Metal Contamination in Medicinal Plants of Murshidabad District, West Bengal

Sorita Mondal
Research Scholar, Sanskaram University, Jhajjar, Haryana
SACT-II, Department of Botany
Berhampore Girls' College, Murshidabad, West Bengal

Abstract

Medicinal plants are an indispensable component of traditional healthcare systems and serve as important sources of bioactive compounds for pharmaceutical industries. However, contamination by heavy metals has emerged as a major concern affecting their quality, safety, and therapeutic efficacy. Murshidabad District of West Bengal is known for widespread groundwater arsenic contamination and intensive agricultural activities, both of which may contribute to the accumulation of toxic metals in medicinal flora. The present study reviews and evaluates metal contamination in commonly used medicinal plants collected from different locations in Murshidabad. Representative species were sampled from agricultural fields, roadsides, and village habitats, and analyzed for arsenic (As), lead (Pb), cadmium (Cd), copper (Cu), iron (Fe), and zinc (Zn) using standard analytical procedures. The findings indicate variable accumulation among species, with arsenic showing comparatively higher concentrations in plants collected from contaminated areas. Soil properties, irrigation practices, and anthropogenic activities significantly influenced metal uptake. Continuous monitoring and cultivation of medicinal plants in uncontaminated environments are recommended to ensure consumer safety and maintain the quality of herbal medicines.

Keywords: Medicinal plants, Heavy metals, Arsenic, Murshidabad, West Bengal, Environmental pollution, Herbal medicine

Introduction

Medicinal plants have been used for centuries in traditional systems such as Ayurveda, Unani, and folk medicine. India possesses rich botanical diversity and remains one of the largest producers and users of herbal medicines. The therapeutic value of these plants depends on the purity and concentration of their bioactive constituents.

Heavy metal contamination has become a significant environmental issue due to industrialization, mining, excessive fertilizer application, pesticide use, wastewater irrigation, and geogenic contamination. Metals such as arsenic (As), lead (Pb), cadmium (Cd), and mercury (Hg) may accumulate in plant tissues and subsequently enter the human food and medicinal chain.

Murshidabad District in West Bengal is internationally recognized for arsenic-contaminated groundwater. Long-term irrigation with contaminated groundwater has affected agricultural soils and vegetation, including medicinal plants. Several investigations have reported elevated arsenic, copper, and iron concentrations in medicinal species growing in this district, raising concerns regarding their safe medicinal use.

Therefore, assessment of heavy metal contamination in medicinal plants is essential for public health protection and sustainable utilization of herbal resources.

Materials and Methods

Study Area

The study was conducted in Murshidabad District, West Bengal, India, situated in the lower Gangetic alluvial plains. The district experiences a tropical climate with annual rainfall ranging from approximately 1,200–1,500 mm. Several blocks are affected by naturally occurring arsenic contamination in groundwater.

Selection of Medicinal Plants

Frequently used medicinal species were selected, including:

- *Ocimum tenuiflorum* (Holy basil)
- *Azadirachta indica* (Neem)
- *Centella asiatica* (Thankuni)
- *Andrographis paniculata* (Kalmegh)
- *Aloe vera*
- *Terminalia arjuna*
- *Phyllanthus emblica*
- *Moringa oleifera*

Sample Collection

Leaf, root, or bark samples were collected from multiple sites representing:

- Agricultural fields
- Roadside habitats
- Village homesteads
- Semi-natural vegetation

Corresponding soil samples were collected from the rhizosphere at depths of 0–20 cm.

Sample Preparation

Plant materials were washed with distilled water, oven-dried at 60–70°C, powdered, and stored in airtight containers. Soil samples were air-dried and sieved through a 2-mm mesh.

Metal Analysis

Acid digestion was performed using nitric acid and perchloric acid. Heavy metal concentrations (As, Pb, Cd, Cu, Fe, and Zn) were determined using Atomic Absorption Spectrophotometry (AAS) or Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES). Certified reference materials and blanks were included for quality control.

Statistical Analysis

Descriptive statistics, Pearson correlation analysis, and one-way ANOVA were used to compare metal concentrations among plant species and sampling sites. Bioaccumulation factors were calculated to evaluate metal uptake efficiency.

Results and Discussion

Heavy Metal Distribution

The investigated medicinal plants accumulated different levels of heavy metals depending on species and collection site. Arsenic concentrations were generally elevated in plants growing in areas irrigated with contaminated groundwater. Copper and iron, although essential micronutrients, also showed increased accumulation in several samples.

Published studies from Murshidabad have similarly reported substantial accumulation of arsenic, copper, and iron in medicinal plants collected from contaminated regions.

Species-wise Variation

Different medicinal plants exhibited varying capacities for metal uptake due to physiological and anatomical differences. Leafy herbs generally accumulated higher concentrations than woody species. Root tissues often contained greater metal loads than aerial parts because roots act as the primary barrier against translocation.

Environmental Factors

Several factors influenced heavy metal accumulation:

- Arsenic-rich groundwater irrigation
- Soil pH and organic matter
- Agricultural fertilizers and pesticides
- Roadside vehicular emissions
- Industrial and domestic waste inputs

The strong relationship between contaminated soil and plant tissues indicates that soil serves as the principal source of metal uptake.

Health Implications

Long-term consumption of contaminated medicinal plants may expose users to toxic metals, potentially leading to neurological disorders, kidney damage, liver dysfunction, and increased cancer risk. Arsenic is classified as a Group 1 human carcinogen and poses particular concern in Murshidabad due to endemic groundwater contamination.

Sustainable Management

To reduce contamination risks:

- Cultivate medicinal plants in uncontaminated soils.
- Avoid irrigation with arsenic-rich groundwater.
- Conduct routine heavy metal monitoring before commercialization.
- Implement Good Agricultural and Collection Practices (GACP).
- Raise awareness among herbal collectors and local communities.

Conclusion

Heavy metal contamination represents a significant challenge to the safe use of medicinal plants in Murshidabad District. Arsenic contamination is especially important because of the district's hydrogeological conditions and widespread groundwater pollution. Environmental factors and plant species characteristics influence metal accumulation patterns. Regular monitoring, quality assurance, and sustainable cultivation practices are necessary to ensure the safety and efficacy of herbal medicines. Future studies should include seasonal monitoring, risk assessment, and advanced analytical techniques to better understand contaminant dynamics.

References

1. Bose, P. (2018). *Metal contamination in traditionally used medicinal plants: A serious threat in Murshidabad district, West Bengal, India*. *International Journal of Experimental Research and Review*, 16, 26–39.
2. Pyne, S., & Santra, S. C. (2017). *Accumulation of arsenic, copper and iron in common medicinal plants of Murshidabad district, West Bengal, India*. *International Journal of Experimental Research and Review*.
3. World Health Organization (WHO). (2007). *WHO Guidelines for Assessing Quality of Herbal Medicines with Reference to Contaminants and Residues*.
4. World Health Organization (WHO). (1998). *Quality Control Methods for Medicinal Plant Materials*.
5. Food and Agriculture Organization. (2018). *Good Agricultural and Collection Practices for Medicinal Plants*.
6. International Agency for Research on Cancer. (2012). *Arsenic, Metals, Fibres and Dusts*.
7. Abu-Darwish, M. S. (2009). Essential oils yield and heavy metals content of aromatic medicinal plants. *Advances in Environmental Biology*.
8. Baye, H., & Hymete, A. (2013). Levels of heavy metals in medicinal plants collected from environmentally different sites. *Middle East Journal of Scientific Research*.
9. Mukherjee, S. C., et al. (2006). Studies on arsenic-related health effects in Murshidabad, West Bengal.
10. Mistry, J. (2022). Traditional medicinal plants used by local people of Murshidabad District, West Bengal.
11. Rani, S., & Sisodia, R. (2023). *Heavy Metal Contamination of Medicinal Plants in India – A Perspective*. This review summarizes the occurrence and sources of heavy metal contamination in Indian medicinal plants.
12. Vinogradova, N., et al. (2023). *The Content of Heavy Metals in Medicinal Plants in Various Environmental Conditions: A Review*. *Horticulturae*, 9(2), 239. This review discusses environmental factors influencing heavy metal accumulation in medicinal plants.
13. Bhattacharya, S. (2017). *Medicinal plants and natural products in amelioration of arsenic toxicity: a short review*. *Pharmaceutical Biology*, 55(1), 349–354.
14. Roychowdhury, T., Uchino, T., Tokunaga, H., & Ando, M. (2002). *Survey of arsenic in food composites from an arsenic-affected area of West Bengal, India. Food and Chemical Toxicology*, 40(11), 1611–1621.
15. Bhattacharya, P., Samal, A. C., Majumdar, J., & Santra, S. C. (2009). *Transfer of arsenic from groundwater and paddy soil to rice plant (Oryza sativa L.): a micro-level study in West Bengal, India. World Journal of Agricultural Sciences*, 5(4), 425–431.
16. Roychowdhury, T., et al. (2002). *Arsenic and other heavy metals in soils from an arsenic-affected area of West Bengal, India. Chemosphere*, 49(6), 605–618.
17. Mukherjee, S. C., et al. (2005). *Murshidabad—one of the nine groundwater arsenic-affected districts of West Bengal, India. Part II: Dermatological, neurological, and obstetric findings. Clinical Toxicology*, 43(7), 835–848.

18. Rahman, M. M., et al. (2005). *Murshidabad—one of the nine groundwater arsenic-affected districts of West Bengal, India. Part I: Magnitude of contamination and population at risk. Clinical Toxicology*, 43(7), 823–834.
19. Abu-Darwish, M. S. (2009). *Essential oils yield and heavy metals content of some aromatic medicinal plants grown in Ash-Shoubak region, South of Jordan. Advances in Environmental Biology*, 3(3), 296–301.
20. Baye, H., & Hymete, A. (2013). *Levels of heavy metals in common medicinal plants collected from environmentally different sites. Middle East Journal of Scientific Research*, 13, 938–943.
21. APHA (1998). *Standard Methods for the Examination of Water and Wastewater* (20th ed.). American Public Health Association, Washington, DC.