly susceptible to parasitic and bacterial infections (Balasurya, 1987; Wimalawickrama and Pathiratne, 2005). *Channa striata* is commonly called Chevron snakehead, striped murrel or striated murrel and is one of the most economically important Channid species inhabiting freshwater as well as brackish water (Bloch, 1793). *Mastacembelus armatus* is a common fish species of Indian subcontinent. It occurs in a variety of freshwater habitats in the plains as well as in hills of India (Talwar and Jhingran, (1991)**.**

This study aspires to afford baseline information to the local authority and the enforcement body on the source of pollution in the Tammileru reservoir. The major objectives of the current study were to identify and quantify the presence of heavy metals in the selected three fresh water fish species *viz*., *Labeo rohita*, *Channa striata* and *Mastacembelus armatus* from the reservoir of Tammileru. There is a significance to measure its quality to assess the possible source of contamination contributing to this problem

MATERIAL AND METHODS

Fish samples (*Labeo rohita*, *Channa striata* and *Mastacembelus*) of about 20 number of each species with same size (length ±5) were collected from point of Tammileru reservoir, West Godavari District. Sampling was conducted at the frequency of twice a week for two consecutive years. Approximately 20 grams of muscle tissue below the dorsal fin was taken by dissecting from the flank area and spanning the lateral line of the fish. This portion is the commonly edible part of the fish, and placed in pre-cleaned polythene bags and were immediately sealed in ice box and brought to the laboratory on the same day.

Heavy metals were determined in edible part by wet oxidation method (AOAC, 2000) using conc. nitric acid and hydrogen peroxide in the ratio 7:3 (v/v). The samples were heated gently and cautiously at first, until the first vigorous reaction subsides, continued heating, until the organic matter was completely destroyed, indicated by a clear solution. A blank was also prepared using hydrogen peroxide and nitric acid used for sample digestion. The above samples were directly fed to a Flame Atomic Absorption Spectrophotometer for heavy metal determination. Statistical analyses were done in penta replicates (±SE) by using Excel and Origin pro 8. Correlation coefficients 'r' was significant between $P<0.01$ and $P<0.05$ was used to indicate significant difference.

RESULTS

The selected fresh water fish samples *viz*., *Labeo rohita*, *Channa striata* and *Mastacembelus armatus* collected from the reservoir of Tammileru, West Godavari District, Andhra Pradesh, were analysed for the determination of heavy metals *i.e*., copper, zinc, iron, lead and cadmium accumulation with the help of F-AAS (Flame Atomic Absorption Spectroscopy). All the results were shown in table 1, 2 and 3; figure 1, 2a and 2b.

Copper: In seasonal wise observation, more amount of copper was accumulated in monsoon (18.86± 0.13) season followed by post-monsoon (18.75± 0.23) season and pre-monsoon (15.04± 0.11) season in *Labeo rohita* (table 1). The highest values of copper content found in the pre-monsoon (27.32± 0.15) season followed by post-monsoon (26.65± 1.62) season and monsoon (22.39± 0.26) season in *Channa striata* (table 2), more amount of copper found in post-monsoon season (45.67± 0.93) followed by pre-monsoon (45.56± 1.78) season and monsoon (44.56± 1.54) season in *Mastacembelus armatus* (table 3). Significant values of copper content were observed within the species in a monthly wise accumulation ($r^2 = 0.91$; $p = 0.02$).

Zinc: The zinc values of seasonal wise variation observed as more amount of zinc concentration was accumulated in pre-monsoon season (24.23± 0.13) followed by monsoon (23.67± 0.14) season and post-monsoon (22.47± 0.83) season in *Labeo rohita* (table 1), whereas in *Channa striata*, the highest values were recorded in the post-monsoon (47.00± 1.27) season followed by monsoon (45.55± 2.11) season and pre-monsoon (39.85± 1.42) season (table 2), while in *Mastacembelus armatus*, the highest values were found in pre-monsoon (24.09± 0.86) season followed by post-monsoon (22.21± 0.39) season and monsoon (22.18± 0.55) season (table 3). The overall mean values of zinc accumulation in *Labeo rohita*, *Channa striata* and *Mastacembelus armatus* was 23.46 ppm, 44.13 ppm and 22.83 ppm . No significant values were observed in between the seasons whereas significant values and regression values were found in between the species ($r^2 = 0.98$; $p = 0.04$).

Iron: Iron found more in post-monsoon (47.47± 1.50) season followed by monsoon (43.83± 1.35) season and pre-monsoon (35.12± 0.06) season in *Labeo rohita* (table 1), while the order of magnitude of accumulation in seasonal wise is monsoon>pre-monsoon>post-monsoon and the values were 19.16± 0.55; 18.97± 0.39; 17.30± 0.32 in the *Channa striata* (table 2) species, even as the order of iron metal magnitude was monsoon>post-monsoon>pre-monsoon and the values recorded as 19.27 ± 0.14; 15.87± 0.81; 15.51± 0.39 in the *Mastacembelus armatus* (table 3). The total average values of iron concentration were 42.14 ppm, 18.48 ppm and 16.89 ppm. The regression values of between the species was $r^2 = 0.93$ and significant values were observed within the species ($p<0.05$) but not between the species ($p>0.05$) respectively.

Lead: The overall mean lead metal accumulation of *Labeo rohita*, *Channa striata* and *Mastacembelus armatus* was 2.09 ppm; 0.58 ppm and 1.68 ppm. In seasonal variation, lead metal concentration accumulated more in monsoon (2.33±0.05) season followed by pre-monsoon (2.11±0.12) season and post-monsoon (1.81±0.07) season in the species of *Labeo rohita* (table 1), whereas in the species of *Channa striata* (table 2), the highest values were recorded in pre-monsoon (0.67±0.18) season followed by monsoon (0.66±0.07) season and post-monsoon (0.39±0.19) season, even as *Mastacembelus armatus* (table 3) accumulated more amount of lead concentration in post-monsoon (2.00±0.07) season followed by pre-monsoon (1.96±0.05) season and monsoon (1.06±0.07) season. No significant values were observed in between the species ($p>0.05$) and significant values were observes within the three selected fish species ($p<0.05$). The regression values were obtained in between the species were as $r^2 = 0.83$.

Cadmium: The overall mean values of cadmium metal concentration were found as 0.45ppm; 1.74 ppm and 0.47 ppm. Lowest values of cadmium content were recorded in pre-monsoon (0.05± 0.04) season followed by post-monsoon (0.47± 0.08) season and monsoon (0.55± 0.05) season of *Labeo rohita* species (table 1), whereas in the species of *Channa striata*, the least concentration of cadmium metal content was found in monsoon (0.95± 0.11) season followed by pre-monsoon (1.94± 0.05) season and post-monsoon (2.31± 0.18) season (table 2), while in the species of *Mastacembelus armatus*, the cadmium concentration accumulated low in pre-monsoon (0.40± 0.04) season followed by monsoon (0.44± 0.09) season and post-monsoon (0.55± 0.07) season (table 3).

DISCUSSION

Heavy metal accumulation was determined for environmental monitoring largely because aquatic organisms are in direct contact with the contaminated water. Tissue metal concentrations in fish are good indicators of aquatic system exposure to the metal contamination (Al-Kahtani, 2009). Heavy metals accumulate in fishes via water, sediments, food such as algae upon which both herbivorous and omnivorous fishes feed (Bebianno *et al*., 2004; Khan *et al*., 2011).

Heavy metal concentrations varied among different tissues of a species as well as between species. Among different observed values of heavy metals, we found that Pb concentrations in different tissues of the experimental species were much higher than cadmium values in *Labeo rohita* and *Mastacembelus armatus,* whereas *Channa striata* showed the highest cadmium content than lead accumulation (Figure 1, 2a and 2b). The overall magnitude of metal accumulation in the studied species of *Labeo rohita* was Fe>Zn>Cu>Pb>Cd, whereas in the species of *Channa striata* has the metal magnification was Zn>Cu>Fe>Cd>Pb, while in the species of *M. armata* has the magnification of metal concentration was Cu>Zn>Fe>Pb>Cd. Studies reported for *Labeo rohita* (Javed and Usmani, 2011) *Clarias gariepinus* (Osman and Kloas, 2009) and *Tinca tinca* (Selda *et al*., 2005) also revealed the maximum accumulation of Fe in liver and least in muscle. Saeed and Shaker (2008) reported two fold higher concentrations of Fe, Zn and Cu in liver, gills and muscle of *Oreochromis niloticus* than the present case.

Previous data showed that different fish species contained strikingly different metal levels in their tissues that might be related to the differences in ecological needs, swimming behaviors and the metabolic activities among different fish species (Kalay *et al*. 1999).

Bioaccumulation of metals in fish can be considered as an index of metal pollution in the aquatic bodies (Tawari-Fufeyin and Ekaye, 2007), that could be a useful tool to study the biological role of metals present at higher concentrations in fish (Dural *et al*., 2007). The current studied fishes were *Labeo rohita, Channa striata* and *Mastacembelus armatus* were more or less similar results found by Staniskiene *et al*. (2006) and Copat *et al*. (2012).

CONCLUSION

Heavy metals are high priority pollutants because of their relatively high toxic and persistent nature in the environment. In this study the distribution, concentration and bioaccumulation of heavy metals Copper, Zinc, iron, lead and cadmium, on these three fresh water fishes were conducted to point out its tendency of bio-magnification in the food chain. More investigations have to be done on different aquatic organisms to confirm the impact of these heavy metals on the sustainability of the aquatic ecosystem.

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Figure 1. Overall mean metal accumulation of *Labeo rohita* of Tammileru reservoir

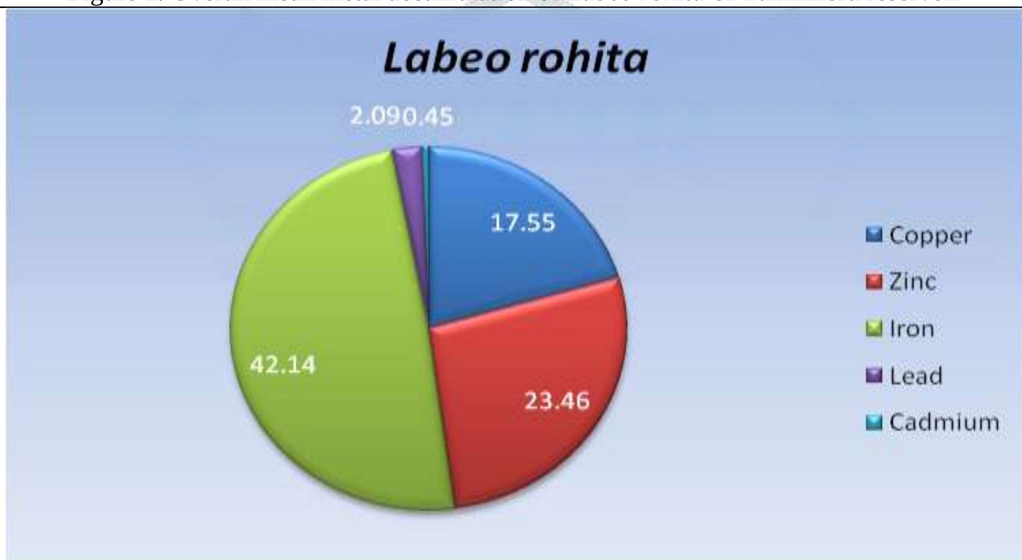
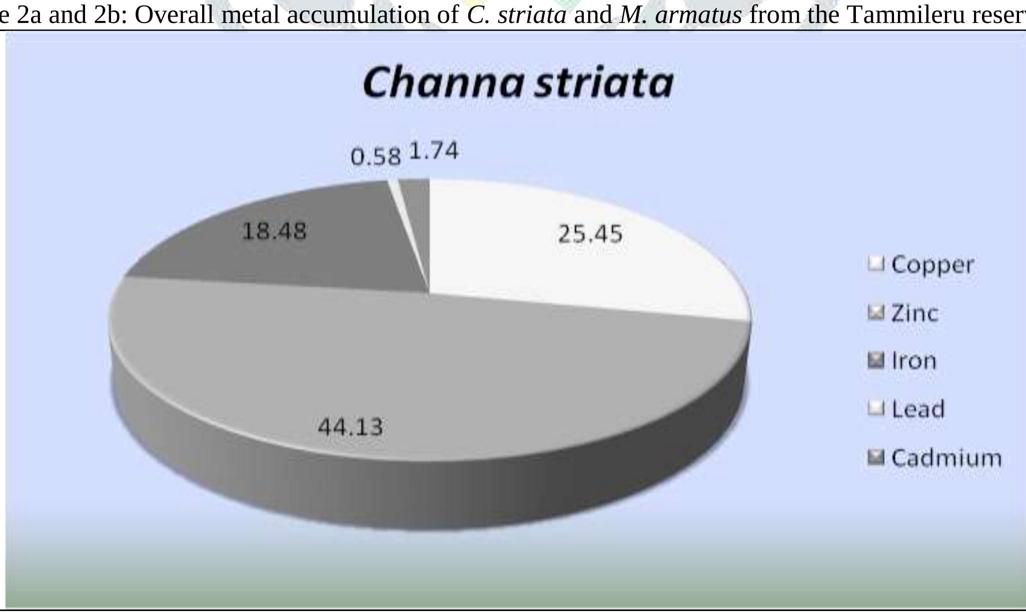


Figure 2a and 2b: Overall metal accumulation of *C. striata* and *M. armatus* from the Tammileru reservoir



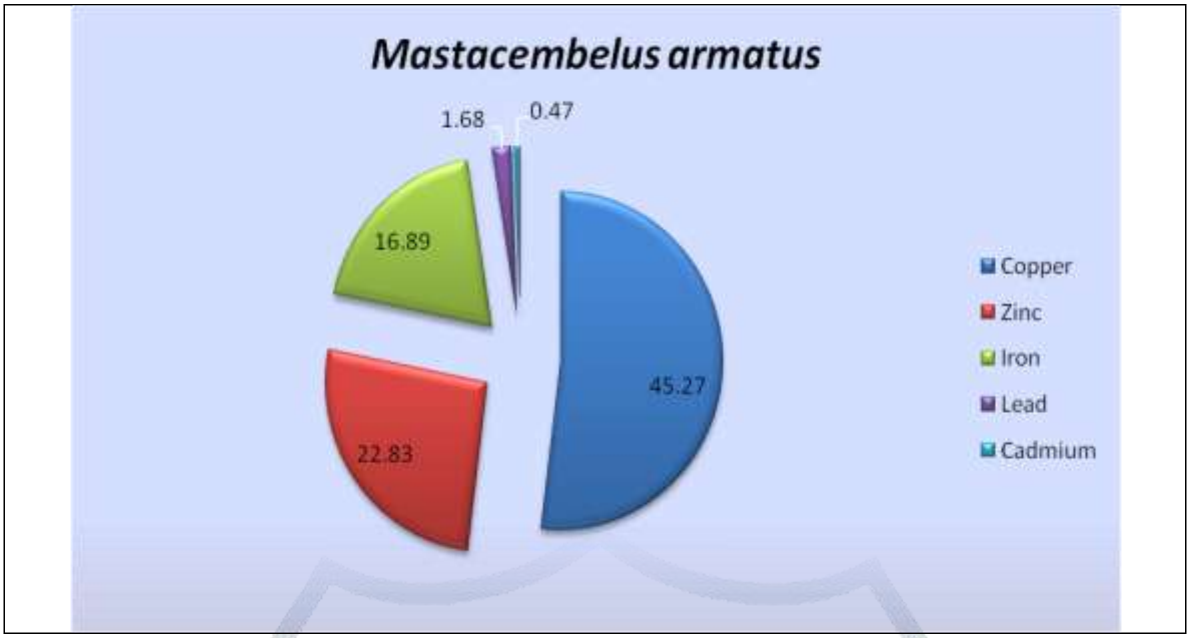


Table 1: Seasonal variation of heavy metal accumulation of *Labeo rohita*

	Copper	Zinc	Iron	Lead	Cadmium
Pre-Monsoon	15.04± 0.11	24.23± 0.13	35.12± 0.06	2.11 ± 0.12	0.05± 0.04
Monsoon	18.86± 0.13	23.67± 0.14	43.83± 1.35	2.33± 0.05	0.55± 0.05
Post-monsoon	18.75± 0.23	22.47± 0.83	47.47± 1.50	1.81± 0.07	0.47± 0.08

Table 2: Seasonal variation of heavy metal accumulation of *Channa striata*

	Copper	Zinc	Iron	Lead	Cadmium
Pre-Monsoon	27.32± 0.15	39.85± 1.42	18.97± 0.39	0.67± 0.18	1.94± 0.05
Monsoon	22.39± 0.26	45.55± 2.11	19.16± 0.55	0.66± 0.07	0.95± 0.11
Post-monsoon	26.65± 1.62	47.00± 1.27	17.30± 0.32	0.39± 0.19	2.31± 0.18

Table 3: Seasonal variation of heavy metal accumulation of *Mastacembelus armatus*

	Copper	Zinc	Iron	Lead	Cadmium
Pre-Monsoon	45.56± 1.78	24.09± 0.86	15.51± 0.39	1.96± 0.05	0.40± 0.04
Monsoon	44.56± 1.54	22.18± 0.55	19.27 ± 0.14	1.06± 0.07	0.44± 0.09
Post-monsoon	45.67± 0.93	22.21± 0.39	15.87± 0.81	2.00± 0.07	0.55± 0.07

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