Ilkogretim Online - Elementary Education Online, 2021; Vol 20 (Issue 6): pp. 5556-5564
http://ilkogretim-online.org
doi: 10.17051/ilkonline.2021.06.539

Assessing Toxicological Effect Of Heavy Metals On Selected Body Parts Of Garra Gotyla

MR. SAHIL Research Scholar, Department of Zoology, Sri Satya Sai University of Technology & Medical Sciences, Sehore, M.P, India.

DR. NAISAR AHMAD GANIE Research Supervisor, Department of Zoology, Sri Satya Sai University of Technology & Medical Sciences, Sehore, M.P, India.

ABSTRACT

Heavy metal pollution in aquatic habitats endangers both aquatic life and human health. Lead, cadmium, mercury, and arsenic, among others, are released into aquatic habitats as a result of a wide range of human activities, with far-reaching and perhaps irreversible consequences for aquatic ecosystems and the natural world at large. In aquatic environments frequented by humans, Garra gotyla serves as a sentinel species, reporting on the state of the local ecology and warning of any possible threats to the human communities that depend on those waters. This research was carried out to determine how much heavy metals had built up in the various tissues of the Garra gotyla fish. Manganese, iron, chromium, zinc, lead, cadmium, and nickel concentrations in the fish samples were measured using an atomic absorption spectrophotometer. Heavy metal concentrations vary widely between fish species and tissue types.

Keywords: Liver, Kidney, Metals, Tissues, Aquatic.

I. INTRODUCTION

Studying the accumulation of heavy metals in aquatic organisms is a complex and multifaceted endeavor that holds profound implications for both ecological conservation and human health. Among the myriad of aquatic species inhabiting our planet's waterways, the humble Garra gotyla, a freshwater fish indigenous to South Asia, emerges as a remarkable and understudied bioindicator species. The accumulation of heavy metals in various organs of Garra gotyla, is a topic of increasing importance. As we stand at the nexus of environmental degradation, climate change, and growing anthropogenic impacts on aquatic ecosystems, understanding the patterns and consequences of heavy metal accumulation in this species provides critical insights into the health of both these ecosystems and the communities that rely upon them.

Garra gotyla, commonly known as the "Indian stone loach" or "Lizardfish," is a member of the family Cyprinidae. These small, benthic, and highly adaptable fish are widely distributed across South Asian countries, including India, Pakistan, Nepal, Bangladesh, and Bhutan. Beyond their ecological significance as an essential component of freshwater ecosystems, Garra gotyla holds cultural importance in several regions and serves as a vital source of sustenance for local communities. Given their proximity to human populations and their position within food webs, these fish are uniquely positioned to accumulate heavy metals, which are often released into water bodies through industrial, agricultural, and urban activities.

Heavy metals, such as lead, cadmium, mercury, and arsenic, are natural constituents of the Earth's crust, but human activities have significantly increased their presence in aquatic environments. These non-degradable pollutants can persist in ecosystems for extended periods, posing serious threats to aquatic life and potentially entering human food chains. Heavy metals can have toxic effects on living organisms, disrupting vital physiological processes and causing long-term damage to both individual organisms and their ecosystems. As such, monitoring and understanding the distribution and accumulation of heavy metals in aquatic organisms, like Garra gotyla, is essential for assessing the health of aquatic ecosystems and safeguarding human health.

This comprehensive exploration aims to unravel the intricate web of factors influencing heavy metal accumulation in the liver, kidneys, gills, and muscle tissues of Garra gotyla. By investigating the levels of heavy metals in these crucial organs, we aim to provide valuable insights into the potential ecological risks posed by heavy metal pollution in freshwater environments. Additionally, we will consider the implications of heavy metal accumulation for local communities that rely on Garra gotyla as a dietary staple, recognizing the interconnectedness of environmental health and human well-being.

II. REVIEW OF LITERATURE

Elbeshti, Randa et al., (2018) Heavy metals are compounds that constitute the most dangerous aspect of chemical water pollution because of their tendency to bioaccumulate and biomagnify and their incapacity to be eliminated by the body via metabolic processes. The effects of heavy metals including cadmium, copper, manganese, nickel, iron, and lead on fish and other aquatic animals are investigated, as well as their general features and sources, absorption by fish, concentration evaluations, and reviews of the existing literature. Heavy metals are shown to cause significant harm to fish, posing threats to fish health and ecosystems as well as to human health through the ingestion of heavy metal-contaminated fish, according to the reviewed scientific literature.

Tepe, Yalçın et al., (2017) Fish from the Tuzla and amlk Lagoons in Adana, Turkey, both on the Mediterranean Coast, had their metal accumulations in muscles, livers, gonads, and gills compared. Muscle tissues of species trapped in either lagoon had mean metal concentrations of 26.0-90.2 mg/kg wet weight for Fe, 4.21-21.2% for Zn, 0.39-2.1% for Cu, 1.5% for Mn, 1.6% for Cr, 0.52-1.09 for Ni, 0.52-1.09 for Pb, 0.26- 0.98 for Cd, and 0.03-0.62 for Co. The largest concentrations of iron were found in skeletal muscle, followed by zinc in the rest of the body. However, cadmium, cobalt, chromium, and lead were found at far lower concentrations. The average metal levels of tissues varied significantly between individuals of the same species caught in various lagoons and between species of fish caught in the same or other lagoons. Fish samples collected from both lagoons showed metal concentrations much below the limits set by various government authorities.

Mahboob, Shahid et al., (2016) The purpose of this research was to determine how exposure to heavy metals affected a vital organ in two fish species, Cyprinus carpio and Wallago attu, collected in the Indus River in the Mianwali District of Pakistan. Gill, muscle, kidney, and liver heavy metal concentrations were compared to a global benchmark for food fish. Overall, Fe concentrations were the highest across all C. carpio weight classes, followed by Cu and Cr. Metal buildup in the gills and muscles of C. carpio, W. attu kidneys and muscles, and C. carpio liver. Heavy metal buildup in several organs of both animals was significantly different ($p<0.01$).

Zeng, Yanyi et al., (2014) Heavy metal deposition patterns in Pearl River watershed Guangdong bream (Megalobrama terminalis) were analyzed. Muscle, gonads, intestines, gills, liver, kidneys, and spinal cord metal concentrations were all calculated using atomic absorption spectrophotometry. Simultaneously, the concentrations of these metals in the region's surface water and sediment were calculated. The kidney had the greatest bio-concentration factor (BCF) for Cd among the several tissues examined, suggesting that the kidney is particularly vulnerable to Cd buildup. The liver had the highest concentration of Cu, whereas the spine had the highest concentrations of Pb and Zn. The accumulation of the metals under study was often lower in muscle than in other tissues. Except for Mn, all other measured metals showed highly significant connections between muscle and other tissue concentrations. There was no correlation between the size of the fish and the amount of metals found in their tissues. Compared to absorption from the water column, dietary uptake of heavy metals via the gut may be more responsible for the fish's Cu and Cd burden, as shown by the ratio of gill and intestinal heavy metal concentrations. The remaining four metals may contribute more through gill absorption from the water column than through food. Local fisherman should limit their eating of this species since its high Pb levels in the muscle tissue surpasses the EU's recommended limit for fish intake. None of the six metal THQs in the bream were higher than 1.

III. RESEARCH METHODOLOGY

Sample

Nine Garra gotyla specimens were gathered from the district's Chenani (upstream) and Jhajjar kotli (downstream) regions, as well as the pollution-free Nagrota stream, which served as a control site. After being cleaned with running water and a plastic knife, the fish were transferred to the lab. We measured, bagged, and froze at -20°C samples of kidneys, muscles, liver, and gills. The samples were prepared using the following method: approximately 1 g of each of the following was weighed in an Erlenmeyer flask.

Analysis of fish samples

Samples of muscle tissue, as well as gill, kidney, and liver tissue, were taken from Garra gotyla. Atomic absorption spectrometer (Z-2000 Hitachi) was used for the purpose of determining the presence of different metals. "Gills, liver, kidneys, and muscle from a variety of fish were digested with concentrated nitric acid in a series of different experiments. Each sample was weighed out at 0.5 g, placed in a 100 ml tube, and then reacted with 3 ml of pure HNO3. A hot plate was used to heat the samples to 100, 150, 200, and 250 degrees Celsius for 1, 1, 1, and 1.5 hours, respectively, in individual test tubes. After the sample had been completely digested and had lost its color, 2 ml of 1N HNO3 was added to the residue, and the solution was then evaporated once more using a hot plate. After the sample was allowed to cool, 10 ml of 1N HNO3 was added to it once again. After digestion, the sample was diluted with water that had been through two distillation processes and then transferred to a volumetric flask with a capacity of 500 ml. Filtration was performed using a 0.45 μm Millipore membrane filter on the volume of the digested material. Similar procedures were used to analyze the blanks and the calibration standard solution as they were with the samples. From their respective salts, a solution of Pb, Cu, Fe, and Cr at a known concentration of 1000 mg/l was created. The analytical reagents were all acquired from the German company Merck.

Statistical Procedure

The findings of the experiment were evaluated in Statistix 8.1 using a appropriate test. The results were reported using a mean and a standard deviation. The statistical cutoff for significance was set at P 0.05. ArcGIS V. 9.3 was used to create the research area map.

IV. DATA ANALYSIS AND INTERPRETATION

Cadmium and nickel were the only heavy metals found in undetectable amounts; the other metals varied in abundance depending on geography and species. Overall, the concentration of heavy metals was found to be highest at the downstream location (Jhajjar kotli), followed by the upstream location (Chenani), with the lowest quantities found in fish samples from the Nagrota stream (reference site).

Heavy metal buildup in Garra gotyla was shown to occur as follows: Mn > Pb > Cu > Cr > Zn > Fe, and Mn > Pb > Cu > Zn > Fe at upstream, then at downstream, then at the reference site. None of the samples taken from any of the three locations tested positive for Ni or Cd (Table 1).

Table 1: Impact of heavy metals Concentration on liver of selected fish

Metals	Chenani	Jhajjar kotli	Nagrota
Pb	0.04	0.02	0.05

Cu	0.03	0.01	0.04
Zn	0.26	0.22	0.35
Cr	0.04	0.01	0.06
Fe	0.27	0.24	0.37
Mn	0.02	0.0	0.05

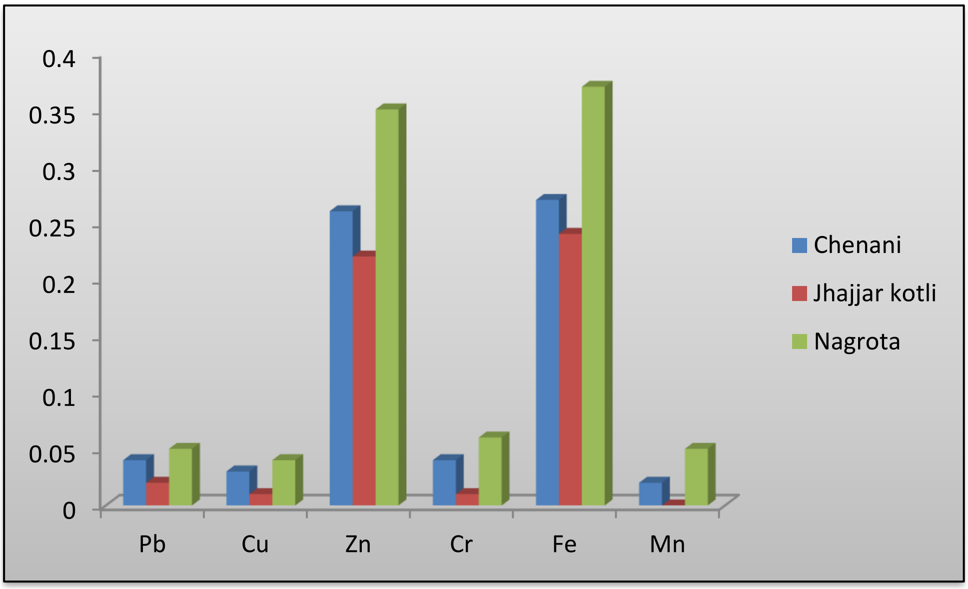

Figure 1: Impact of heavy metals Concentration on liver of selected fish

In the kidney of G. gotyla, heavy metal accumulation occurred in the following Mn<Pb=Cu=Cr< Fe<Zn, Mn<Pb=Cu=Cr<Zn<Fe and Pb=Cu= Cr<Fe<Zn at the source, the endpoint, and the baseline. G. gotyla livers from the control location were tested for Mn and found to be Mn-free (Table 3).

Table 2: Impact of heavy metals Concentration on kidney of selected fish

Metals	Chenani	Jhajjar kotli	Nagrota
Pb	0.03	0.01	0.04
Cu	0.04	0.01	0.05
Zn	0.30	0.20	0.33
Cr	0.04	0.02	0.06

Fe	0.29	0.17	0.40
Mn	0.01	0.0	0.03

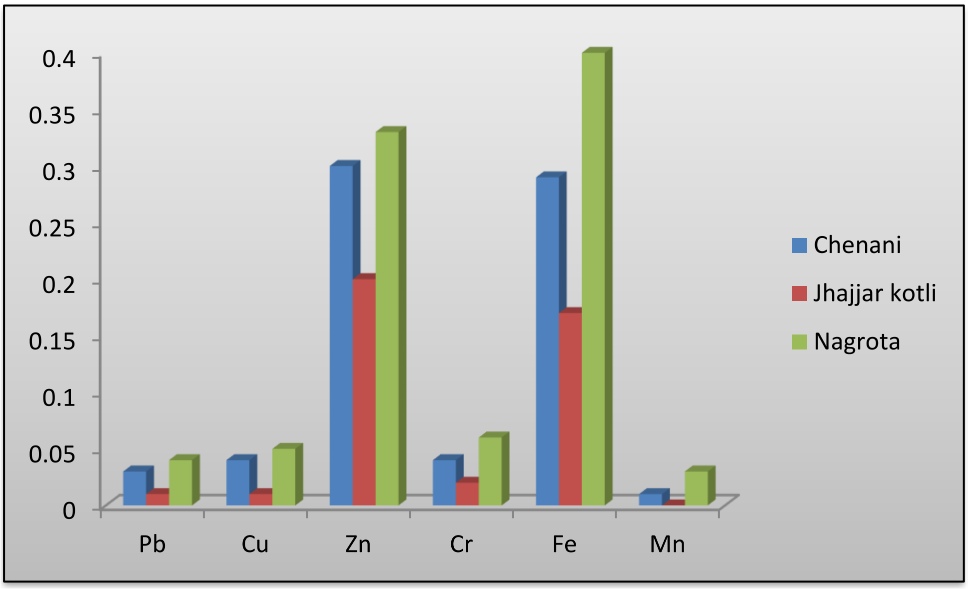

Figure 2: Impact of heavy metals Concentration on kidney of selected fish

Heavy metal buildup in gills followed the following order: Mn<Pb=Cr=Cu<Zn<Fe, Mn<Cu=Cr<Pb<Fe<Znand Cu=Cr<Fe=Zn at the source, the endpoint, and the baseline. On the other hand, neither lead nor mercury was found in the gills of the control fish (Table 3).

Table 3: Impact of heavy metals Concentration on gills of selected fish

Metals	Chenani	Jhajjar kotli	Nagrota
Pb	0.02	0.00	0.05
Cu	0.03	0.02	0.06
Zn	0.24	0.20	0.34
Cr	0.05	0.02	0.07
Fe	0.26	0.21	0.32
Mn	0.02	0.0	0.02

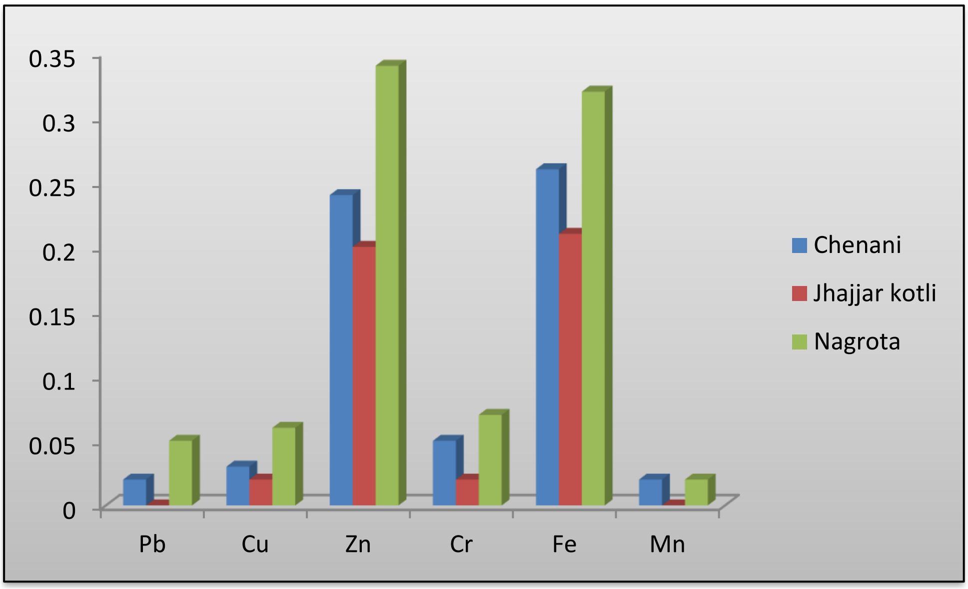

Figure 3: Impact of heavy metals Concentration on gills of selected fish

Accumulation in skeletal muscle occurred in the following order Mn=Pb<Cr=Cu<Zn=Fe, Mn=Pb<Cu=Cr<Zn<Fe,and Cu=Cr<Zn<Fe at the source, the endpoint, and the baseline. Muscle samples of G. gotyla from the reference site did not reveal the presence of Mn or Pb (Table 4).

Table 4: Impact of heavy metals Concentration on muscle of selected fish

Metals	**Chenani**	**Jhajjar kotli**	**Nagrota**
Pb	0.01	0.00	0.03
Cu	0.03	0.02	0.06
Zn	0.27	0.18	0.32
Cr	0.03	0.01	0.05
Fe	0.26	0.23	0.34
Mn	0.01	0.0	0.05

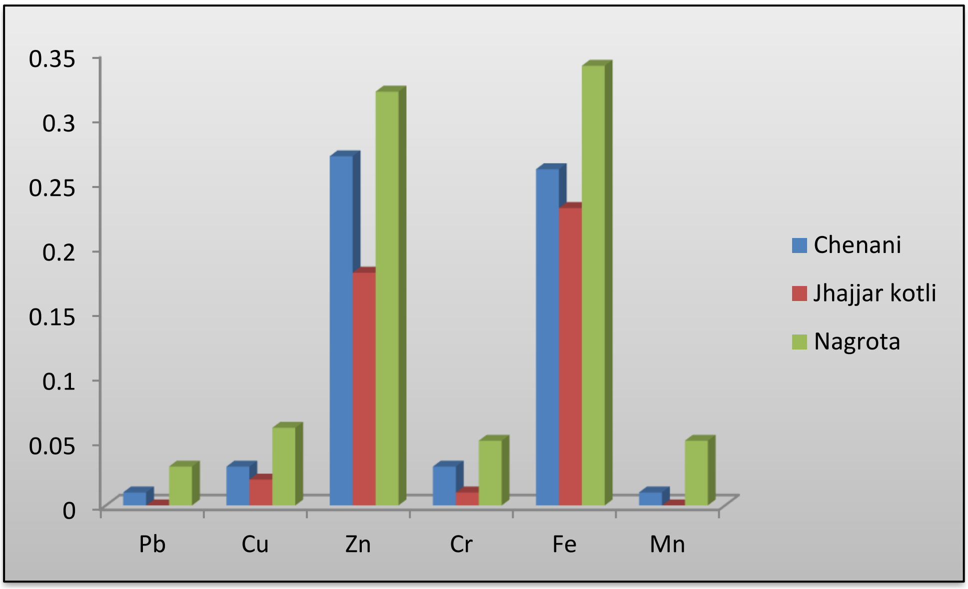

Figure 4: Impact of heavy metals Concentration on muscle of selected fish

V. CONCLUSION

Through this study, we have unraveled a web of factors that influence the accumulation of heavy metals in this bioindicator species and the potential consequences for both the environment and human health. The liver and kidneys, being vital detoxification and filtration organs, tend to accumulate higher concentrations of heavy metals compared to muscle tissues and gills. This distribution reflects the organism's efforts to sequester and eliminate these toxic substances, thereby safeguarding other essential physiological functions. However, this protective mechanism can also result in potential harm to the fish itself, leading to adverse health effects.

REFERENCES: -

1. Ullah, Sana & Li, Zhongqiu & Hassan, Said & Ahmad, Shahid & Guo, Xinle & Wanghe, Kunyuan & Nabi, Ghulam. (2021). Heavy metals bioaccumulation and subsequent multiple biomarkers based appraisal of toxicity in the critically endangered Tor putitora. Ecotoxicology and Environmental Safety. 228. 113032. 10.1016/j.ecoenv.2021.113032.

2. Ali, Hazrat & Khan, Ezzat. (2021). Bioaccumulation of Selected Toxic Heavy Metals in Mastacembelus armatus from Three Rivers of Malakand Division, Pakistan. Pakistan Journal of Zoology. 53. 1251.

3. Khan, Mohd & Javed, Mehjbeen & Rehman, Md & Urooj, Maryam & Ahmad, Irshad. (2020). Heavy metal pollution and risk assessment by the battery of toxicity tests. Scientific reports. 10. 16593. 10.1038/s41598-020-73468-4.

4. Elbeshti, Randa & ELDERWISH, Nuri & ABDELALI, Khalifa & Taştan, Yiğit. (2018). Effects of Heavy Metals on Fish. 4. 36-47.

5. Achakzai, Wali & Saddozai, Shagufta & Malik, Yasmeen. (2017). Determination of heavy metal concentrations in six species of fresh water fish sold in Quetta city, Pakistan. Pure Appl. Biol. 6. 79-86. 10.19045/bspab.2016.50169.

6. Tepe, Yalçın & Türkmen, Aysun & Türkmen, Mustafa. (2017). Comparison of heavy metal accumulation in tissues of economically valuable fish species from two nearby lagoons in mediterranean coastal area. Indian Journal of Geo-Marine Sciences. 46. 1333-1338.

7. Ullah, Sana & Hussain, Zaqhim & Mahboob, Shahid & Al-Ghanim, Khalid. (2016). Heavy Metals in Garra gotyla , Cyprinus carpio and Cyprinion watsoni from the River Panjkora, District, Lower Dir, Khyber Pakhtunkhwa, Pakistan:. Brazilian Archives of Biology and Technology. 59. 10.1590/1678-4324-2016160321.

8. Ahmed, Mukhtiar & Ahmad, Taufiq & Liaquat, Muhammad & Abbasi, Kashif & Abdel-Farid, Ibrahim & Jahangir, Muhammad. (2016). Tissue specific metal characterization of selected fish species in Pakistan. Environmental Monitoring and Assessment. 188. 10.1007/s10661-016-5214-6.

9. Mahboob, Shahid & Kausar, Shazia & Jabeen, Farhat & Sultana, Salma & Sultana, Tayyaba & Al-Ghanim, Khalid & Hussain, Bilal & Al-Misned, Fahad & Ahmad, Zubair. (2016). Effect of Heavy Metals on Liver, Kidney, Gills and Muscles of Cyprinus carpio and Wallago attu inhabited in the Indus. Brazilian Archives of Biology and Technology. 59. 10.1590/1678-4324-2016150275.

10. Zeng, Yanyi & Lai, Zini & Gu, Binhe & Yang, Wanling & Gao, Yuan & Wang, Chao & Li, Yuefei. (2014). Heavy metal accumulation patterns in tissues of Guangdong bream (Megalobrama terminalis) from the Pearl River, China. Fresenius Environmental Bulletin. 23. 851-858.

11. Mahboob, Shahid & Alkaham Albalawi, Hmoud & Almisned, Fahad & Al-Quraishy, Saleh & Ahmad, Zubair. (2013). Tissue Metal Distribution and Risk Assessment for Important Fish Species from Saudi Arabia. Bulletin of environmental contamination and toxicology. 93. 10.1007/s00128-013-1139-8.

12. Khan, Bushra & Khan, Hizbullah & Muhammad, Said & Khan, Tariq. (2012). Heavy Metals Concentration Trends In Three Fish Species From Shah Alam River (Khyber Pakhtunkhwa Province, Pakistan) INTRODUCTION. 310. 22-12.