OPEN ACCESS

Manuscript ID:
ASH-2023-10046132

Volume: 10

Issue: 4

Month: April

Year: 2023

P-ISSN: 2321-788X

E-ISSN: 2582-0397

Received: 12.01.2023

Accepted: 22.03.2023

Published: 01.04.2023

Citation:
Venkataramana, GV, and PN Sandhya Rani. "Heavy Metal Concentrations in Certain Edible Freshwater Fishes and Sediments from Kapila River in Mysore District, Karnataka." *Shanlax International Journal of Arts Science and Humanities*, vol. 10, no. 4, 2023, pp. 29–38.

DOI:
https://doi.org/10.34293/sijash.v10i4.6132

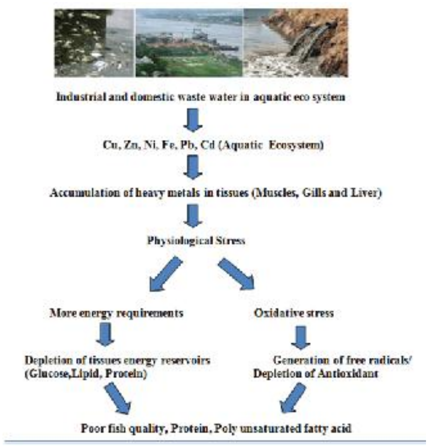
Heavy Metal Concentrations in Certain Edible Freshwater Fishes and Sediments from Kapila River in Mysore District, Karnataka

G.V. Venkataramana
Professor, Department of Studies in Environmental Science,
University of Mysore, Manasagangotri, Mysore, Karnataka, India
https://orcid.org/0000-0003-4967-4500

P.N. Sandhya Rani
Department of Studies in Zoology, Bangalore University
Bangalore, Karnataka, India

Abstract
Aim: *Three species of fish, Notoptrus notoptrus, Channa punctatus and Glossogobius giuris, were shown to accumulate heavy metals like Zn,Fe,Ni,Pb,Cd, and Cu in their gut-free bodies, liver, and gills.*
Methodology: *These fish inhabit the Kapila River in the Nanjangud area of the Mysore district.*
Result: *Fish tissues (muscle, gills and liver) and sediments were found to contain Fe, Pb, Ni, Zn and Cu pollution. It was also determined that these pollutants had accumulated and been physiologically amplified in fish tissues. Sediment samples had greater metal concentrations than water samples or fish tissue samples. The outcome showed that although these metals were present in large quantities throughout the research area, their amounts in the water samples were below detection level (BDL).*
Interpretation: *According to estimates, the liver and gills accumulated heavy metals in the following order: Fe > Ni > Cu > Pb > Zn and Fe > Pb > Ni > Zn > Cu. Accordingly, Fe occurred before Pb, followed by Ni, Zn and then Cu in the case of whole fish tissues. In comparison to other heavy metals, iron and lead contents in C. punctatus tissues were deliberately elevated. Fish are negatively impacted by heavy metal accumulation in freshwater since they are the primary consumers of aquatic systems. For the most part, people in those regions where fish is the primary food are influenced by the consumption of fish as well.*
Keywords: Heavy Metals, Sediment, Fish, Kapila River, N. Notoptrus, C. Punctatus and G. Giuris

Graphical Abstract



Pollution poses risks to both the environment, animal life and the world's expanding population. Rapid industrialization and urbanisation have increased the amount of pollutants such radionuclides, radioactive materials, and different kinds of organic and inorganic materials, metals that are released into the environment, the primary source of metal pollution for aquatic creatures is industrial waste. According to some sources, heavy metals are the main environmental contaminants. Because they are concentrated in mineral organic compounds and cannot be removed from aquatic systems naturally, like organic contaminants, heavy metals are significant pollutants for fish. The result is a degradation of the agricultural fields as well. The health dangers to various creatures have increased as a result of the uncontrolled discharge of industrial effluents (Praveena et al., 2013). The natural world has been continuously impacted by human activity, especially aquatic environments. Heavy metal and organ chlorine pesticide use in industries has cause extensive environmental damage. Due to their toxicity, ubiquity and knowledge of remaining stable in aquatic environments, some of these chemicals are the subject of research (Fernandez et al., 1992; Ayas and Kolankaya, 1996; Heiny and Tate, 1997; Sharma et al., 2005; Singh and Singh, 2006). According to past study that was primarily focused on the water and sediment in the Kapila river, the aquatic ecosystem has significantly deteriorated in recent decades as a result of heavy metal contamination from industrial and agricultural operations.

The Kabini river is lying in a long, narrow, surrounded mainly by bare land, small villages and limited agricultural areas due to its topography and soil characteristics. The fishery established in the river has a great importance for the economic well being of locals and in addition, the river water is being used for irrigation of the nearby agricultural areas. This Kabini river receives various kinds of pollutants, including domestic and industrial effluents from the settlements located along the upstream of the river. Therefore, there has been continuous flow of pollutants into the river and pollution in these water systems became significant during the last two decades. However, there is a dearth of information regarding the occurrence of heavy metal contamination in fish from the Kapila river. For the purpose of heavy metal research, three fish species C. punctatus, N. notopterus, and G. giuris were taken from the study region. We looked studied how the heavy metals Fe, Ni, Zn, Cu, and Pb were distributed and accumulated in different fish species. Although domestic and to a lesser extent industrial wastewater discharges have been worked on by several studies, there are only a few studies in the belt of Kabini river (Ekmekci and Erkakan, 1989; Ekmekci et al., 2000). This study aims to determine the extent of heavy metal contamination of the aquatic ecosystem covering the Kabini river belt (Nanjanagudu industrial area to T.Narisipura). The main objective was to obtain basic and simple information permitting, a better understanding of environmental impact of some heavy metals used in the basin. This information would be a useful tool for effective management and control of the natural area with respect to input of some metals that are carried and their bioavailability on aquatic animals through food chain.

Materials and methods

Kerala is the birthplace of the Kapila River. It passes through Nanjangud, merges with the Cauvery at T. Narasipura (Myosre District), flows through Shivanasamudram (Bluff), and finally reaches Mettur Dam in Tamil Nadu. All year long, the river Kapila provides ample water for domestic, commercial, and industrial applications. The location of the fish species sampling is depicted in Fig. 1.

The Kabini River runs through Nanjangud (12.12°N 76.68°E). The taluk is bordered to the north by Mysore, the east by T. Narsipur, the west by H D Kote, and the south by Gundlupet and Chamarajanagar, 534-acre radius known as Nanjangud industrial area (2.16 km2). In 1978, industries with a 3000-person workforce under the name Sujatha Textile Mills (STM) began to sprout in Nanjangud. According to the National Investigation Agency (NIA), there are currently 36 big enterprises, 12 medium-sized industries, and 35 small-scale units. Nanjangud was the second-highest tax-paying taluk in the State after Bangalore, collecting over Rs 400 crore in sales tax annually. Samples were collected at the three locations shown on Fig.1

as Bannari amman sugar limited, rikanteshwara temple and Kapilla river bridge stations. The Kabini River, a tributary of the Kaveri River, rises from the Kabini Dam, which was built in 1974 and provides drinking water and irrigation for 22 villages and 14 hamlets at latitudes of 11.97°N and 76.35°E. The primary project is the KRS Hydro Electricity Plant in the Heggadadevanakote village near Beechanahalli. Both the Madhavmantri Mini Hydel Station (Bhoruka Power Corp Ltd) and the Cauvery Hydro Energy Limited Hydroelectric Power Plant are small-scale electricity generating plants that are successfully supplying electricity to the area. The Kabini joins Kaveri a major river of the highest order at Tirumakudalu Narasipura (T.Narasipura, 12.21° N, 76.91° E). On the Mysuru-Nanjangud Road, the Kabini River near Mallanamoole Mutt is typically closed to traffic. A kilometer-long section of the road was submerged in floodwaters. The entire width of the Kabini River is surrounded by more than 20 temples, 14 bridges, and numerous companies for metal, furniture, pharmaceuticals, leather, and oil (Mahesh, 2021). Based on this sample, sample locations are determined and samples are collected for investigations. These businesses naturally produce pollution, which includes heavy metals, microplastics, hazardous chemicals, etc., which accumulates and enters the food chain.

Sample Collection, Storage and Analyses

Water: Seasonal water samples were taken throughout 2018 and 2019 (summer and autumn in 2018, winter and spring in 2019). Every year, seasonal sampling of the water and sediment was done from the summer to the fall, and (winter - spring). Water samples were taken at a depth of 0.1 m, placed in glass bottles, cleansed with distilled water beforehand, and then acidified with concentrated nitric acid to a pH of less than 2.0. These glass bottles were then kept at 4 0C until the analyses were performed. All water samples were delivered to the lab immediately, filtered through 0.45 m millipore filters, and acidified to a pH of less than 2.0 using pure nitric acid (1:1 vlv) per litre. Analysis was done in accordance with APHA, 1995.

Sediments: Ekman grab was used to collect sediment samples from the top 10 cm of the bottom layer. Separate acid-soaked clean plastic packets containing each sediment core were used to transport them to the lab. The sediment samples were dried in the lab at 105 0C to a consistent weight, crushed and the fraction that passed through a BS20 sieve was stored at

20 0C in polyethylene packets that had been cleaned and bathed in acid. Analysis was done in accordance with APHA, 1995.

Fishes: Three fish species; Notoptrus notoptrus, Channa punctatus, and Glossogobius giuris, Due to the different niches and environmental preferences of these species, they were chosen (Ekmekci et al., 2000). Fish samples from the river, collected using gill nets, were donated by the neighbourhood fishermen. As far as possible, fish samples were chosen from the same age group. The fish were anaesthetized in Tricaine methanesulfonate (MS222) containing plastic gallon and these samples were moved to laboratory in ice-boxes. Fish samples were dried to a consistent weight at 102 °C. Fish were peeled of their exoskeletons, had their muscle, gills and liver sliced into bits and then were kept at 20 °C in polyethylene packets.

At the Institution of Excellence, University of Mysore, atomic absorption spectrophotometer measurements of metal concentrations in all samples were performed. Wavelengths for Pb were found to be 283.3 nm, Ni to be 232.0 nm, Cd to be 222.8 nm, and Cu to be 365.4 nm. For each metal, the least concentration at which it could be identified was 0.02 ppm. Standard solutions were used for the calibration. Recovery tests and repeated analysis of the subsamples of the standards were used to verify the precision and accuracy of the determination. To prevent inaccuracies brought on by changing amounts of moisture in soft tissues, results were reported on a dry-weight basis (Adrian and Stevens, 1979). Geometric means were presented for residue data values, while values below detection limits were designated as “BDL” on the tables.

Analyses of variance (ANOVA) were used to statistically examine the metal concentrations found in fish tissue, sediment, and water samples. The data for the metal concentrations found in fish tissue and sediments were adjusted.

Results and Discussions

Heavy metal analysis of Kapila River

Table 1 provides information on the metal concentrations of Fe, Ni, Zn, and Pb in Kapila, with values ranging from 0.181 to 0.548, 0.044 to 0.181, 0.014 to 0.302, and 0.017 to 0.211 mg/L, respectively. The Cd was below the threshold for detection. Fe was accumulated in the water sample before Ni, Zn, and Pb. Although Cu and Cd levels also accumulated, they were much lower than the detection threshold. The outcomes agreed with those of Munshi et al. (1998) and Kress et al., (1999), who discovered the presence of heavy metals in the Subernarekha river. Similar results were also discovered by Ayaz Zafar et al., (2007) in the water of Nallihan Bird Paradise, where heavy metals such as Pb, Cd, Cu, and Ni were below the detection limit. As a result, they came to the conclusion that although the metal pollution in the Nallihan Bird Paradise and reservoir has not reached the point where it may have an impact on human health, it does have an impact on the aquatic life and other nearby wildlife. Although the concentration of heavy metals found in the water of the Kapila River was comparable to that found by the aforementioned researchers, it was much higher in the fish samples used in the current analysis.

Concentration of Heavy Metals in Sediments from Different Sampling Stations

Metal concentration in water, sediments samples are shown in Table 1 and 3. Metal concentration of the water samples were found to be below the detection limits (BDL). Fe, Pb, Zn, Cd, Cu and Ni contamination were determined in sediments and fish samples and the levels of heavy metals in fishes were found to be higher than that of both, sediments and water.In sediment samples, the highest metal concentration was found in Bannari amman sugar limited followed by Srikanteshwara temple and Kapilla river bridge station. The highest value for Fe, Ni, Pb and Zn in sediments were in the station located in Bannari amman sugar limited station. These concentrations decrease at the point where Kapilla river bridge leaves the river towards T. Narisipura. Cd and Cu was not found in water or sediment samples in any of the stations, but it was detected in the liver tissue of the all the three fish species samples that was caught in the sampling stations.

The sediment analysis indicated that metals transported to the river were dispersed in the river depending on the flow direction. In addition, metals were settled and accumulated in the sediments especially at Bannari amman sugar limited followed by Srikanteshwara temple and Kapilla river bridge station, where the water is comparatively deep. Since more than 50% of the total metals present (and up to 99.9%) in water are usually adsorbed onto suspended particles (Chapman, 1992), heavy metal residues were detected in sediment samples, but not in water samples. The sediments of Kapilla River, just before flowing into the T. Narisipura have higher Fe, Pb and Ni residue levels than the other stations in our study area. There is very poor vegetation along the river and erosion is another important factor for increased sedimentation. Erosion subsequently transfers the sediments or soil particles from their point of origin into freshwater systems. As it was stated by Chapman (1992), sediments may then be re-suspended and transported further until it comes to its ultimate resting point or sink where active sediment accumulation occurs. Transportation occurs as a direct function of water movement.

Heavy Metal Analysis in Fish Sample

Notopterus

It was observed that fish accumulate more heavy metals than water. The whole fish had the highest concentration of Fe (excluding the intestines) at 0.242 ± 0.62 mg/g Zn 0.088 ± 0.23 mg/g, 0.014±0.21 Cu and 0.022 ± 0.22 mg/g Pb. The metal concentrations in the liver were 0.113 ± 0.48 mg/g Fe, 0.289 ± 0.47 mg/g Zn, 0.184 ± 0.22 mg/g Ni, 0.056 ± 0.51 mg/g Cu, 0.123 ±0.21 mg/g Pb, whereas the concentrations in the gills were 0.326 ± 0.45 mg/g Fe, 0.201 ± 0.04 mg/g Zn, 0.273± 0.21 mg/g Ni, 0.120 ± 0.35 mg/g Pb and 0.238 ± 0.41 mg/g Cu (Table 2). The concentration of the heavy metals was in the following order in the various organs of N. notoptrus: Fe>Ni>Cu >Zn>Pb in the gills; Fe>Zn>Ni> Pb> Cu in the body as a whole, with the exception of the gut; and Zn>Ni>Pb>Fe>Cu in the liver. The iron level was highest, and the lead and copper levels were lowest (Fig. 2).

Channa Punctatus

In comparison to water, C. punctatus accumulated more heavy metal. Fe concentrations in entire fish (excluding the stomach) ranged from 0.262-0.02 mg/g, with 0.164-0.21 mg/g Ni, 0.125-0.021 mg/g Cu, 0.091-0.02 mg/g Zn, and 0.032-mg/g Pb following. The level of Cd was below the limit of detection. The concentration of each metal in the liver was as follows: 0.489 0.18 mg/g Fe, 0.309 0.94 mg/g Ni, 0.169 0.72 mg/g Zn, 0.303 0.76 mg/g Cu, and 0.237 0.81 mg/g Pb. The Cd level was below the detection limit, as shown in the liver (Table 2). With the exception of the stomach, the following heavy metals were present in entire fish at the highest concentrations: Fe> Ni>Cu> Zn>Pb>Pb; Fe> >Zn>Pb>Cu>Ni in the gills; Fe> >Ni >Cu>Pb>Zn>Pb in the liver (Fig. 2.)

Glossogobius gGiuris

G. giuris had greater levels of heavy metals than water did. The concentration of Ni in the entire fish (excluding the stomach) was at its highest (0.214±0.03 mg/g), followed by concentrations of Fe (0.169 ± 0.23 mg/g), Zn (0.147 ± 0.62 mg/g), Pb (0.113 ± 0.21 mg/g), and Cu (0.101 ± 0.81 mg/g), with Cd concentrations below the detection threshold. The concentrations of heavy metals in the liver tissue were 0.526 ± 0.59 mg/g Fe, 0.391 ± 0.61 mg/g Ni, 0.261 ± 0.43 mg/g Pb, 0.247 ± 0.41 mg/g Cu, 0.153 ± 0.01 mg/g Zn, whereas in the gills they were 0.423 ± 0.71 mg/g Fe, 0.233 ± 0.28 mg/g Zn, 0.191 ± 0.42 mg/g Ni, 0.320 ± 0.81 mg/g Pb, and 0.112± 0.61 mg/g Cu. The level of Cd was below the detection limit, as seen in liver tissues. With the exception of the gut, the metal levels in entire fish were as follows: Ni > Fe > Zn > Pb > Cu in the liver Fe > Ni > Pb > Cu > Zn (Table 2 and Fig.2).

The accumulation of heavy metals in three different fish species' whole fish (excluding the intestines) revealed that their concentration was significantly higher than that of river and water. N. notoptrus had the highest concentration of Fe, followed by C. punctatus and G. giuris. C. punctatus had the highest level of Zn, whilst N. notopterus had the lowest. These fish species accumulated Ni in the following order: N. Notoptrus prevails over C. Punctatus and G. giuris. The Cu level changed according to: G. giuris received the highest Pb scores, followed by N. notoptrus, and C. punctatus. Fish's liver serves as the primary organ for controlling metals. When heavy metlas is exposed, metallothineins are induced, metlas is produced, and then it binds to the protein. Table 2 shows that the fish liver samples had the highest concentration of Fe. Heavy metal toxicity can have an impact on a fish's individual growth rate, physiological processes, mortality, and reproduction (Ayas et al., 2007 and Ali et al., 2014). Fish bodies can be exposed to heavy metals in three different ways: through the gills, the digestive system, and the body surface. The body surface is typically thought to play a minimal role in the intake of heavy metals in fish, with the gills being the important site for direct uptake of metals from the water.

The food supply may also contribute to heavy metals accumulation, which could then bio-magnify and cause poisons to move up the food chain (Arne et al., 1997 and Sharma et al., 2005). The industrial usage of heavy metals and organochlorine insecticides has resulted in widespread environmental damage. Some of these substances are the subject of research due to their toxicity and widespread use, and they are also known to be stable in aquatic environments (Fernandez et al.,1992; Ayas et al., 2007; and Ali et al., 2014). The Cauvery and Kapila rivers are on places that are both nationally and globally recognised. These significant areas are home to native fish and bird populations that breed there, as well as several endemic fish species like the Gobidae, Clarius, and Channa, among others. Due to its terrain, the Kapila river is located in a long, narrow, and deep valley that is mostly bordered by wet lands, agricultural land, small communities, and a tiny amount of dry ground. After the rainy seasons, the end of the river lands are utilised for vast agriculture, and the fisheries built in the river belt is very important for the economic well-being of the residents.

The Kabini dam was constructed on the Kapila River and collects a variety of pollutants, including agricultural runoff and domestic and industrial effluents from communities along the reservoir's downstream edge. As a result, contaminants have been continuously flowing into the Kapila River, and during the past two decades, pollution in these water systems has significantly increase (Jia et al., 2017).The results revealed that metal accumulation in fish tissues is generally higher than in sediments and water, with the exception of the gut, liver, and gills. In addition, metal accumulation in fish livers was shown to be higher than in gills and muscles. G. giuris liver had the highest level of bioaccumulation among the fish. The degree of accumulation in the fish samples increased from G. giuris to C. puctatus to N. notoptrenus.

Heavy rains in the area convey the pollutants from the heavy industry and agricultural areas to the Kapila river's downstream sections. Arunkumar and Achyuthan (2007) showed that the east cost basins were considerably contaminated with Cd, Pb, Cu, and Ni, and that these heavy metals, particularly Cd and Pb, were deposited in fish. They also found that metal contamination in marine animals and the east coast of Chennai. Similar findings were made, and the amounts of Pb, Cu, Fe, and Zn are especially greater in fish sample sediments and liver tissues. Heavy metal concentrations including Cu, Zn, and Cd were found to be below detection limits in water samples from every location. Due to suspended solids' ability to adsorb and accumulate metals, concentrations of metals in bottom sediments were found to be higher than in the water column above the sediments. The pH and DO content of water play a major role in determining the solubility of metals (Chapman, 1992 and Ayas et al., 2007). The results of the current investigation showed that fish species' liver tissues are where metal accumulation occurs most frequently. Fish physically absorb metals from the water through their gills, and they also indirectly do so through their diet (Barron,1990 and Ayas et al., 2007; Ali et al.,2014).

Due to greater metal concentrations in the water and sediments, metal residual issues in the fish epithelium are serious. Contrarily, heavy metals are a big problem in this regard because their bioaccumulation process makes it simple for them to be increased in the food chain (Beijer and Jernelov 1986). According to numerous criteria, including the fish's age and developmental and physiological characteristics, the pattern of heavy meal uptake varies between fish species. As a result of their greater absorption mechanisms for these elements in their tissues, fish can transfer significant dietary amounts of arsenic and mercury to humans. According to Ali et al., (2014), processed water from the detergent, textile, and cosmetic industries that are located close to rivers has a greater content of heavy metals, which, if present at much higher concentrations, disturbs the ecological balance of river water. For Cd and Pd, respectively, the pattern of heavy metal buildup in the liver and gills was determined to be minimal. The gut was the only area of the whole fish where the highest concentrations of Pb and Cd were found. In tissues of G. giuris, the bioaccumulation of Pb and Cd amounts was significantly increased for all heavy metals.

According to Garcia Lestón et al., (2010), lead is a non-essential element that, at trace levels, can seriously harm human health. Only the muscle and gill and the muscle and liver of G. giuris and C. punctatus showed significant differences in the result (Fig). Gill > liver > muscle made up the descending sequence of Pb accumulation in fish tissues. The target organ for the buildup of heavy metals from water is the gill. It was shown that the gills of the sensitive and prolific breeder wild fish G. giuris may quickly acquire Pb when exposed to Pb-contaminated water (Grosell et al., 2006). Due to its role in the formation of haemoglobin, copper is regarded as an essential trace element. However, excessive Cu consumption would have a negative impact on both animal and human health (Sivaperumal et al., 2007). Muscle, gill, and liver tissues of the three species were found to have the largest differences in Cu amounts. Similar to what Pb previously described, this was mostly related to metallothionein proteins in the liver. Almost all living things, including fish and humans, depend on iron because it helps the blood. The liver, an organ flush with blood, has a tendency to accumulate a large amount of iron since there were considerable changes in the amounts of iron in the three species' various tissues, according to the results. As a result, liver has a much higher Fe content than other tissues. The outcome was consistent with previous research on wels catfish (Silurus glanis) from the Danube River (Jovicic et al., 2015).

Zinc plays a biological role in transcription factors, making it a crucial vitamin for both animals and humans. Numerous chronic problems, including malabsorption, growth impairment, immunological abnormalities, chronic liver and renal diseases, etc., can result from a Zn deficiency. Muscles had much higher Zn concentrations than other tissues. This means that instead of in the fish's muscle, Zn preferred to collect in the gill and liver. The muscle, gill, and liver of G. guris were shown to collect the highest levels of harmful metals (As, Cd, and Pb). This is because wild animals are sensitive and prolific breeders, and because harmful trace substances have the ability to bioaccumulate and biomagnify (Tao et al., 2012). These variations can be linked to the environments of different fish species and the pathways by which nutrients are absorbed.

The distribution of heavy metals in different fish species was significantly influenced by feeding behaviour. Through the food chain, heavy metals were bioaccumulated and transported from primary producers and low trophic levels to higher trophic levels (Tao et al.,2012). Additionally, the habitat site affected the variability in heavy metal concentrations in fish species, with the demersal species (N. notopterus) accumulating more heavy metals than the midwater species (C. punctatus).

The heavy metals, viz., Fe, Ni, Cu, Zn and Pb are toxic to all human beings, animals, fishes and environment. The excess levels of heavy metals cause severe toxicity. Though some heavy metals are essential for animals, plants and several other organisms, all heavy metals exhibit their toxic effects via metabolic interference and mutagenesis. The Pb cause severe toxicity in all. Fishes are not the exception and they may also be highly polluted with heavy metals, leading to serious problems and ill-effects. The heavy metals can have toxic effects on different organs. They can enter into water via drainage, atmosphere, soil erosion and all human activities by different ways. With increasing heavy metals in the environment, these elements enter the biogeochemical cycle leading to toxicity in animals, including fishes.

Table 1. Concentration of heavy metals (ppm) in ware samples from different sampling stations at Kapila River (Mean ± SE).

Heavy metals	Kapilla Rriver Bridge.			Srikanteshwara Temple			Bannari Amman Sugar limited		
	*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	0.014 ± 0.041	0.10 ± 0.06	0.039± 0.06	0.014 ± 0.21	0.06 ± 0.41	0.302 ± 0.14
Ni	0.144 ± 0.15	0.084 ± 0.32	0.181± 0.40	BDL	0.048 ± 0.06	0.120 ± 0.21	0.148 ± 0.22	0.044 ± 0.09	BDL
Fe	0.512 ± 0.41	0.318 ± 0.09	0.341 ± 0.06	0.188 ± 0.33	0.461 ± 0.19	0.316 ± 0.14	0.548 ± 0.19	0.467 ± 0.41	0.411 ± 0.51
Pb	0.018 ± 0.21	0.030 ± 0.01	0.017 ± 0.03	0.070 ± 0.24	0.027 ± 0.04	BDL	0.019 ± 0.07	0.064 ± 0.34	0.211± 0.22
Cd	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

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

Table 2 Concentration of heavy metals (mg/g of dry weight) in Whole fish, Liver and Gills of different fish samples (Mean ± SE)

Heavy metals	Kapilla Rriver Bridge.			Srikanteshwara Temple			Bannari Amman Sugar limited		
	*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	0.014 ± 0.041	0.10 ± 0.06	0.039± 0.06	0.014 ± 0.21	0.06 ± 0.41	0.302 ± 0.14

Ni	0.144 ± 0.15	0.084 ± 0.32	0.181± 0.40	BDL	0.048 ± 0.06	0.120 ± 0.21	0.148 ± 0.22	0.044 ± 0.09	BDL
Fe	0.512 ± 0.41	0.318 ± 0.09	0.341 ± 0.06	0.188 ± 0.33	0.461 ± 0.19	0.316 ± 0.14	0.548 ± 0.19	0.467 ± 0.41	0.411 ± 0.51
Pb	0.018 ± 0.21	0.030 ± 0.01	0.017 ± 0.03	0.070 ± 0.24	0.027 ± 0.04	BDL	0.019 ± 0.07	0.064 ± 0.34	0.211± 0.22
Cd	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

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

Table 3 Concentration of heavy metals (ppm) in sediments from different sampling stations at Kapila River (Mean ± SE)

Heavy metals	Kapilla Rriver Bridge.			Srikanteshwara Temple			Bannari Amman Sugar limited		
	*SD.S.(1)	SD.S(2)	SD.S.(3)	SD.S.(1)	SD.S.(2)	SD.S.(3)	SD.S.(1)	SD.S.(2	SD.S.(3)
Cu	**BDL****	**BDL**	**BDL**	**BDL**	**BDL**	**BDL**	**BDL**	**BDL**	**BDL**
Zn	BDL	BDL	BDL	0.014 ± 0.041	0.10 ± 0.06	0.039± 0.06	0.014 ± 0.21	0.06 ± 0.41	0.302 ± 0.14
Ni	0.144 ± 0.15	0.084 ± 0.32	0.181± 0.40	BDL	0.048 ± 0.06	0.120 ± 0.21	0.148 ± 0.22	0.044 ± 0.09	BDL
Fe	0.512 ± 0.41	0.318 ± 0.09	0.341 ± 0.06	0.188 ± 0.33	0.461 ± 0.19	0.316 ± 0.14	0.548 ± 0.19	0.467 ± 0.41	0.411 ± 0.51
Pb	0.018 ± 0.21	0.030 ± 0.01	0.017 ± 0.03	0.070 ± 0.24	0.027 ± 0.04	BDL	0.019 ± 0.07	0.064 ± 0.34	0.211± 0.22
Cd	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

***SD.S= Sediment Sample, **BDL = Below Detection Limit**

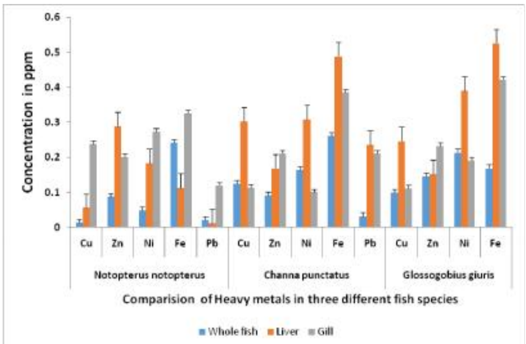


Fig. 2: Mean metal concentrations were significantly different among the different organs of the three fish species collected between T. Narasipura and Nanjangudu Industrial area, Kapilla river.

Fig. 1: Map showing sampling stations in Bannari amman sugar limited, Srikanteshwara temple and Kapilla river bridge.

Acknowledgments

Authors are gratefully thanks to Department of Science and Technology (DST-SERB) AND University Grant Commission (UGC) for providing financial support and Institute of Excellence and Department of Studies in Environmental Science, University of Mysore for providing laboratory facilities for analyses

Conflict of Interest

The authors have no conflict of interest

References

Adrian, WiIIiam J., and Mitchell L. Stevens. "Wet versus Dry Weights for Heavy Metai Toxicity Determinations in Duck Iiver." *Journal of Wildlife Diseases*, vol. 15, 1979, pp. 125-26.

Afshan, Sehar, et al. "Effect of Different Heavy Metal Pollution on Fish." *Research Journal of Chemical and Environmental Sciences*, vol. 2, no. 1, 2014.

Amundsen, Per-Arne, et al. "Heavy Metal Contamination in Freshwater Fish from the Border Region between Norway and Russia." *Science of the Total Environment*, vol. 201, no. 3, 1997, pp. 211-24.

Ayas, Zafer, and Durdane KoIankaya. "AccumuIation of Some Heavy Metals in Various Environments and Organisms at Goksu DeIta, Turkey, 1991-1993." *Bulletin of Environmental Contamination and Toxicology*, vol. 56, no. 1, 1996, pp. 65-72.

Beijer, K., and A. Jernelov. "Sources, Transport and Transformation of Metals in the Environment." *Handbook on the Toxicology of Metals*, edited by Friberg, Lars, et al., Elsevier, 1986.

Chapman, Deborah. *Water Quality Assessments - A Guide to Use of Biota, Sediments and Water in Environmental Monitoring*. Chapman and Hall Publishing, 1992.

Ekmekci, F.G., and F. Erkakan. "The Levels and Variation of Pollution in the Sariyar Dam Lake." *Proceeding of Fifth Environment Congress*, 1989.

Fernandez, M.A., et al. "Organochlorinated Compounds and Selected Metals in Waters and Soils from Donana NationaI Park (Spain)." *Water, Air, and Soil Pollution*, vol. 65, 1992, pp. 293-305.

García-Lestón, Julia, et al. "Genotoxic Effects of Lead: An Updated Review." *Environment International*, vol. 36, no. 6, 2010, pp. 623-36.

Grosell, M., et al. "Influence of Ca, Humic Acid and pH on Lead Accumulation and Toxicity in the Fathead Minnow during Prolonged Water-Borne Lead Exposure." *Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology*, vol. 143, no. 4, 2006, pp. 473–83.

Heiny, Janet S., and C. M. Tate. "Concentration, Distribution and Comparison of Selected Trace Elements in Bed Sediments and Fish Tissue in the South Platte River Basin, USA, 1992-1993." *Archives of Environmental Contamination and Toxicology*, vol. 32, 1997, pp. 246-59.

Jia, Yuyu, et al. "Effects on Heavy Metal Accumulation in Freshwater Fishes: Species, Tissues, and Sizes." *Environmental Science and Pollution Research*, vol. 24, 2017.

Jovicic, Katarina, et al. "Mapping Differential Elemental Accumulation in Fish Tissues: Assessment of Metal and Trace Element Concentrations in Wels Catfish (Silurus glanis) from the Danube River by ICP-MS." *Environmental Science and Pollution Research International*, vol. 22, 2015.

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.

Mahesh, T.M. "Industrialization and Environmental Quality in Mysuru City and Its Environs." *International Journal of Computational Engineering Research*, vol. 11, no. 1, 2021.

Munshi, J.S.D., et al. "Heavy Metal Pollution of Subernarekha River: Its Ecological Impact on Water Quality and Biota." *Proceedings of the National Seminar on Environmental Biology*, 1998.

Praveena, M., et al. "Impact of Tannery Effluent, Chromium on Hematological Parameters in a Fresh Water Fish, Labeo Rohita (Hamilton)." *Research Journal of Animal, Veterinary and Fishery Sciences*, vol. 1, no. 6, 2013.

Sharma, Rajesh Kumar, and MadhooIika Agrawal. "BiologicaI Effects of Heavy Metals: An Overview." *Journal of Environmental Biology*, vol. 26, 2005, pp. 301-13.

Singh, Vivek Kumar, and Jaswant Singh. "Toxicity of Industriai Wastewater to the Aquatic Piant Lemna minor L." *Journal of Environmental Biology*, vol. 27, 2006, pp. 385-90.

Sivaperumal, P., et al. "Heavy Metal Concentrations in Fish, Shellfish and Fish Products from Internal Markets of India vis-a-vis International Standards." *Food Chemistry*, vol. 102, no. 3, 2007, pp. 612-20.

Tao, Yu, et al. "Distribution and Bioaccumulation of Heavy Metals in Aquatic Organisms of Different Trophic Levels and Potential Health Risk Assessment from Taihu Lake, China." *Ecotoxicology and Environmental Safety*, vol. 81, 2012, pp. 55-64.

Author Details

G. V. Venkataramana, *Professor, Department of Studies in Environmental Science, University of Mysore, Manasagangotri, Mysore, Karnataka, India,* ***Email ID:*** *venkataraman_1970@yahoo.co.in*

P.N. Sandhya Rani, *Department of Studies in Zoology, Bangalore University, Bangalore, Karnataka, India.*