Accumulation of Heavy Metal in Water and Certain Freshwater Fishes of Bellandur Lake, Karnataka

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S. Muniraju
Department of Zoology, Government College for Women
Chinthamani, Chikkaballapur, Karnataka, India

M. R. Delvi
Department of Zoology, Government College for Women
Chinthamani, Chikkaballapur, Karnataka, India

Abstract
Human activity has continuously concerned the natural environment, particularly the aquatic ecosystems. The use of heavy metals in the industry has led to general environmental contamination. Some of these compounds are the object of study because of their toxicity and ubiquity. Moreover, they are known to remain stable in the aquatic environment. Trace metals are regarded as serious pollutants of the aquatic environment because of their toxicity, persistence, non-biodegradability and tendency to accumulate in aquatic organisms. A chemical can build up to a potentially harmful level in animal tissues as its bioaccumulation need not elicit a biological response. In the present investigation, toxicology about aquatic animals has become a key subject in water pollution studies. Accumulation of the heavy metals like Zn, Fe, Ni, Pb, Cd and Cu in the gut-free body, liver and gills of three species of the fish, Notopterus monopteros, Oreochromis mossambicus and Mystus vittatus, inhabiting the Bellandur lake, Bangalore was observed. The results showed that these metals were common throughout the study area, but the metal concentrations in the water samples were below the detection levels (BDL). Accumulation of Zn, Fe, Ni, Pb, Cd and Cu was determined in fish tissues (whole fish, liver and gill) and it was found to have reached a biologically magnified level in fish tissues. Interestingly, the metal concentration levels in fish tissue samples were elevated than those of water.

Keywords: Bellandur lake, Heavy metals, liver, Gills N. monopteros, O.mossambicus, M. vittatus.

Introduction

Surface water contamination is caused by industrial effluent discharges, pollutant deposition in the atmosphere, and occasionally unintentional spills of toxic chemicals (Canli et al., 1998; Samanta et al., 2005). Because of their toxicity, persistence, non-biodegradability, and tendency to accumulate in aquatic life, trace metals are known major contaminants of the aquatic environment.

The use of live organisms as pollution biomonitors in aquatic habitats has sparked much interest (Kress et al., 1999; Nwani et al., 2010). Heavy metal pollution has been discovered in numerous industrial sites. The non-biodegradable nature of heavy metals in soils necessitates limiting their escape into the natural environment. After iron, zinc is the second most important trace element in the body, playing a role in the biological functions of various proteins and enzymes. Despite its importance as a trace element, zinc is one of the most poisonous heavy metals to most species in specific quantities and for long periods (Radhakrishnan et al., 2007).

Lead, unlike zinc, is not recognized to play an important role in living organisms, but its hazardous potential is uncommon. However, little is known about the regulation of Pb and Zn intracellular levels in aquatic flora and fauna.

Metals enter aquatic systems due to weathering of rocks and soils, as well as human acts such as mining, where the processing and use of metals for industry contribute to metals entering the aquatic environment (Gutenmann et al., 1988 and Bu-Olayan and Thomas, 2008). Metallic cations such as copper, zinc, and iron are required for fish metabolism, whereas mercury, cadmium, and lead have no recognized biological function. The required metals must be picked up from water, food, or deposited for fish to function normally. Non-essential metals are also taken up by fish from such sources, and they accumulate in their tissues in the same way as essential metals are (Canli et al., 1998). Because they operate as sinks for metals, which accumulate in sediments, aquatic systems are particularly vulnerable to metal pollution. Heavy metals may become bioavailable under specific ecological conditions.

The natural environment, particularly aquatic ecosystems, has been constantly affected by human activity. The widespread poisoning of the environment has resulted from heavy metals in industry. Because of their toxicity and ubiquity, some of these compounds are being studied, and they are also known to be stable in the aquatic environment (Amundsen 1997, Canli et al., 1998; Samanta et al., 2005, Radhakrishnan et al., 2007). This study aims to determine the amounts of accumulation of various heavy metals such as Zn, Fe, Ni, Pb, Cd, and Cu in the Bellandur lake and the fish fauna that inhabit it.

Materials and Methods

The largest lake in Bengaluru is Bellandur Lake, located in the city's southeast. During the British administration, it was utilized to park amphibious aircraft. It is a part of the Bellandur drainage system, which drains the city's southern and south-eastern areas. The lake has around 148 square kilometers and is fed by three chains of lakes upstream (37,000 acres). This lake's water travels east to Varthur Lake, down the plateau and into the Pinakani basin. The three most frequent fish species in Bellandur Lake, Oreochromis mossambicus, Notopterus monopteros, and Mystus vittatus, consumed by locals, were chosen for this study. The fish fauna was taken to a laboratory for further examination. They were processed in four hours from the time they were collected.

Their size, weight, and opercula movement were all taken into account right immediately. The fresh weight of the complete fish (excluding the gut), gills, and liver were measured. After three weeks of drying samples in the sun, their dry weight was reported. All samples were then oven-dried until they attained a consistent weight. Then, using porcelain mortar and pestles, they were pounded into powder. After the entire digestion of the fish, metal extraction was performed. Using an Atomic Absorption Spectrophotometer, the digested sample was filtered, and the filtrate was utilized to estimate heavy metals. The results were represented in milligrams per gram of dry weight. To prevent inaccuracies caused by changing moisture levels in soft tissues, the results were given on a dry weight basis (Adrian and Stevens, 1979). Water samples for heavy metal analysis were taken from the same place where the fish fauna was collected. The water samples were filtered and acidified using atomic absorption spectrophotometer analytical techniques (Mathis and Cummings, 1973). The effluents not contained within the research were analyzed for heavy metals using the methods described in the APHA (1995).

Results and Discussions

Heavy Metal Analysis of Bellandur Lake

Table 1 shows the metal concentrations of Fe, Ni, Zn, and Pb in Bellandur Lake, having concentrations ranging from 0.141 0.03 to 0.489 0.21, 0.002 0.01 to 0.138 0.11, 0.013 0.01 to 0.04 0.01,0.010 0.01 to 0.019 0.01 mg/L, respectively. The Cd content was below the detection limit. The following was the accumulation order in the water sample: Fe>Ni>Zn>Pb. Cu and Cd levels accumulated too, though, but they have been considerably below the detectable range. The findings were consistent with Munshi et al. (1998) and Kress et al. (1999), who discovered heavy metals in Subernarekha. Ayaz Zafar et al. (2007) and Nawani et al. (2010) obtained similar results in the water of Nallihan Bird Paradise and Afikpo, Nigeria, where heavy metals including Pb, Cd, Cu, and Ni were below the detection limit.

As an outcome, they determined that contamination by heavy metals in the Nallihan Bird Paradise and reservoir did not affect human health but did impact aquatic life and animals. Though the concentration of heavy metals in Bellandur Lake water was identical to that found by the past study, it was more in the fish samples used in this study.

Heavy Metal Analysis in the Fish Sample

Notopterus Notopterus

The heavy metal accumulation in fish was higher than that in water. The amount of Fe in the whole fish (except gut) was highest at 0.142 ± 0.02 mg/g dry weight followed by 0.044 ± 0.02 mg/g Zn, 0.029 ± 0.01 mg/g Ni, 0.004 ± 0.01 mg/g Cu and 0.002 ± 0.01mg/g Pb. The level of heavy metals amount of Fe in liver was 0.901 ± 0.43 mg/g Fe, 0.189 ± 0.07 mg/g Zn, 0.146 ± 0.03 mg/g Ni, 0.056 ± 0.01 mg/g Cu, 0.019 ±0.01 mg/g Cd and 0.013 ± 0.01 mg/g Pb. The quantity of heavy metals in gill was 0.226 ± 0.05 mg/g Fe, 0.101 ± 0.04 mg/g Zn, 0.073 ± 0.01 mg/g Ni, 0.020± 0.01 mg/g Pb and 0.008 ± 0.01 mg/g Cu. Among different organs of N.notopterus, iron level was highest and copper level was the lowest (Table 2). The concentration of the heavy metals was in the following order: Fe>Zn>Ni>Pb. In the whole body, Fe>Zn>Ni>Cu>Cd>Pb in liver and Fe>Ni>Pb>Cu in gills (Fig 1).

Oreochromis Mossambicus

Heavy metal deposition was greater in O. mossambicus than in water. Fe was detected in the greatest concentration in whole fish (except the stomach), at 0.122 0.02 mg/g, followed by 0.051 0.02 mg/g Zn, 0.024 0.024 mg/g Ni, 0.005 0.01 mg/g Cu, and 0.002 mg/g Pb. The Cd concentration was below the detection threshold. Heavy metal concentrations in the liver were 0.489 0.19 mg/g Fe, 0.309 0.04 mg/g Ni, 0.169 0.02 mg/g Zn, 0.103 0.06 mg/g Cu, 0.037 0.037 mg/g Pb, and 0.018 0.01 mg/g Cd, respectively. Heavy metal concentrations in the gills were determined to be 0.287 0.03 mg/g Fe, 0.112 0.03 mg/g Zn, 0.051 0.01 mg/g Pb, 0.051 0.01 mg/g Ni, and 0.013 0.01 mg/g Cu, respectively. The Cd level in the liver was below the detection limit, as observed (Table 2). The following is the order wherein heavy metal concentrations were found in whole fish (excluding the gut): Fe>Zn>Ni>Cu>Pb. In the liver, it was Fe>Ni>Zn >Cu>Pb>Cd, and in the gills, it was Fe>Zn>Pb>>Ni> Cu (Fig 2.)

Mystus Vittatus

Heavy metal concentrations in M.vittatus were higher than in water. Fe concentrations in entire fish (excluding stomach) were highest (0.069 0.03 mg/g), followed in 0.047 0.02 mg/g Zn, 0.014 0.01 mg/g Ni, 0.003 0.01 mg/g Pb, and 0.001 0.01 mg/g Cu, with Cd concentrations below the detection limit. Heavy metal concentrations in the liver were 0.906 0.51 mg/g Fe, 0.161 0.03 mg/g Pb, 0.153 0.06 mg/g Zn, 0.091 0.01 mg/g Ni, 0.047 0.01 mg/g Cu, whereas in the gills they were 0.713 0.11 mg/g Fe, 0.233 0.08 mg/g Zn, 0.173 0.02 mg/g Ni, 0.02 0.01 mg/g Pb, and 0.012 0. The Cd levels in the liver was below the detection limit. In entire fish (excluding the gut) the heavy metal levels follows the order Zn>Fe>Zn>Ni>Pb>Cu> in the liver. Fe>Pb>Zn>Ni>Cu, and Fe>Zn>Ni>Pb>Cu in the gills (Table 2 and Fig.3)

The accumulation of heavy metals in selected fish species' total fish (excluding stomach) revealed that their concentrations were higher than those in water. N.notopterus had the greatest Fe concentration, followed by O.mossambicus and M.vittatus. O.mossambicus had the greatest Zn content, whereas N.notopterus had the lowest. Ni was accumulated in these fish species in the following order: N.notopterus >O.mossambicus >M.vittatus. Cu levels ranged as follows: O.mossambicus >N. notopterus >M.vittatus, with M.vittatus scoring highest and N. notopterus scoring lowest.

Metal absorption in fish occurs primarily through the liver. The induction of metallothioneins and the subsequent synthesis and binding of metals to the protein occurs when heavy metals are present. Fe levels were highest in fish liver samples, as seen in Table 2. O.mossambicus had the highest concentration at 0.489 0.019 mg/g, while M.vittatus had the lowest at 0.906 0.51 mg/g. Zn concentrations in fish liver samples ranged from 0.153 0.06 mg/g in M.vittatus to 0.189 0.07 mg/g in N.notopterus, with Ni concentrations ranging from 0.091 0.01 mg/g in

M.vittatus to 0.309 0.04 mg/g in O. mossambicus, and Pb concentrations in fish liver samples ranging from 0.013 0.01 mg/g in N.notopterus to 0.161 0.03mg/g in M.vittatus. The Cd level in O. mossambicus ranged from 0.018 0.01 mg/g to 0.019 0.01 mg/g in N.notopterus, while it was below the detection limit in M. vittatus.

Heavy metal Fe was 0.226 0.05 mg/g in N.notopterus gills and 0.713 0.11 mg/g in M.vittatus, as shown in Fig.1–3. Ni concentrations in O. mossabmbicus range from 0.051 0.01 mg/g to 0.171 0.02 mg/g in M.vittatus. N.notopterus had a Pb record of 0.020 0.01 mg/g, while O.mossambicus had a Pb record of 0.051 0.01 mg/g. Cu levels in N.notopterus range from 0.008 0.01 mg/g to 0.013 0.01 mg/g in O. mossambicus. Heavy metal Fe was detected in abundance in the gills of freshwater fish species, as was heavy metal Cd, which was not found in the gill organs of fish samples (Arunkumar and Achyuthan, 2007). Heavy metal accumulation is primarily seen in the liver tissues of fish species, according to several studies. Heavy metals are absorbed directly from the water via fish's gills, as well as indirectly from the diet (Barron, 1990 Nwani et al., 2010). Although negligible concentrations of metals were observed in the water, some metal deposition was found in the liver retrieved from the Bellandur lake in this study. Heavy metal accumulation was higher in N. notopterus than in the other fish species. Cu, Fe, Zn, Pb, and Ni concentrations in muscle tissue were higher than in water. This is most likely owing to metabolic activities, feeding practices, ecological needs, living modes, and the heavy metals' distinct aquatic geochemistry. Several other fish species showed similar results (Davies et al., 2006; Demirak et al., 2006).

Low Cu levels also were discovered in the fish muscle by Kress et al. (1999). Fe is a metal that helps aquatic organisms carry oxygen (Bajc et al., 2005). Zn is a vital trace metal for all living creatures. It is required for nucleic acid production and is found in various enzymes. Hemocyanin synthesis, oxygen transport, and a good indication of urban wastewater discharge are all aided by copper (Carvalho et al., 2000; Bu-Olayan and Thomas, 2008). Copper and zinc, on the other hand, are considered possible dangers that can harm both animal and human health. It is thus critical to be aware of their amounts in fish for both ecosystem management and human consumption (Yilmaz et al., 2007).

Conclusion

Metal pollution in the Bellandur Lake area is not at a level that directly affects health, but it may hurt aquatic life. The heavy metals concentrations in the water of the and accumulated in fishes, according to the findings. It should be remarked that the N. monopteros, O. mossambicus and M. vittatus inhabiting the Bellandur Lake are endemic fish species and have special importance in means of biodiversity. Pollution levels in water supplies that discharge into the have the potential to harm birds and wildlife in the area.

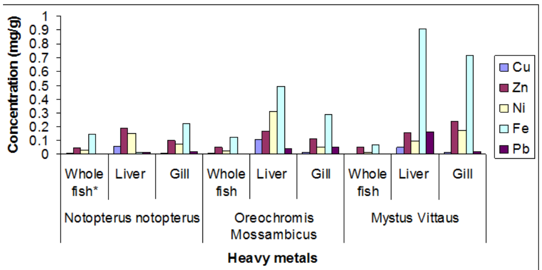

Fig.1: Average concebtration of heavy metals in freshwater fishes (mg/g of dry weight)

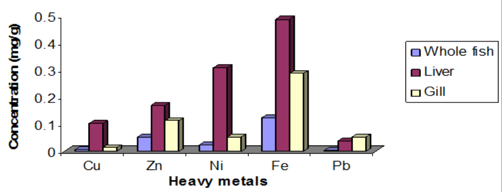

Fig. 2 Average concentration of heavy metals in *Oreochromis mossambicus* (mg/g of dry weight)

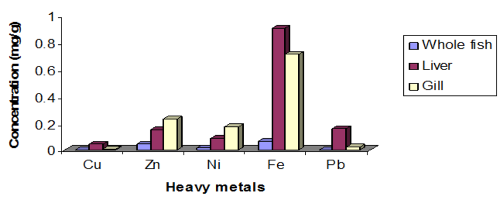

Fig.3 Average concentration of heavy metals in *Mystus vittatus* (mg/g of dry weight)

Table 1: The Concentration of Heavy Metals (ppm) was Determined in the Bellandur Lake Water (Mean ± SE)

Heavy metals	A			B			C		
	*W.S.(1)	W.S(2)	W.S.(3)	W.S.(1)	W.S.(2)	W.S.(3)	W.S.(1)	W.S.(2	W.S.(3)
Cu	BDL**	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Zn	BDL	BDL	BDL	0.013 ± 0.01	0.04 ± 0.01	BDL	0.013 ± 0.01	0.04 ± 0.01	BDL
Ni	0.136 ± 0.04	0.065 ± 0.01	BDL	BDL	0.023 ± 0.01	0.002 ± 0.01	0.138 ± 0.11	0.065 ± 0.01	BDL
Fe	0.489 ± 0.21	0.216 ± 0.05	0.281 ± 0.04	0.141 ± 0.03	0.316 ± 0.16	0.216 ± 00.10	0.448 ± 0.17	0.328 ± 0.41	0.302 ± 0.21
Pb	0.015 ± 0.01	0.010 ± 0.01	0.012 ± 0.01	0.019 ± 0.01	0.017 ± 0.03	BDL	0.017 ± 0.01	0.014 ± 0.01	0.011± 0.01
Cd	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

*W.S=Water Sample, **BDL = Below Detection Limit

Table 2: The Average Concentration of Heavy Metals (mg/g of Dry Weight) in Fish Samples (Mean ± SE)

Heavy metals	Notopterusnotopterus			Oreochromismossambicus			Mystusvittatus		
	Whole fish*	Liver	Gill	Whole fish	Liver	Gill	Whole fish	Liver	Gill
Cu	0.004 ± 0.01	0.056 ± 0.01	0.008 ± 0.01	0.005 ± 0.01	0.103 ± 0.06	0.013 ± 0.01	0.001 ± 0.01	0.047 ± 0.01	0.012 ± 0.01
Zn	0.044 ± 0.02	0.189 ± 0.07	0.101 ± 0.04	0.051 ± 0.02	0.169 ± 0.02	0.112 ± 0.03	0.047 ± 0.02	0.153 ± 0.06	0.233 ± 0.08
Ni	0.029 ± 0.01	0.146 ± 0.03	0.073 ± 0.01	0.024 ± 0.01	0.309 ± 0.04	0.051 ± 0.01	0.014 ± 0.01	0.091 ± 0.01	0.171 ± 0.02
Fe	0.142 ± 0.22	0.013 ± 0.43	0.226 ± 0.05	0.122 ± 0.02	0.489 ± 0.19	0.287 ± 0.03	0.069 ± 0.03	0.906 ± 0.51	0.713 ± 0.11
Pb	0.002 ± 0.01	0.013 ± 0.01	0.020 ± 0.01	0.002 ± 0.01	0.037 ± 0.01	0.051± 0.01	0.003 ± 0.01	0.161 ± 0.03	0.020 ± 0.01
Cd	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

*whole Fish(except gut) ** BDL =Below Detection Limit.

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Department of Zoology, Government College for women, Chinthamani, Chikkaballapur, - 563125, Karnataka, India.

References

Adrian, William J., and Mitchell L. Stevens. "Wet versus Dry Weights for Heavy Metal Toxicity Determinations in Duck Liver." *Journal of Wildlife Diseases*, vol. 15, no. 1, 1979, pp. 125-26.

Amundsen, P.A., et al. "Heavy Metal Contamination in Freshwater Fish from the Border Region between Norway and Russia." *The science of the Total Environment,* vol. 201, 1997, pp. 211-44.

APHA. *Standard Methods for the Examination of Water and Waste Water*. APHA, 1995.

Arunkumar, K., and Hema Achyuthan. "Heavy Metal Accumulation in Certain Marine Animals along the East Coast of Chennai, Tamil Nadu, India." *Journal of Environmental Biology*, vol. 28, no. 3, 2007, pp. 637-43.

Ayaz, Zafar, et al. "Heavy Metal Accumulation in Water, Sediments and Fishes of Nallihan Bird Paradise, Turkey." *Journal of Environmental Biology*, vol. 28, no. 3, 2007, pp. 545-49.

Bajc, Zlatka, et al. "The Contents of Cu, Zn, Fe and Mn in Slovenian Freshwater Fish." *Slovenian Veterinary Research*, vol. 42, 2005, pp. 15-21.

Barron, Mace G. "Bioconcentration. Will Water-borne Organic Chemicals Accumulate in

Aquatic Animals." *Environmental Science and Technology*, vol. 24, no. 11, 1990, pp. 1612-18.

Bu-Olayan, A.H., and B.V. Thomas. "Trace Metals Toxicity and Bioaccumulation in Mudskipper *Periophthalmus waltoni* Koumans 1941 (Gobiidae: Perciformes)." *Turkish Journal of Fisheries and Aquatic Sciences*, vol. 8, 2008, pp. 215-18.

Canli, M., et al. "Levels of Heavy Metals (Cd, Pb, Cu, Cr, and Ni) in Tissue of *Cyprinus carpio*, *Barbus capito* and *Chondrostoma regium* from the Seyhan, Turkey." *Turkish Journal of Zoology*, vol. 22, 1998, pp. 149-57.

de Carvalho, G.P., et al. "Preliminary Assessment of Heavy Metal Levels in Mytella Falcate (Bivalvia, Mytilidae) from Bacanga River estuary, Sao Luis, State of Maranhao, Notheastern Brazil." *Revista Brasileira de Biologia*, vol. 60, 2000, pp. 11-16.

Davies, O.A., et al. "Bioaccumulation of Heavy Metals in Water, Sediment and Periwinkle (Tympanotonus fustacus var radula) from the Elechi Creek, Niger Delta." *African Journal of Biotechnology*, vol. 5, no. 10, 2006, pp. 968-73.

Demirak, Ahmet, et al. "Heavy Metals in Water, Sediment and Tissues of *Leuciscus cephalus* from a Stream in Southwestern Turkey." *Chemosphere*, vol. 63, no. 9, 2006, pp. 1451-58.

Forstner, Ulrich,and Gottfried T.W. Wittman. *Metal Pollution in the Aquatic Environment*. Springer, 1981.

Karadede, H., and E. Unlu. "Concentrations of Some Heavy Metals in Water, Sediment and Fish Species from the Ataturk Dam Lake (Euphrates), Turkey." *Chemospehere*, vol. 41, 2000, pp. 1371-76.

Kress, Nurit, et al. "Trace Element Levels in Fish from Clean and Polluted Coastal Marine Sites in the Mediterranean Sea, Red Sea and North Sea." *Helgoland Marine Research*, vol. 53, 1999, pp. 163-70.

Mathis, B.J., and T.F. Cummings. "Selected Metals in Sediments Water and Biota in the Illinois River." *Journal - Water Pollution Control Federation*, vol. 45, 1973, pp. 1573-83.

Nwani, C.D., et al. "Heavy Metals in Fish Species from Lotic Freshwater Ecosystem at Afikpo, Nigeria." *Journal of Environmental Biology*, vol. 31, no. 5, 2010, pp. 595-601.

Ozdilek, Hassan Goksel, et al. "Distribution of Heavy Metals in Vegetation Surrounding the Blackstone River, USA: Considerations regarding Sediment Contamination and Long Term Metals Transport in Freshwater Riverline Ecosystems." *Journal of Environmental Biology*, vol. 28, 2007, pp. 493-502.

Radhakrishnan, R., et al. "A Comparative Study on the Physic Chemical and Bacterial Analysis of Drinking, Borewell and Sewage Water in the Three Different Places of Sivakasi." *Journal of Environmental Biology*, vol. 28, no. 1, 2007, pp. 105-08.

Samantha, S., et al. "Heavy Metals in Water of the rivers Hooghly and Haldi at Haldia and their Impact on Fish." *Journal of Environmental Biology*, vol. 26, no. 3, 2005, pp. 517-23.

Sindhe, V.R., and R.S. Kulkarni. "Fecundity of the Freshwater Fish, Notopterus notopterus (Pallas) in Natural and Heavy Metal Contaminated Water." *Journal of Environmental Biology*, vol. 26, no. 2, 2005, pp. 287-90.

Yigit, Sibel, and Ahmet Altindag. "Concentration of Heavy Metals in the Food Web of Lake Egirdir, Turkey." *Journal of Environmental Biology*, vol. 27, no. 3, 2006, pp. 475-78.

Yilmaz, Ayse Bahar. "Levels of Heavy metals (Fe, Cu, Ni, Cr, Pb and Zn) in tissue of Mugil cephalus and Trachurus mediterraneus from Iskenderun Bay, Turkey." *Environmental Research*, vol. 92, no. 3, 2003, pp. 227-81.

Yilmaz, Fevzi, et al. "Heavy Metal Levels in Two Fish Species Leuciscus cephalus and Lepomis gibbbosus." *Food Chemistry*, vol. 100, no. 2, 2007, pp. 830-35.

Author Details

S. Muniraju, *Department of Zoology, Government College for Women, Chinthamani, Chikkaballapur, Karnataka, India,* ***Email ID****: Drmunirajusanju@gmail.com*

M. R. Delvi, *Department of Zoology, Government College for Women, Chinthamani, Chikkaballapur, Karnataka, India*.