International Journal of Advanced Academic Studies 2023; 5(12): 31-34

E-ISSN: 2706-8927
P-ISSN: 2706-8919
www.allstudyjournal.com
IJAAS 2023; 5(12): 31-34
Received: 02-10-2023
Accepted: 09-11-2023

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Analysis of heavy metals in water, Sediments and fish samples of Son River at Diya Pipar ghat, Shahdol (M.P.) India

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DOI: https://doi.org/10.33545/27068919.2023.v5.i12a.1087

Abstract
Heavy metal (Pb, Cd, Cr, Ni) concentration in water sediments and fish was analysed from Son river in the month of June 2023. There was an appreciable increase in metal concentrations in going from the water to the sediment samples. The Heavy metal concentration, in water was in the order Pb > Cr > Cd > Ni, in sediments Pb > Cr > Cd > Ni. Five fish species [*Catla, Common carp, Tilapia* (*Oreochromis niloticus*), *Mrigal Nandus nandus*] were collected from this river and analyzed for Heavy metal content of muscle, liver, gills and kidney tissues. The maximum concentration of heavy metals was found in Kidney and liver, the order of heavy metal level in various argons is Muscle >Gills >liver > kidney. The Order of heavy metal concentration in Muscle Pb >Cd>Ni>Cr, in Gills Pb =Cd>Ni>Cr, in kidney Pb >Cd>Ni>Cr and in liver Pb >Cd>Ni>Cr. It is really worrying that there are too much Pb and Cd in the water, and it could make people sick if they eat fish from the river.

Keywords: Son river, heavy metals concentration, fish diversity

Introductions

The rapid urbanization and industrialization that have pervaded our society have led to a disturbing rise in heavy metal contamination, stemming from the disposal of industrial, agricultural, and geological waste. This worrisome pollution not only poses a significant risk to our public water supplies but also endangers those who rely on fish as a vital source of sustenance (Sufiani and Ishak, 2015) [1].

According to Hui (2008) [2], heavy metals are characterized by their density surpassing 5g/cm^3 and are naturally present in our surroundings. These metallic elements can be detected in various components of both living and non-living ecosystems, encompassing water bodies, sediments, flora, fauna, and even mankind (Hui, 2008) [2]. Heavy metals enter the environment naturally through the weathering of existing rocks containing these heavy metals and anthropogenically through the use of heavy metals in industrial and agricultural activities (Pati *et al*., 2013; Wuana and Okieimen, 2011) [3-4]. Some heavy metals, such as zinc and iron, are required by living organisms to aid growth and development (Sukdeo, 2010) [5]. However, when in excess, these can become toxic and cause health deteriorations in organisms (Hui, 2008) [2]. Pollution from land-use practices such as urbanization and industrialization pose significant threats to the water quality of rivers and estuaries as this can lead to an increase in heavy metal contamination (Cloern *et al*., 2016) [16].

The presence of pollutants in our rivers, lakes, and oceans has greatly affected the sediment. These pollutants have various sources, including industrial and sewage plants, urban and agricultural runoff, and historical contamination. The contamination of sediments poses a threat to the organisms in the benthic environment, as they are exposed to dangerous levels of toxic chemicals. Certain types of toxic sediments can even lead to the death of benthic organisms, which in turn reduces the food supply for larger animals like fish. The contaminants present in the sediment can be absorbed by benthic organisms through a process known as bioaccumulation. When larger animals consume these contaminated organisms, the toxins gradually accumulate in their bodies, creating a process called bio-magnification. Consequently, fish, shellfish, waterfowl, and both freshwater and marine mammals may accumulate hazardous levels of toxic chemicals. It is important to note that contaminated sediments can be disrupted and re-suspended in the water through activities such as dredging. This means that not only the benthic organisms, but all aquatic organisms can be affected. Different types of aquatic organisms respond differently to external contamination, and the quantity and form of the element present in water, sediment, or food will determine the extent of accumulation (Begum *et al.* 2008 and Begum *et al.* 2008) [7-8]. The accumulation of heavy metals in fish is influenced by various factors such as the method of uptake, the specific heavy metals involved, and the species of fish. This makes their potential use as bio-monitors valuable in assessing the accumulation and spread of contaminants in the ecosystem. When dangerous chemical elements are released into the environment, they tend to build up in the soil and sediment of water bodies. From there, lower aquatic organisms absorb these elements and pass them along the food chain to higher trophic levels, including fish. In acidic conditions, fish gills can directly absorb the free divalent ions of many metals from the water, resulting in heavy metal concentrations in the fish's organs being primarily determined by water and food pollution levels. Additionally, in certain circumstances, chemical elements that have accumulated in silt and bottom sediments of water bodies can migrate back into the water, essentially turning silt into a secondary source of heavy metal pollution.

Materials & Methods

Study site: The Shahdol district lies in the north-east part of Madhya Pradesh extending from 29°39'28" and 24°16'13" North latitude and from 80°32'56" to 82°12'21" East longitude approximately. The region lies in the heart of the country. The district is surrounded by Sone river and Rewa district in North, Mandla, in South Sidhi, Anuppur in Surguja East and Umaria and Satna in West. It is situated 489 meter above of the sea surface. Diya Pipar Ghat is located in Sohagpur tehsil of Shahdol district in Madhya Pradesh, India. It is situated 16km away from Shahdol, which is both district & sub-district headquarter of Diya Pipar ghat.

Diya Pipar Ghat is located in Sohagpur tehsil of Shahdol district in Madhya Pradesh, India. It is situated 16km away from Shahdol, which is both district & sub-district headquarter of Diya Pipar ghat. For the study of four study sites A, B, C and D were selected from Son river at Diyapipar ghat.

Water samples and Sediment samples were collected in June 2022 from various sites (region of maximum/minimum water flow, inlet and outlet areas). Sediments were collected via a polyethylene corer, preserved according to standard methods. Samples were digested in acid-cleaned Teflon microwave vessels with 5 ml of ultrapure nitric acid and 2 ml ultrapure hydrofluoric acid. and were digested for 30 min at 200 °C. After allowing at least 2h for cooling, the vessels were opened and 0.8 g boric acid was added to dissolve the fluoride precipitates and were detected by Atomic Absorption Spectrometer. pH and salinity were measured with a YSI 33 model portable conductivity meter.

Fish samples [*Catla, Common carp, Tilapia (Oreochromis niloticus), Mrigal Nandus nandus*] were purchased from the river. The size of the fish collected varied, depending on the species, between 12cm and 54cm, and their age was from 6 months to 1 years. Fish from each variety dissected to separate organs (flesh, gills, liver and kidney) according to FAO method. The separated organs were put in petridishes to dry at 120 °C until reaching a constant weight. The separated organs were placed into digestion flasks and ultrapure Conc. HNO_3 and H_2O_2 (1:1 v/v) was added. The digestion flasks were heated to 130°C until dissolution, diluted with water and analysed for heavy metal concentration using atomic absorption Spectrometer (Begum *et al.* 2009; Begum *et al.* 2008; Clesceri, 1998) [9-11].

Results and Discussion

The measurement of water's pH is a crucial indicator of its overall quality, intimately tied to the delicate balance of carbon dioxide and carbonate-bicarbonate equilibrium. The profound impact of acid-base reactions on groundwater cannot be understated, as they wield considerable influence over both pH levels and the chemistry of ions present. The pH value in the study area varies between 6.8 and 7.9. Low pH of water may be attributed to discharge of acidic water by agricultural and paper mill effluents. A pH value of 7.3 may be due to the presence of carbonates of calcium and magnesium. The fish community in this study site includes the native species. There are more than 30 species of fishes identified from this site. Fishes belonging to genus *Puntius, Labeo, Cirrhinus, Channa, Mystus* are more common. *Oreochromis mossambica* (Tilapia), which has inadvertently entered and dominated this study site are prolific breeder and are multiping faster. Other exotic fish species commonly found are *Cyprinus carpio* (Common carp) and *Ctenopharyngodon idella* (Grass carp), which are mainly stocked for fish production. *Puntius filamentosus*, *Channa striatus* and *Labeo konitus* were few endangered species. To conserve all endemic fish species and the total fish diversity. Sustainable fish production by taking appropriate steps for sustaining fish diversity is necessary to conserve these vulnerable, but valuable resources (Facetti *et al.* 1998; Lokhande and Kelkar, 1999; Mishra, 2018; Saket and Pandey, 2019) [12-15]. The Heavy metal concentration, in water was in the order Pb > Cr > Cd > Ni, in sediments Pb > Cr > Cd > Ni. Five fish species [*Catla, Common carp, Tilapia (Oreochromis niloticus), Mrigal, Nandus nandus*] were collected from this study site and analyzed for Heavy metal content of muscle, liver, gills and kidney tissues. The maximum concentration of heavy metals was found in Kidney and liver, the order of heavy metal level in various argons is Muscle >Gills >liver >kidney. The Order of heavy metal concentration in Muscle Pb >Cd>Ni>Cr, in Gills Pb =Cd>Ni>Cr, in kidney Pb >>Cd>Ni>Cr and in liver Pb >Cd>Ni>Cr. The presence of elevated levels of Pb and Cd in almost argons is a serious matter of concern and the potential for human exposure to heavy metals from eating fish caught in the river.

Table 1: Physiochemical parameters measured in the sampling sites

Stations	Temp. °C	Salinity (%)	pH	DO (mg/L)
Site A	28.6	19.21	7.5	6.87
Site B	30.1	17.41	6.8	7.56
Site C	29.9	18.56	7.3	6.36
Site D	27.8	19.12	7.9	5.46

Table 2: Detection of heavy metals in fish species harvested from Son river at Diya pipar ghat, Shahdol

	Heavy Metal Concentration µg/kg															
Fish species	**Muscle**				**Gill**				**Kidney**				**Liver**			
	Cr	**Cd**	**Ni**	**Pb**	**Cr**	**Cd**	**Ni**	**Pb**	**Cr**	**Cd**	**Ni**	**Pb**	**Cr**	**Cd**	**Ni**	**Pb**
Catla	1.52	1.1	0.13	2.54	2.36	4.67	5.54	7.5	2.75	4.38	4.96	6.32	3.66	9.24	4.76	9.34
common carp	1.11	1.89	1.18	2.46	4.57	6.44	4.41	4.32	2.55	4.31	1.86	6.34	2.46	6.26	3.55	9.06
Tilapia	1.33	1.66	0.81	2.66	5.68	7.24	3.65	5.57	2.43	4.28	1.81	6.35	2.64	6.01	5.54	7.36
Mrigal	1.45	1.44	0.79	2.16	4.34	6.46	6.43	4.67	2.41	4.26	1.87	6.31	2.60	6.95	3.70	7.36
Nandus nandus	1.34	1.97	0.55	2.64	6.92	4.86	5.25	2.97	2.32	4.16	2.98	7.55	2.76	6.57	3.15	7.27

Table 3: Heavy metal concentrations in water (µg/L) in various sampling sites

Heavy metal Sites Load in water (μgL^{-1})	Site A	Site B	Site C	Site D
Cr	2.51	2.11	1.06	1.78
Ni	5.62	6.41	1.21	1.33
Cd	4.90	3.22	1.10	1.01
Pb	7.23	5.23	2.29	1.11

Table 4: Heavy metal concentrations in sediments (µg/kg) in various sampling sites

Heavy metal Sites Load in water (μgL^{-1})	Site A	Site B	Site C	Site D
Cr	2.46	2.26	1.96	1.66
Ni	6.61	6.44	1.75	1.74
Cd	5.44	3.97	1.54	1.51
Pb	7.89	5.65	2.86	1.52

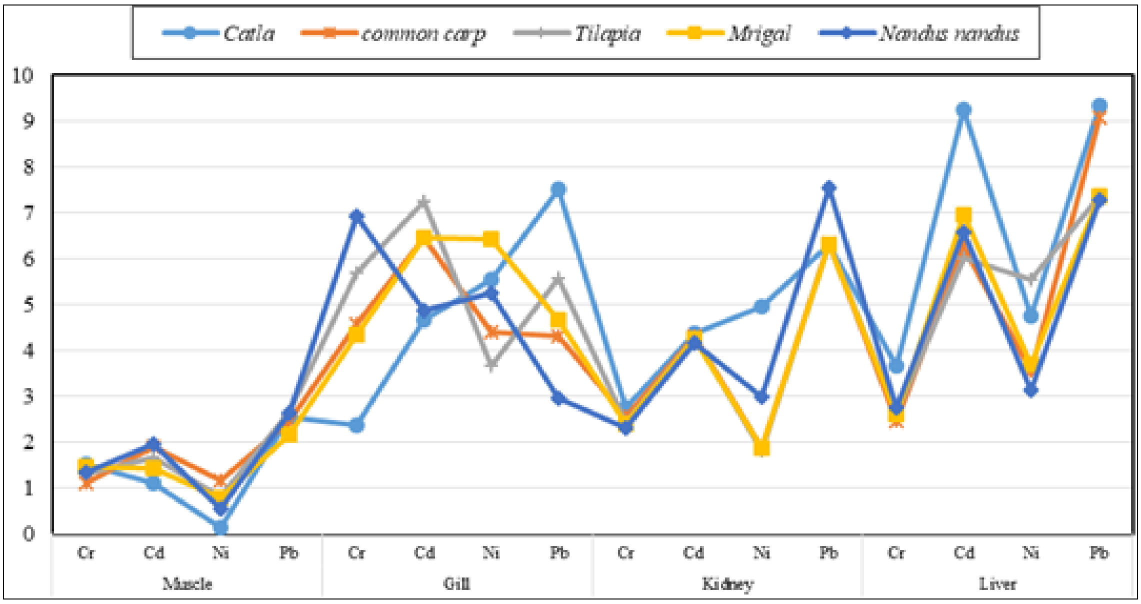

Fig 1: Graph analysis of detection of heavy metals in fish species harvested from son river at Diyapipar ghat, shahdol

Conclusion

The likely origin of the pollutants can be attributed to human activities, specifically agriculture and the discharge of waste from paper mills into the river. The possibility of human exposure to these metals primarily stems from consuming fish caught in the river, as the analysis of various fish species has revealed substantial levels of these metals already present.

Acknowledgement

The authors are thankful to authority of Govt. I.G. Home Science Girls P.G. College, Shahdol (M.P.) carry out this work.

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