ORIGINAL RESEARCH PAPER

Pharmacognosy

QUANTITATIVE ASSESSMENT OF HEAVY METAL CONTENT IN "*HIBISCUS MICRANTHUS LINN*"

KEY WORDS: Heavy metal, Hibiscus micranthus, ICP-OES

Dr. V. R. Ravikkumar	Professor & Head, Department of Pharmacognosy- The Erode College of Pharmacy, Erode.
Ms. S. Mahalakshmi*	PG Scholar, Department of Pharmacognosy- The Erode College of Pharmacy, Erode. *Corresponding Author
Mrs. K. P. Boovizhi	PG Scholar, Department of Pharmacognosy- The Erode College of Pharmacy, Erode.
Mr. R. Sathiya	PG Scholar, Department of Pharmacognosy- The Erode College of Pharmacy, Erode.
Mr. C. Srikeerthivasan	PG Scholar, Department of Pharmacognosy- The Erode College of Pharmacy, Erode.
Ms. M. Loganayagi	Assistant Professor, Department of Pharmacognosy- The Erode College of Pharmacy, Erode.
Ms. V. Maheswari	Assistant Professor, Department of Pharmacognosy- The Erode College of Pharmacy, Erode.

ABSTRACT

The heavy metal analysis of *Hibiscus Micranthus* was conducted using the Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES) instrument, employing a precise and robust methodology. Approximately 20 mg of the plant sample was subjected to microwave-assisted digestion using ultrapure nitric acid, ensuring complete breakdown of the matrix over a 45-minute digestion period. The digested sample was then diluted to a final volume of 50 mL for analysis. To guarantee accurate quantification, calibration standards of arsenic, cadmium, mercury, and lead were prepared at concentrations ranging from 2 µg/mL to 10 µg/mL, which established high linearity for each respective metal, with correlation coefficients exceeding 0.996. The ICP-OES instrument was optimized with an RF power setting of 1.2 kW, a plasma gas flow rate of 12 L/min, and a nebulizer gas flow rate of 0.70 L/min to enhance the sensitivity and reproducibility of detection. Analytical results indicated that the levels of all tested heavy metals arsenic, cadmium, mercury, and lead—were below the detection limits of the instrument, signifying negligible or non-detectable contamination in the *Hibiscus Micranthus* sample. This outcome confirms the sample's safety for pharmaceutical or herbal applications, minimizing concerns related to heavy metal toxicity. The study further validated the analytical procedure by documenting calibration curves and linearity graphs, reinforcing the reliability of the method used. Overall, this ICP-OES-based evaluation establishes a trustworthy framework for heavy metal determination in herbal materials, contributing critical insights into the quality control of *Hibiscus Micranthus* and endorsing its continued use where safety is paramount. The results are significant for researchers and manufacturers focused on ensuring contaminant-free botanical products through advanced instrumental techniques.

INTRODUCTION[1-15]

Heavy metal analysis is crucial for assessing the safety, quality, and therapeutic efficacy of medicinal plants and their formulations. Medicinal herbs are widely used in traditional and modern medicine due to their potent pharmacological effects. However, the presence of toxic heavy metals, such as arsenic (As), cadmium (Cd), mercury (Hg), and lead (Pb), can significantly compromise safety, posing serious health risks. Even in trace amounts, these metals are known for their cumulative toxicity, leading to chronic diseases in vital organs like the liver, kidneys, and nervous system. Therefore, measuring and monitoring heavy metal levels in herbal raw materials is crucial to ensure they meet pharmacopeial standards and regulatory guidelines worldwide. One of the most advanced methods for detecting trace elements is Inductively Coupled Plasma–Optical Emission Spectroscopy (ICP-OES). This technique is preferred because of its high sensitivity, accuracy, fast analysis, and ability to detect multiple elements at low concentrations simultaneously. It works by converting the sample into an aerosol, which is introduced into a high-temperature plasma. The plasma excites the atoms of each element, causing them to emit light at specific wavelengths. The signal intensity correlates directly with the element's concentration, making ICP-OES a reliable tool for measuring toxic metals in complex herbal matrices. In this analysis, the heavy metal content of Hibiscus micranthus, a medicinal plant known for its therapeutic potential, was examined using ICP-OES. The sample underwent microwave-assisted acid digestion to completely break down organic matter and release metal ions for detection. The parameters were carefully optimized, and calibration curves were prepared for each element within the range of 2–10 µg/mL to ensure high linearity and accuracy. Such heavy metal screening is vital not only for ensuring the safety of herbal raw materials but also for supporting their acceptance in the global market, where strict quality standards are required. This kind of analysis helps validate herbal medicines scientifically, fostering their safe use in modern healthcare systems.

MATERIAL AND METHODS[16-21]

Take about 20 mg of sample into the Teflon microwave digestion vessel and add 1 mL of ultrapure nitric acid to digest for about 45 minutes using the Anton Paar microwave digestion unit. After that, the sample is made up to a 50 mL standard measuring flask. The calibration standard solution is prepared for 2 µg/mL to 10 µg/mL by using ultrapure nitric acid and a blank solution. Agilent ICP-OES 5100 VDV instrument used with the following operation conditions: a RF power of 1.2 kW, a plasma gas flow rate of 12 L min^{-1}, and a nebulizer gas flow rate of 0.70 L min^{-1}. The samples are introduced into the plasma using a nebulizer and a spray

chamber for the analysis.

RESULTS

Table 1: Standard Linearity

Elements	Wavelength	R^2 Valve
Arsenic [As] (µg/ml)	188.980	0.9972
Cadmium [Cd] (µg/ml)	226.502	0.9964
Mercury [Hg] (µg/ml)	184.887	0.9985
Lead [Pb] (µg/ml)	220.353	0.9969

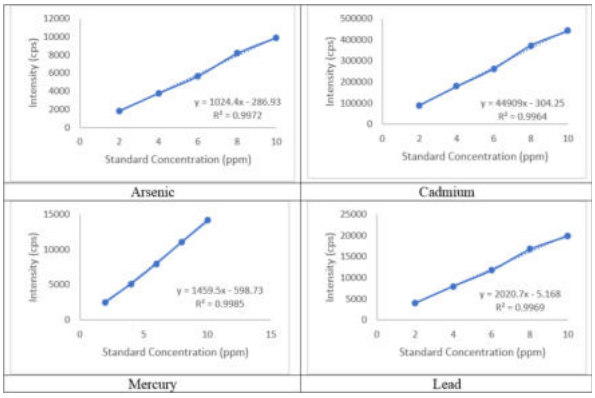

Fig 1: Standard Linearity

Table 2: BDL – Below Detection Limit

Elements	Hibiscus micranthus Linn
As	BDL
Cd	BDL
Hg	BDL
Pb	BDL

Inductively Coupled Plasma–Optical Emission Spectroscopy (ICP-OES)

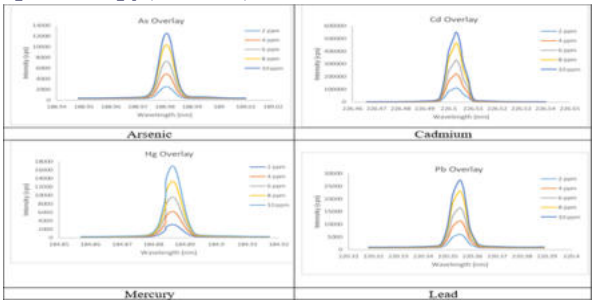

Fig 2: Standard Overlaid Graphs

Inductively Coupled Plasma–Optical Emission Spectroscopy (ICP-OES)

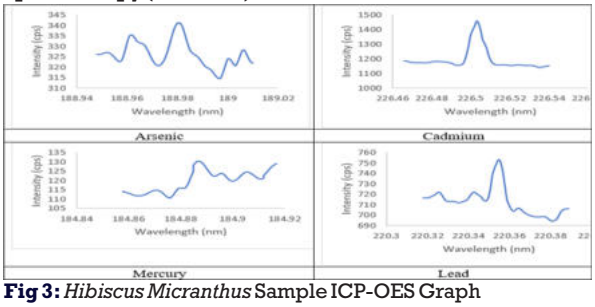

Fig 3: *Hibiscus Micranthus* Sample ICP-OES Graph

DISCUSSION

Heavy metal contamination in medicinal plants poses serious health risks, necessitating rigorous analytical assessment to ensure safety and compliance with regulatory standards; therefore, the present study employed Inductively Coupled Plasma–Optical Emission Spectroscopy (ICP-OES), a high-sensitivity, multi-element detection technique widely recognized for accuracy and efficiency in analyzing trace metals in complex herbal matrices. After microwave-assisted nitric acid digestion to completely break down organic matter and release bound metals, samples of *Hibiscus micranthus* were analyzed using an Agilent ICP-OES 5100 VDV under optimized plasma and nebulizer conditions to quantify arsenic, cadmium, mercury, and lead levels, with calibration standards ensuring linearity and precision across the relevant concentration range. The results showed that all toxic metals were below detection limits, indicating the absence of hazardous contamination and affirming the plant's safety for medicinal use. This outcome aligns with the growing body of literature emphasizing the criticality of heavy metal monitoring in herbal medicines, as soil, environmental pollution, and agricultural practices heavily influence metal uptake in plants. The study underscores ICP-OES as an indispensable tool for quality control and safety assurance in herbal medicine production, supporting both scientific validation and regulatory compliance. Moreover, the negligible heavy metal content observed enhances consumer confidence and strengthens the potential for global market acceptance of *Hibiscus micranthus* based Phyto-therapeutics, contributing significantly to public health protection and the advancement of herbal drug standardization and safety practices worldwide. This approach reflects evolving trends in phytochemical safety evaluation, which integrate advanced instrumental techniques to address contamination risks while fostering the integration of traditional medicines into modern healthcare systems.

REFERENCE

1. Luo L, et al. Heavy metal contaminations in herbal medicines: a global concern. Front Pharmacol. 2021;12:647131.
2. World Health Organization. Quality control methods for medicinal plant materials. Geneva:WHO;2019.
3. Rahman MS, Islam MN. Heavy metals in medicinal plants: sources, accumulation, and health risks. Environ Sci Pollut Res Int. 2021;28(33):44432–47.
4. Becker JS. Inductively coupled plasma mass spectrometry: a practical guide. 2nd ed. Wiley; 2019.
5. Hou XY, Jones BT. Inductively coupled plasma optical emission spectrometry. Encycl Anal Chem. 2013;1–37.
6. Oladeji OM, et al. Investigation of heavy metal levels in medicinal plants used in skin cancer treatment using ICP-MS. J Environ Sci Health A Tox Hazard Subst Environ Eng. 2023;58(4):345–58.
7. Syed RS, et al. Heavy metal toxicity in plants: a review. Plant Arch. 2018;18(2):1229–38.
8. Sperdouli I. Heavy metal toxicity effects on plants. Plants (Basel). 2022;11(12):1631.
9. Abu-Darwish MS, et al. Heavy metal contents in water extracts of selected medicinal plants. Toxicol Rep. 2024;11:865–72.
10. Rani S, et al. Heavy metal contamination of medicinal plants in India. Asian J Water Environ Pollut. 2023;20(6):1147–55.
11. Bisht VK, et al. Assessment of heavy metal content in herbal raw materials and safety evaluation. J Tradit Complement Med. 2022;12(4):315–24.
12. Jaishankar M, et al. Toxicity, mechanism and health effects of some heavy metals. Interdiscip Toxicol. 2014;7(2):60–72.
13. Gomez MR, et al. Determination of heavy metals for quality control in phytomedicines by ICP-OES. Talanta. 2007;71(2):862–7.
14. Angon PB, et al. Sources, effects and present perspectives of heavy metals pollution in soils. Environ Res. 2024;218:114888.
15. He S, et al. Research progress of the detection and analysis methods for heavy metals in plants. Front Plant Sci. 2024;15:1310328
16. Hou XY, Jones BT. Inductively coupled plasma optical emission spectrometry. Encycl Anal Chem. 2013;1–37.
17. Becker JS. Inductively coupled plasma mass spectrometry: a practical guide. 2nd ed. Wiley; 2019.
18. Olmez-Hanci T, et al. Optimization of microwave digestion procedure for the determination of heavy metals in complex matrices. Microchem J. 2018;137:289–94.
19. Csuros M. Sample preparation for ICP spectroscopy. In: Csuros M, editor. Sample preparation for trace element analysis. CRC Press; 1998. p. 37–56.
20. Agilent Technologies. Agilent 5100 ICP-OES Series Operating Manual. Agilent Technologies; 2018.
21. Garcia-Montelongo F, et al. Determination of trace metals using ICP-OES with optimized plasma conditions and nebulizer parameters. J Anal At Spectrom. 2015;30(1):60–8.