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Evaluation of some minerals and trace elements in *Bacopa monnieri* (Wettst) Linn.

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Abstract
Bacopa monnieri (wettset) Linn. is a plant renowned for its diverse therapeutic characteristics and extensive use in the treatment of numerous human ailments. The elemental composition of *Bacopa monnieri* (wettset) Linn. was analyzed to detect the presence of ten specific elements: Cu, Na, Hg, Cr, Mn, Fe, Ni, Cd, Zn, and Pb. This analysis aimed to establish a more solid understanding of the plant's therapeutic properties. ICPES technique was used to analyze elements from leaves. Different elements with biological significance for human metabolism were discovered to be present in different amounts. The results were analyzed in relation to the well-established role of elements in the physiology and pathology of human existence. The acquired data would function as a tool for determining the appropriate dosage of the Ayurvedic medication derived from this plant.

Keywords: *Bacopa monnieri* (Wettst) Linn., elemental analysis, ICPES

Introduction
The global utilisation of herbal medicines is increasing. Individuals have a preference for natural products due to their reduced side effects, increased efficacy, lower cost, and gentler impact. Everything was based on experience because at the time, neither the causes of the ailments nor the specific plants that could be used as a therapy were known with sufficient certainty. As the rationale for using particular medicinal plants to treat specific ailments came to light throughout time, the use of medicinal plants gradually renounced the empiric framework in favor of facts that provided an explanation [1].

In India, songs and poetry recite were used to transmit knowledge and wisdom from one generation to the next. Indian knowledge system was primarily based on oral transmission of knowledge, in this tradition four Vedas hold a significant importance. The Rig Veda contains countless poetry hymns that explain the fundamentals of Ayurvedic medicine as well as the medicinal properties of various plants. The famous Samhita (medical encyclopedia) was written at the University of Banaras around 500 BC, which was also the first institution to educate Ayurvedic medicine. The foundation of the Ayurveda was created using these two monumental encyclopedias, which were authored 700 years apart [2].

For a wide range of studies, including those aiming to enhance plant nutrition and crop productivity and lower concentrations of harmful contaminants in food, visualization of elements in plants is crucial. Therefore, in plant molecular biology, agronomy, plant nutrition, plant physiology, and ionomics, having a thorough grasp of the distribution and chemical form of target components in plants is essential [3].

The most used emission spectrometric method is inductively coupled plasma atomic emission spectrometry (ICP-AES). It is also known as ICP-OES (optical emission spectrometry). The argon-based plasma gives high energy for drying, dissociation, atomization, and ionization of the analytes and is compatible with aqueous aerosols. The temperature that an argon ICP reaches is between 5500 and 6500 K, which is high enough to greatly weaken molecular bonds and ionize a variety of elements. A high atomization yield and thus great sensitivity are produced by the high level of excitation. A pneumatic nebulizer is used to create the aerosols in the ICP's typical setup, and a spray chamber serves as a filter to pick droplets with a maximum cutoff diameter. Depending on the apparatus, a monochromator or a polychromator resolves the light that the excited atoms produce upon their return to a less energetic state into a line spectrum. The intensity corresponds to the concentration, and the wavelength to the individual atom. The frequency of potential interferences brought on by matrix components is very high and necessitates thorough investigation [4].

Materials and Methods

Sample collection

Whole plant parts of *Bacopa monnieri* (wettst) Linn. was procured from Yash Chedda Farm, Palghar.

Sample Preparation

Plant samples' surface pollutants were cleaned off using distilled water. After that, it was dried before being ground into powder. The powder was utilized for additional examination and kept in airtight glass containers.

Digestion

The digestion of plant sample was carried out following the method of Saraf & Sawant, 2013 [14]. Nitric acid was used to dissolve the two grams of plant powder, which was then heated until the reddish-brown fumes vanished. The aforementioned solution was then boiled for 5 minutes after perchloric acid was added. Aqua regia was then added and boiled after that. Then, 25ml of deionized water was added to the capacity in a standard flask. The Inductively Coupled Plasma - Optical Emission Spectrometer was used to estimate the elements. (Model: ICP-OES Agilent 5800, United States).

Table 1: Concentration of elements in *Bacopa monnieri* wettst Linn.

Plant sample	Cu PPM	Zn PPM	Mn PPM	Fe PPM	Cr PPM	Na PPM	Ni PPM	Pb PPM	Cd PPM	Hg PPM
	0.52	0.79	1.07	0.51	0.13	1.57	0.08	0.03	0.01	0.05

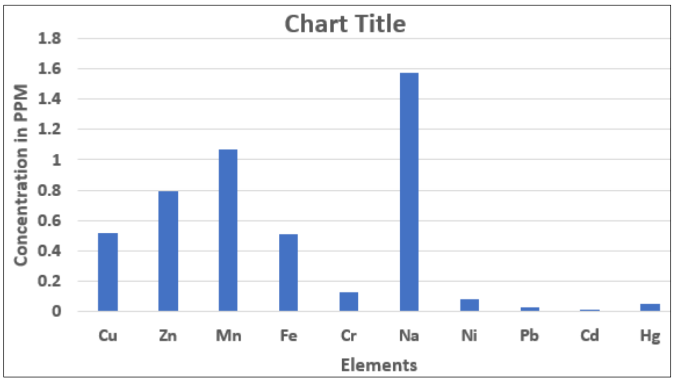

Fig 1: Concentration of Elements in *Bacopa monnieri* (Wettst) Linn.

Results and Discussion

According to review of literature, trace metals like Fe, Mn, Cu, Zn, Co, and Ni are micronutrient for living system, their deficiency or excess can lead to a number of disorderness in human body [5]. The prevention of chronic diseases is aided by trace elements such as iron, zinc, fluoride, selenium, copper, chromium, iodine, manganese, and molybdenum.

Copper: The content of copper seen in plant sample is 0.52 ppm (Table 1 & Figure 1). The permissible limit set by FAO/WHO for copper in edible plants was 3.00 ppm [6]. However, for medicinal plants the WHO limits not yet been established for Cu. The thresholds for Cu in medicinal plants, as established by China and Singapore, were 20 ppm and 150 ppm, respectively [7].

Copper (Cu) is crucial at the cellular level for various functions including cell wall metabolism, signaling to the transcription protein trafficking machinery, oxidative phosphorylation, iron mobilization, and the synthesis of molybdenum cofactor. Copper ions act as cofactors in several enzymes, including as Cu/Zn-superoxide dismutase (Cu/ZnSOD), cytochrome c oxidase, ascorbate oxidase, amino oxidase, laccase, plastocyanin, and polyphenol oxidase. [8].

Zinc: 0.79 ppm Zinc is present in plant sample. Zinc is a micronutrient. It plays a significant role in numerous enzymatic activities in plants. Zinc is necessary for the synthesis of tryptophan, which is a constituent of certain proteins and a molecule required for the formation of growth hormones (auxins) such indoleacetic acid. It plays a role in the production of chlorophyll and the maintenance of cell membrane structure [9].

Manganese: Manganese (Mn) is a crucial micronutrient for plants, playing a vital role as a catalyst in the oxygen-evolving complex of photosystem II (PSII). In addition to its role in PSII, the availability of Mn also impacts root growth and architecture [10]. Manganese primarily participates in the process of photosynthesis and serves as a cofactor for antioxidant enzymes [11].

The plant sample contains a concentration of 1.07 parts per million (PPM) of Mn. The FAO/WHO (1984) established a maximum allowable value of 2 ppm for Mn in edible plants. [12]. However, the permissible WHO (2005) limits for Mn in medicinal plants have not yet been set.

Iron: Iron plays a crucial role in the synthesis of chlorophyll in plants and is necessary for the upkeep of chloroplast structure and function [13]**.** Iron is crucial for the synthesis of haemoglobin and also plays a vital function in the transportation of oxygen and electrons inside the human body. Research indicates that consuming high levels of Iron can be detrimental to one's health [14].

The concentration of Iron in the plant sample is 0.51 ppm. The permissible level set by WHO for Iron in edible plants was 20 ppm [6].

Chromium: Chromium is a crucial micronutrient necessary for the proper metabolism of carbohydrates. The biological role of chromium is intricately linked to that of insulin, and most processes triggered by chromium also rely on the presence of insulin. Optimal chromium intake results in reduced insulin dependency and enhanced blood lipid profile [15].

Various adverse effects have been documented, including oral ulcers, dyspepsia, acute tubular necrosis, emesis, abdominal discomfort, renal failure, and potentially fatal outcomes. (16). The concentration of chromium in sample is found to be 0.13 PPM. the permissible limit for chromium set by FAO/WHO in edible plants is 2 ppm [6].

Sodium: Sodium is required for the survival of all living beings. The elemental constitution of the human body is primarily composed of 12 fundamental chemical elements, which account for 99% of its composition. Sodium comprises around 2% of the body's overall mineral composition among these elements [17]. The level of sodium in plant is 1.57 ppm. The recommended daily consumption of sodium (Na) is 2.4 g, whereas the recommended daily intake of potassium (K) is 3.5 g.

Consuming too much sodium has been linked to a higher risk of stomach cancer, nephrolithiasis, and osteoporosis. This is due to increased urine calcium losses, which leads to a negative calcium balance [18].

Nickel: Nickel plays a crucial part in the enzymatic activity of several plant enzymes. Its primary function is associated with the functioning of enzymes such as ureases, acetylo-S-CoA synthase, glyoxalase I, and hydrogenases [19]. Exposure of humans to situations with high levels of nickel pollution has the capacity to cause a range of pathological outcomes. These include skin allergies, lung fibrosis, respiratory tract cancer, and iatrogenic nickel toxicity [20-21].
The amount of Nickel in plant sample is found to be 0.08 ppm. The World Health Organization (WHO) has established a maximum allowable concentration of 1.63 parts per million (ppm) for nickel in food plants. However, no specific allowed limits for nickel in medicinal plants have been determined yet.
Lead: Lead lacks any biological purpose and is harmful to living organisms even at low levels. While Pb is not necessary for life, certain plant species thrive in areas contaminated with Pb and store it in various parts. Roots are the initial organ that comes into contact with the diverse components of the rhizosphere [22].
According to WHO (1992), the acceptable level of lead in edible plants was set at 0.43 ppm [23]. However, China, Malaysia, Thailand, and the World Health Organization (WHO) have established a maximum allowable limit of 10 ppm for medicinal plants [24].

Cadmium: The concentration found in plant sample is 0.01 PPM and the acceptable threshold (as defined by the World Health Organization) for cadmium in edible plants is 0.21ppm, whereas for medicinal plants it is 0.3 ppm [24].
Cadmium (Cd) is a metallic element that is present in the environment in various forms and is associated with a range of harmful reactions. In plants, the presence of Cd can hinder growth and result in leaf discoloration [25]. Multiple experimental studies suggest that long-term exposure to cadmium in humans can be linked to the development of cancer, particularly in the lungs, as well as the prostate, kidneys, breast, urinary bladder, nasopharynx, pancreas, and haematological system [26].

Mercury: In recent decades, Hg and its derivatives have gained notoriety as substances associated with various poisoning occurrences. Nevertheless, mercury (Hg), being an inherent element, has been in the environment for millions of years [27]. An excessive amount of mercury can lead to infertility, miscarriage, premature births, digestive abnormalities, thyroid disorders, and negative impacts on brain function and the learning process [28].
The concentration in the plant sample is 0.05 PPM. The World Health Organization (WHO) and the Food and Agriculture Organization of the United Nations (FAO) have established a maximum allowable level of 1 μg/g for mercury in herbal remedies [29].

Discussion

Conclusion and Discussion: The medicinal herb *Bacopa monnieri* (wettst) Linn. examined in this work is a great source of biologically relevant components that may have several medicinal uses. Thus, it may supplement macro and micronutrients in the body. Many ailments are treated effectively by Ayurvedic remedies. Trace elements affect medicinal plant pharmacological effectiveness.
Most element concentrations vary due to botanical structure and soil mineral makeup. Plant preference absorbability, fertilizer use, irrigation, and climate also affect element composition. There exists a link between plant elemental makeup and therapeutic qualities. Limited data on mineral buildup of this medicinal plant has led to skepticism about its use as a mineral supplement. Hence, traditional medicine medicinal plant elemental makeup analysis is desirable.
Bacopa monnieri (wettst) Linn. elemental makeup is examined in this work. It has been found to be a very good source of trace elements. This knowledge will aid the development of new Ayurvedic drugs for various conditions. To further comprehend *Bacopa monnieri* (wettst) Linn. therapeutic qualities, we must study how soil and climate affect its elemental composition. Iron (Fe), copper (Cu), zinc (Zn), and manganese (Mn) are abundant in *Bacopa monnieri* (wettst) Linn., a medicinal herb. Plants abundant in these macro and micronutrients may improve human health. All element measurements in the studied plants are below the World Health Organization's therapeutic plant limits. Thus, these measurements are unlikely to harm consumers.

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

1. Petrovska BB. Historical review of medicinal plants' usage. Pharmacogn Rev. 2012;6(11):1–5.
2. Gurib-Fakim A. Medicinal plants: Traditions of yesterday and drugs of tomorrow. Mol Aspects Med. 2006;27(1):1–93.
3. Kopittke PM, Lombi E, van der Ent A, Wang P, Laird JS, Moore KL, *et al*. Methods to visualize elements in plants1[open]. Plant Physiol. 2020;182(4):1869–82.
4. Cornelis R, Nordberg M. General Chemistry, Sampling, Analytical Methods, and Speciation. Handb Toxicol Met Third Ed; c2007. p. 11–38.
5. Jinwal A, Dixit S, Malik S. Some trace elements investigation in ground water of Bhopal and Sehore district in Madhya Pradesh. Indian J Environ Prot. 2009;29(11):991–6.
6. Of B, Synopses E. WJ wm; c1999. (October).
7. Mechkovski. WHO_PHARM_92.559_rev.1.pdf. 1998.
8. Raven JA, Evans MCW, Korb RE. The role of trace metals in photosynthetic electron transport in O2-evolving organisms. Photosynth Res. 1999;60(2–3):111–50.
9. Speight JG. Acidity and Alkalinity. Rules of Thumb for Petroleum Engineers; c2017. p. 17–17.
10. Schmidt SB, Jensen PE, Husted S. Manganese Deficiency in Plants: The Impact on Photosystem II. Trends Plant Sci. 2016;21(7):622–32.
11. Millaleo R, Reyes-Díaz M, Ivanov AG, Mora ML, Alberdi M. Manganese as essential and toxic element for plants: Transport, accumulation and resistance mechanisms. J Soil Sci Plant Nutr. 2010;10(4):476–94.
12. World Health Organization. Environmental Health Criteria 17 Manganese, 1981, 7.
13. Rout GR, Sahoo S. Role of Iron in Plant Growth and Metabolism. Rev Agric Sci. 2015;3(0):1–24.
14. Saraf A, Sci ASIJP, 2013 undefined. Evaluation of some minerals and trace elements in Achyranthes aspera Linn. AcademiaEdu [Internet]. 2013;3(3):229–33. Available from: https://www.academia.edu/download/52710972/ijps229-233.pdf

15. Anderson RA. Nutritional role of chromium. Sci Total Environ. 1981;17(1):13–29.
16. Beaumont JJ, Sedman RM, Reynolds SD, Sherman CD, Li LH, Howd RA, *et al*. Cancer mortality in a Chinese population exposed to hexavalent chromium in drinking water. Epidemiology. 2008;19(1):12–23.
17. Kodintsev VV, Lenda IV, Ponomarev AV, Naumov NA, Salatov YAS. Sodium As One of the Basic Elements in Human Life c2022. p. 1–35. Available from: https://world-science.ru;
18. Pasquale Strazzullo* CL. Sodium 1. 2014;2:3–4.
19. Mielcarz L, Smoli B. Nickel – the use and influence on living organisms. 2016;80(1):43–52.
20. Kasprzak KS, Sunderman FW, Salnikow K. Nickel carcinogenesis. Mutat Res - Fundam Mol Mech Mutagen. 2003;533(1–2):67–97.
21. Cempel M, Nikel G. Nickel: A Review of Its Sources and Environmental Toxicology. Polish J Environ Stud. 2006;15(3):375–82.
22. Lynch JM, Whipps JM. Substrate flow in the rhizosphere. Plant Soil. 1990;129(1):1–10.
23. Environmental health criteria for cadmium Environmental aspects. Environ Heal Criteria. 1992;(135):1–156.
24. Jabeen S, Shah MT, xKhan S, Hayat MQ. Determination of major and trace elements in ten important folk therapeutic plants of Haripur basin, Pakistanx. J Med Plants Res. 2010;4(7):559–66.
25. Zhang H, Reynolds M. Cadmium exposure in living organisms: A short review. Sci Total Environ [Internet]. 2019;678:761–7. Available from: https://doi.org/10.1016/j.scitotenv.2019.04.395
26. Genchi G, Sinicropi MS, Lauria G, Carocci A, Catalano A. The effects of cadmium toxicity. Int J Environ Res Public Health. 2020;17(11):1–24.
27. Li C, Shen J, Zhang J, Lei P, Kong Y, Zhang J, *et al*. The silver linings of mercury: Reconsideration of its impacts on living organisms from a multi-timescale perspective. Environ Int [Internet]. 2021;155:106670. Available from: https://doi.org/10.1016/j.envint.2021.106670
28. Gaur S, Singh N, Singh A, Singh HK. Biological Influences of Mercury on Living Organisms. Int J Med Biomed Stud. 2017, 1(6).
29. World Health Organization. Quality control methods for medicinal plant materials. World Health Organization; c1998.