AgriCos e-Newsletter
ISSN: 2582-7049

AgriCos e-Newsletter

Open Access Multidisciplinary Monthly Online Magazine

Volume: 06 Issue: 02 February 2025 Article No: 12

Residue Analysis of Heavy Metals in Fish

Senthamil R.[1] and Imtiyaz Qayoom[2]

[1]M.F.Sc. Division of Aquatic Environmental Management Research Scholar, SKUAST-K, Faculty of Fisheries, Rangil, Jammu and Kashmir

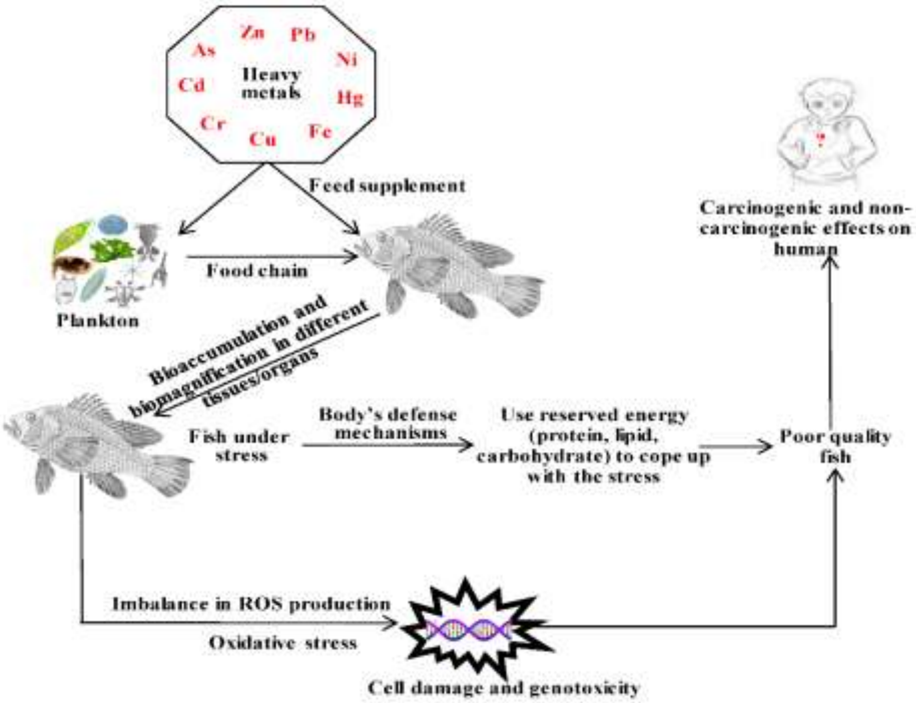
[2]Assistant Professor (Toxicology), Division of Aquatic Environmental Management SKUAST-K, Faculty of Fisheries, Rangil, Jammu and Kashmir

SUMMARY

Heavy metal contamination in aquatic ecosystems poses a significant threat to environmental health, food safety, and biodiversity. Residue analysis of heavy metals in fish focuses on detecting and quantifying toxic metals such as mercury, cadmium, lead, and arsenic, which accumulate due to industrial effluents, agricultural runoff, and other anthropogenic activities. Fish, being integral to aquatic food chains, serve as bioindicators of contamination and accumulate heavy metals in their tissues through ingestion, gill ion exchange, and adsorption. This study highlights the methods for sample collection, preparation, and analysis, including advanced techniques like Atomic Absorption Spectroscopy (AAS) and Inductively Coupled Plasma-Mass Spectrophotometer (ICP-MS), to determine metal concentrations in fish tissues. Understanding heavy metal residues aids in assessing ecological risks, identifying contamination sources, and ensuring human health and environmental sustainability through mitigation strategies. The findings emphasize the need for continuous monitoring to protect marine life and human populations dependent on these aquatic resources.

INTRODUCTION

Residue analysis of heavy metals involves the detection and quantification of trace amounts of heavy metals in various samples, including food, water, soil, and biological tissues. This analysis is essential for monitoring environmental pollution, ensuring food safety, and assessing the impact of industrial activities. Scientific researches have proven that, the presence of heavy metals in foods is harmful to human health which be associated with immune-suppression, hypersensitivity to chemical agents, breast cancer, reduce sperm count and infertility. Those heavy metals such as mercury, cadmium and lead introduced into environmental water system may pose high toxicities on the aquatic organisms (Ambreen *et al*., 2015).



Routes of heavy metals accumulation in fish (Emon et al., 2023)

These heavy metals contaminate water, fish, and sediments, leading to the disruption of ecosystems and causing significant harm to coastal areas, affecting both marine life and the surrounding environment. Coastal areas have experienced significant heavy metal contamination from both point sources (e.g., industrial effluents, ditches) and non-point sources (e.g., agricultural runoff), making it a pressing environmental issue (Maurya and Malik, 2016). This contamination leads to the accumulation of heavy metals such as lead, cadmium, mercury, and arsenic in water and sediments, increasing contamination levels and reducing fish visibility. Fish absorb and accumulate heavy metals from their habitats through ingestion, ion exchange across gills and membranes, or adsorption onto tissues (Ahmed *et al*., 2014). Marine organisms, particularly benthic species feeding on sediments, contribute to bioaccumulation, where toxic substances build up in organisms faster than they can be eliminated. In fish, heavy metals concentrate in organs like the liver, gills, and kidneys, leading to health issues such as organ damage and reproductive problems. This bioaccumulation also results in biomagnification, as heavy metals move up the food chain, ultimately impacting higher organisms, including humans. In summary, the analysis of heavy metal residues in water is essential for ensuring safe, clean water, protecting both human and ecological health, and adhering to legal and environmental standards.

Methods Involved in Heavy Metal Analysis:

Sample Collection

Fresh fish samples will be collected from various sites with the help of local fishermen to ensure representativeness. The samples will be immediately placed in polythene bags inside iceboxes and then transported to the laboratory. Upon arrival, the samples will be preserved at a temperature of -18°C to -20°C to maintain their integrity and prevent contamination (Patchaiyappan *et al*., 2023). The collected samples will then be weighed, measured, and divided into two categories: large (individuals with a larger body length and greater body weight) and small (individuals with a smaller body length and lesser body weight). The fish will be categorized by size and weight to assess the relationship between body size and weight with the accumulation of heavy metals. Various fish tissues (e.g., muscle, liver, and gills) will be selected for analysis.

Sample Preparation

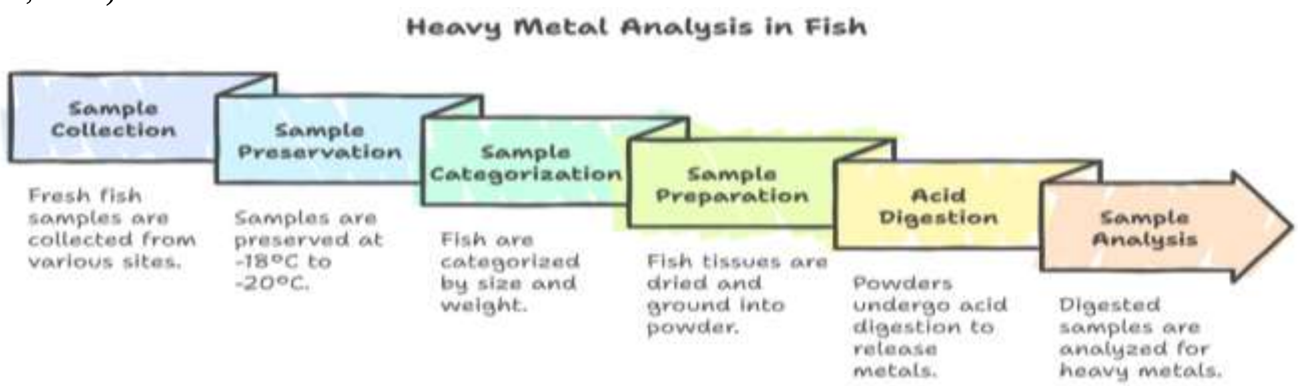
For fish tissue, the samples will first be dried at 105°C for 24hr (Hamed *et al*., 2013) to a constant weight. After drying, the fish tissue will be finely ground into a powder using a clean mortar and pestle or grinder and stored in polyethylene bottles at 30 °C until digestion (Rather *et al*., 2019).

Digestion and Extraction

The powdered samples will then be subjected to acid digestion in a Kjeldahl digestion assembly, typically using a mixture of nitric acid (HNO_3), which may be combined with hydrochloride acid (HCl), and processed using either a microwave digestion system or a conventional digestion block at 150-200°C (Islam *et al*., 2015). After digestion, the samples will be cooled and filtered if necessary to remove any remaining particulate matter. The digestate will be reconstituted with deionized water/distilled water to the desired volume. This process will help to break down organic materials and release metals into solution. The digestion process ensures that metals will present in an ionic form in the solution that can be accurately measured (Lipy *et al*., 2021).

Analysis of heavy metals

The digested samples from fish tissue, will be analysed for heavy metals such as Hg, Cu, Zn, Pb, As, Cr using Atomic Absorption Spectroscopy (AAS) or Inductively Coupled Plasma (ICP) techniques (ICP-OES or ICP-MS). AAS (Flame or Graphite Furnace) measures the absorption of light by metal atoms (Dalman *et al*., 2006). while ICP-OES and ICP-MS measure the emitted light or ions produced by metals in a high-temperature argon plasma to determine the concentrations of metals and allowing for multi-element analysis with high sensitivity (USEPA, 2007).



CONCLUSION

The analysis of heavy metals in fish is crucial for understanding the extent of environmental contamination and its implications for aquatic ecosystems and human health. Fish, being integral to the food web, serve as bioindicators of heavy metal pollution, as they absorb and accumulate toxic metals through various pathways. Monitoring heavy metal concentrations in fish not only highlights the contamination levels in aquatic habitats but also assesses potential risks to biodiversity and food safety. Comprehensive heavy metal analysis helps identify contamination sources, supports the formulation of mitigation strategies, and ensures the protection of both marine life and human populations reliant on aquatic resources.

REFERENCES

Ahmed, M. K., Parvin, E., Islam, M. M., Akter, M. S., Khan, S., & Al-Mamun, M. H. (2014). Lead-and cadmium-induced histopathological changes in gill, kidney and liver tissue of freshwater climbing perch *Anabas testudineus* (Bloch, 1792). *Chemistry and Ecology*, **30**(6), 532-540.

Ambreen, F., Javed, M., & Batool, U. (2015). Tissue specific heavy metals uptake in economically important fish, *Cyprinus carpio* at acute exposure of metals mixtures. *Pakistan Journal of Zoology*, **47**(2).

Dalman, Ö., Demirak, A., & Balcı, A. (2006). Determination of heavy metals (Cd, Pb) and trace elements (Cu, Zn) in sediments and fish of the Southeastern Aegean Sea (Turkey) by atomic absorption spectrometry. *Food chemistry*, **95**(1), 157-162.

Hamed, Y. A., Abdelmoneim, T. S., ElKiki, M. H., Hassan, M. A., & Berndtsson, R. (2013). Assessment of heavy metals pollution and microbial contamination in water, sediments and fish of Lake Manzala, Egypt. *Life science journal*, **10**(1), 86-99.

Islam, M. S., Ahmed, M. K., Habibullah-Al-Mamun, M., & Masunaga, S. (2015). Assessment of trace metals in fish species of urban rivers in Bangladesh and health implications. *Environmental toxicology and pharmacology*, **39**(1), 347-357.

Jamil Emon, F., Rohani, M. F., Sumaiya, N., Tuj Jannat, M. F., Akter, Y., Shahjahan, M., ... & Goh, K. W. (2023). Bioaccumulation and bioremediation of heavy metals in fishes—A review. *Toxics*, *11*(6), 510.

Lipy, E. P., Hakim, M., Mohanta, L. C., Islam, D., Lyzu, C., Roy, D. C., ... & Abu Sayed, M. (2021). Assessment of heavy metal concentration in water, sediment and common fish species of Dhaleshwari River in Bangladesh and their health implications. *Biological Trace Element Research*, **199,** 4295-4307.

Maurya, P. K., & Malik, D. S. (2019). Bioaccumulation of heavy metals in tissues of selected fish species from Ganga River, India, and risk assessment for human health. *Human and Ecological Risk Assessment: An International Journal*, **25**(4), 905-923.

Patchaiyappan, A., Arulkumar, A., Shynshiang, K., Anandkumar, A., Prabakaran, K., Basu, A., ... & Devipriya, S. (2023). Bioaccumulation of heavy metals in commercially important marine species from Puducherry coast, Southeast India. *Regional Studies in Marine Science*, **65**, 103080.

Rather, M. Y., Tilwani, Y. M., & Dey, A. (2019). Assessment of heavy metal contamination in two edible fish species *Carassius carassius* and *Triplophysa kashmirensis* of Dal Lake, Srinagar, Kashmir, India. *Environmental monitoring and assessment*, *191*, 1-6.

USEPA. (2007). Method 6020: Inductively Coupled Plasma Mass Spectrometry. *U.S. Environmental Protection Agency*.