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Analysis Of Trace Elements In Some Medicinal Parasitic Plants Through Atomic Absorption Spectroscopy

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Abstract:

Parasitic plants derive nutrients from their host plants, often resulting in significant alterations in their trace element composition. Similarly, the accumulation of various elements in these parasitic species raises ecological and health concerns, particularly in polluted environments. This study was examined the concentration of 14 different trace elements (measured in mg/L) in selected parasitic plants, namely Striga asiatica *(L.) O. Ktze.,* Alectra parasitica *A. Rich, and* Viscum articulatum *Burm.f, using Atomic Absorption Spectroscopy (AAS). The primary objective was to provide evidence of both essential and non-essential heavy metals present in these herbs, which are widely utilized in the formulation of herbal products and standardized extracts.*

Keywords: Trace Elements, Medicinal, Parasitic Plants and Atomic Absorption Spectroscopy.

Introduction:

Medicinal plants and their extracts play a crucial role in human health and deserve significant attention. For a large portion of the global population, these plants serve as the primary means of healthcare (WHO, 2005). Some of the most common heavy metals associated with toxicity in humans include lead, mercury, arsenic, and cadmium, while aluminum and cobalt can also pose health risks. Due to these concerns, the World Health Organization advises monitoring medicinal plants—used as raw materials in many herbal remedies—for the presence of heavy metals. Additionally, plants serve as a valuable source of natural compounds, often inspiring the development of new pharmacologically active substances (Gunavathy and Sherine, 2019).

Parasitic plants depend on their host plants for water, minerals, and organic nutrients, influencing both their own growth and the health of their hosts (Kujit, 1969). Analyzing their elemental composition provides insight into nutrient transfer dynamics and the effects on host plant vitality. These parasitic species not only draw nutrients from their hosts but can also absorb environmental contaminants, including heavy metals (Jain, 2005). Toxic elements such as lead (Pb), cadmium (Cd), arsenic (As), mercury (Hg), and zinc (Zn) can have adverse effects on plants, animals, and human health (Pirzada *et al*., 2009). Investigating the accumulation patterns of these metals in parasitic plants is essential for understanding their ecological impact and their potential role in phytoremediation (Sahito *et al*., 2003). Therefore, monitoring heavy metal content in medicinal plants is critical to ensuring the safety and effectiveness of herbal products and

traditional medicines (Nookabkaew *et al.*, 2006).

Atomic Absorption Spectroscopy (AAS) is a highly sensitive analytical method used for detecting elemental composition in biological samples (Sarpong *et al.*, 2012; Khathi *et al.*, 2016). Since no comprehensive study has been conducted on the elemental profile of traditionally valued parasitic plants, this research aims to establish a basis for their standardization and identification. Such findings can help assess the authenticity and quality of these plants. Three medicinally significant parasitic plant species were selected for elemental analysis: *Striga asiatica* (L.) O. Ktze. and *Alectra parasitica* A. Rich, both from the family Scrophulariaceae, and *Viscum articulatum* Burm.f from the family Viscaceae.

Materials and Methods:

The three selected parasitic plants—*Striga asiatica* (L.) O. Ktze., *Alectra parasitica* A. Rich, and *Viscum articulatum* Burm.f—were collected from various locations in the Akola district of Maharashtra, India (Kakpure *et al.*, 2011) and identified using standard floras (Kamble & Pradhan, 1988; Naik, 1998; Singh *et al.*, 2001). The collected samples were dried, ground, and digested using a combination of nitric acid and hydrogen peroxide.

Elemental analysis of the medicinal parasitic plant samples was conducted following the dry ashing digestion method, based on the Perkin-Elmer atomic absorption spectrophotometry protocol. For each plant, 10 grams of powdered sample were weighed and placed in a porcelain crucible. The samples were dried at 110°C and treated with 50% (w/v) magnesium nitrate solution. The ashing process was carried out in a controlled muffle furnace at 450°C and left overnight to ensure complete oxidation of organic matter.

The resulting ash was dissolved in 20 mL of concentrated nitric acid (HNO_3) within a 200 mL digestion tube and heated in a block digester to facilitate complete dissolution. The process continued until the brown nitric acid fumes disappeared, and the solution turned clear. Distilled water was then added to bring the final volume to 20 mL. The solution was filtered using a 0.45 µm Whatman No. 41 membrane filter paper to obtain a particle-free sample.

The prepared analyte was aspirated into the VARIAN SPECTRA AA220 Zeeman Atomic Absorption Spectrometer (AAS) for analysis. A total of 14 elements—aluminum, arsenic, barium, cadmium, chromium, cobalt, copper, iron, magnesium, manganese, nickel, potassium, sodium, and zinc—were quantified in each sample. The mean values (n=3 ± SD) were recorded for each element. Similar methodologies have been described in previous studies (Harborne, 1998; Kalia, 2005; Khan *et al.*, 2011; Sarpong *et al.*, 2012; Khathi *et al.*, 2016).

Results and Discussion:

The elemental analysis of extracts from *Striga asiatica* (L.) O. Ktze., *Alectra parasitica* A. Rich, and *Viscum articulatum* Burm.f, using the digestion method, confirmed the presence of 12 trace elements, measured in mg/L. These include aluminum, barium, chromium, cobalt, copper, iron, magnesium, manganese, nickel, potassium, sodium, and zinc. However, heavy metals such as arsenic and cadmium were not detected in the extracts. The results indicated that magnesium (Mg), potassium (K), sodium (Na), and iron (Fe) were present in higher concentrations compared to other elements in all three plants. The concentration of these elements ranged from 2.13 to 16.34 mg/L, while aluminum (Al), barium (Ba), chromium (Cr), cobalt (Co), copper (Cu), manganese (Mn), nickel (Ni), and zinc (Zn) were detected in lower concentrations, ranging from 0.024 to 0.813

mg/L. A detailed breakdown of these findings is presented in Table 1.

Table 1: Concentration of elements in three selected parasitic plants (Mean Value in mg/L)

S. N.	Elements	*S. asiatica*	*A. parasitica*	*V. articulatum*
1	Aluminum (Al)	0.308 ± 0.12	0.125 ± 0.020	0.037 ± 0.003
2	Barium (Ba)	0.024 ± 0.004	0.063 ± 0.004	0.065 ± 0.007
3	Chromium (Cr)	0.100 ± 0.014	0.150 ± 0.032	0.253 ± 0.052
4	Cobalt (Co)	0.021 ± 0.004	0.067 ± 0.009	0.049 ± 0.009
5	Copper (Cu)	0.099 ± 0.006	0.033 ± 0.007	0.147 ± 0.069
6	Iron (Fe)	5.605 ± 0.94	16.34 ± 1.60	4.360 ± 1.14
7	Magnesium (Mg)	14.77 ± 0.031	14.58 ± 0.042	13.41 ± 0.28
8	Manganese (Mn)	0.219 ± 0.007	0.438 ± 0.007	0.137 ± 0.010
9	Nickel (Ni)	0.028 ± 0.006	0.043 ± 0.008	0.188 ± 0.026
10	Potassium (K)	13.42 ± 0.88	2.136 ± 0.048	13.59 ± 1.01
11	Sodium (Na)	6.684 ± 0.74	12.83 ± 0.075	5.670 ± 1.30
12	Zinc (Zn)	0.626 ± 0.010	0.813 ± 0.041	0.377 ± 0.028
13	Arsenic (Ar)	ND	ND	ND
14	Cadmium (Cd)	ND	ND	ND

(n=3 ± SD), ND= Not Detected

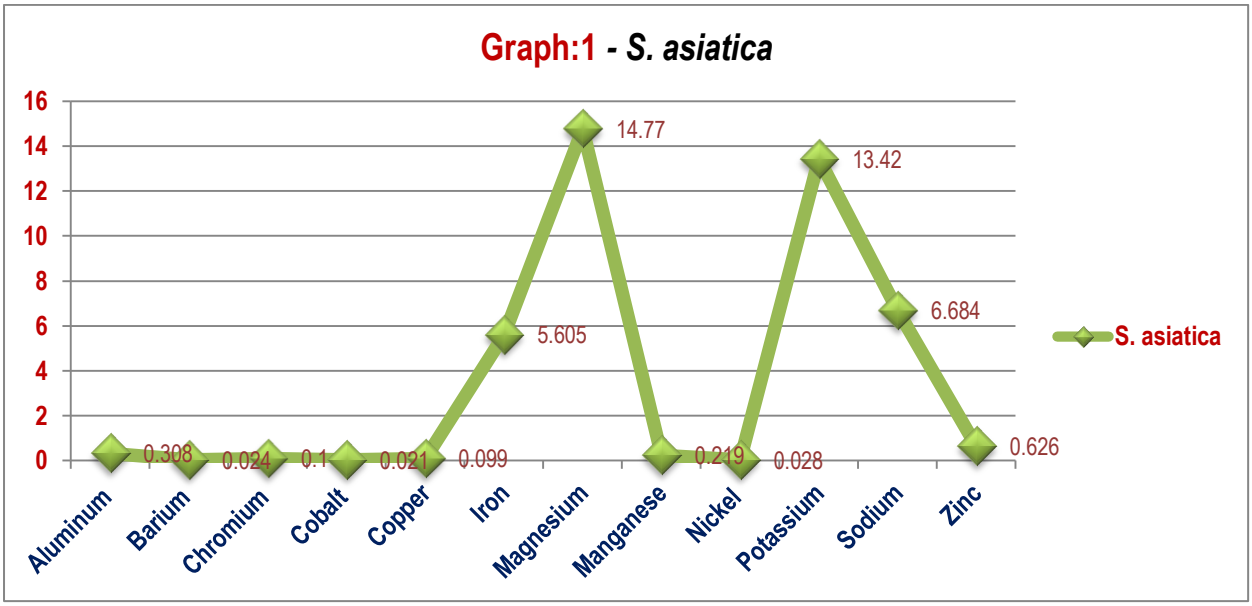
In this study, trace elements such as aluminum, barium, cobalt, chromium, copper, iron, potassium, magnesium, manganese, sodium, nickel, and zinc were detected within permissible limits (WHO, 2005) in all three parasitic plant samples. These elements contribute to the therapeutic properties of these plants, which have been traditionally used to treat various diseases. The Iron (Fe) content in plants varies significantly, reflecting the influence of soil composition and climatic conditions. Research on trace element toxicity in plants has produced varying results, depending on the species and environmental factors.

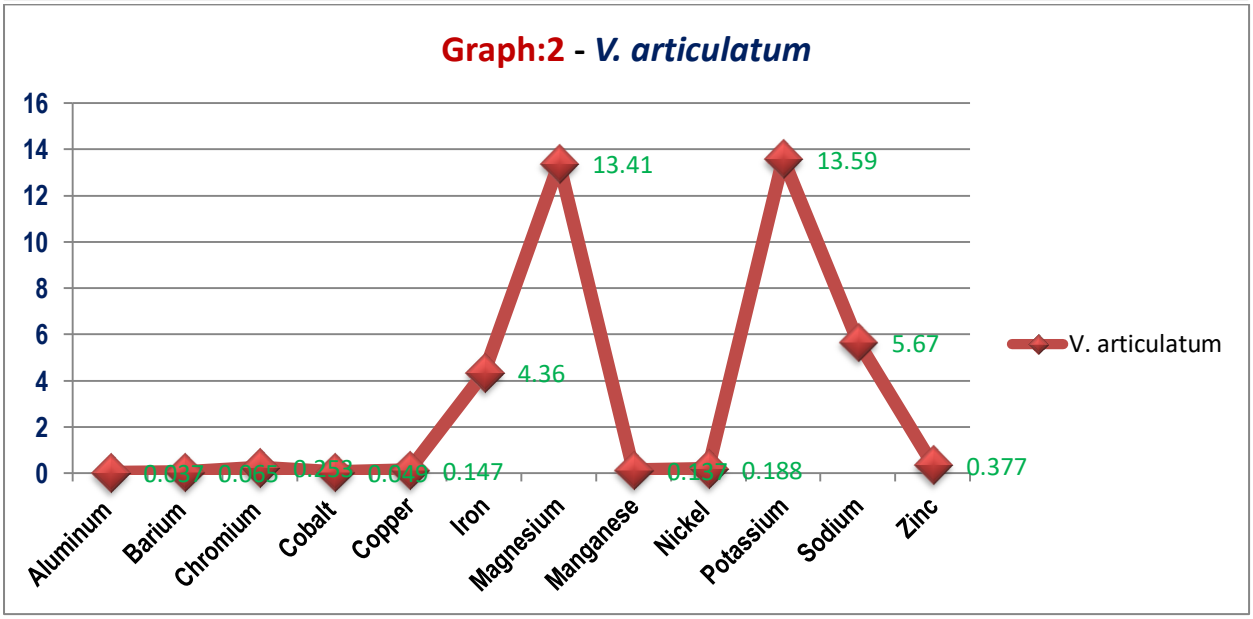
Previous studies (Kakpure & Rothe, 2012, 2016, 2020) have documented the medicinal potential of these plants. These trace elements play a crucial role in the biosynthesis of secondary metabolites, which are responsible for the pharmacological effects of medicinal plants. Additionally, they contribute to both preventive and curative healthcare applications (Kunle *et al.*, 2012). Notably, toxic elements such as arsenic and cadmium were not detected in the analyzed plant samples. Heavy metals like lead, cadmium, arsenic, and mercury are not essential for the human body and can cause harmful effects even at low concentrations (Abu-Darwish *et al.*, 2009).

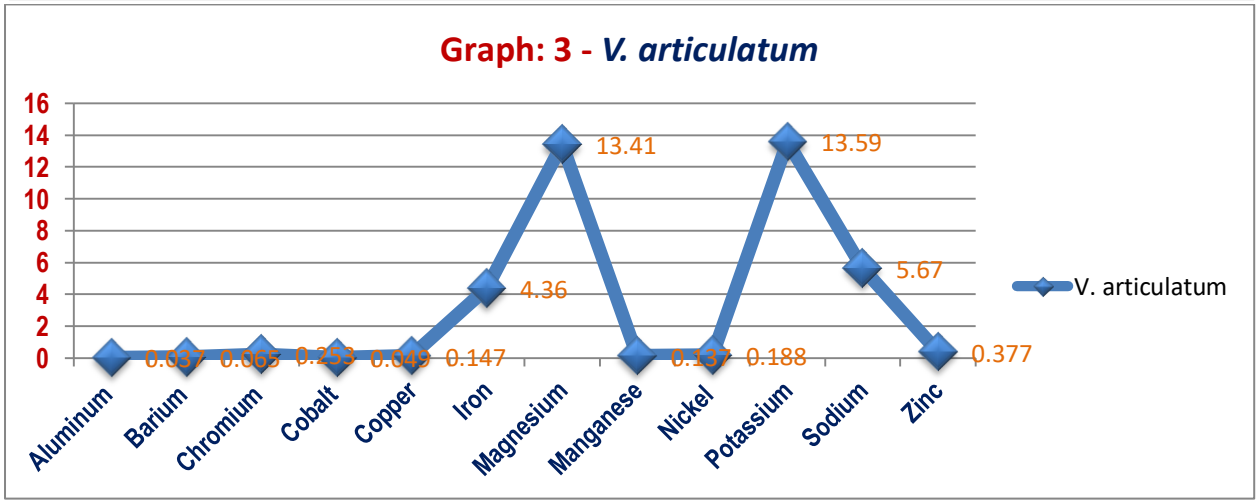
The findings of this study can aid in the formulation of new pharmaceutical drugs, combining various medicinal plants for ethnomedicinal applications. These plants serve as valuable sources of essential mineral elements in safe concentrations, supporting their use in disease treatment. Several researchers (Khan, 2010; Ravi *et al.*, 2011; Khan *et al.*, 2011; Sarpong *et al.*, 2012) have highlighted the role of mineral

elements in different plant species for addressing various health conditions.

Graph 1, 2 &3: Statistical analysis of concentration of elements in three selected parasitic plants respectively.







Conclusion:

This study found that the heavy metal content in the selected medicinal parasitic plants—*Striga asiatica* (L.) O. Ktze., *Alectra parasitica* A. Rich, and *Viscum articulatum* Burm.f—collected from the Akola district of Maharashtra, India, remained within the permissible limits set by the FAO and WHO. Therefore, these plants are unlikely to pose a risk of metal toxicity, and their consumption as herbal medicine or dietary supplements is not expected to have harmful effects on human health.

The analyzed medicinal plants serve as valuable sources of essential elements, supporting their potential role in nutrition and enhancing their nutraceutical significance for traditional healers and herbal remedy users. As a result, these parasitic plants hold promise for the development of pharmaceutical and herbal products. Further studies are necessary to investigate their potential applications in phytoremediation and their broader ecological impact.

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