

Study on Trace Elements Concentration in Medicinal Plant Using ICP-MS Technique

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Abstract

The main objective of this study is to determine the concentration of trace elements in selected medicinal plant which elements used for the treatment of reduced stress and anxiety levels and reduced serum cortisol levels of Aswagandha (*Withania Somnifera*) were quantitatively evaluated by the inductively coupled plasma mass spectrometry (ICP-MS) technique. The analytical investigations allow totally 8 elements (Mn, Fe, Cu, K, Zn, Cr, Mg, Ca,) from these plant extracts. The ICP-MS techniques are well suited for the analytical control of infusions in order to ascertain the nutritional role of medicinal plant and daily dietary intake. The results of present investigation used to set new standards for prescribing the dosage of the herbal drugs.

Keywords: ICP-MS, trace elements. Medicinal plants. Microwave digestion.

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Introduction

Ashwagandha (*withaniasomnifera*) also known as Indian ginseng or winter berry has been used in Ayurvedic medicines for over 3000 years. Biological source: -it consists of the dried roots and stem bases of *withania somnifera* dunal which belongs to the *solanaceae* family. *Withania* is widely distributed from southern Europe to India and is wild in Africa. The use of Ashwagandha in Ayurvedic medicines dates back more than 3000-4000 years and traces its origins to the attolian teachings of an revered rishi (sage) Punarvasu [1]. It is mentioned in ayurvedic texts such as the *charaka* and *sushruta samhitas* where it is widely pressed as a tonic against weakness especially for people of all ages including infants and as an improver of the reproductive function in both men and women.

For centuries, plants have been used for medicinal purposes to treat various diseases, including enteritis [2]. The development, regulation and application of traditional or herbal medicines in distinct parts of the world often present challenges. Common challenges in many countries are those connected to regulatory status, quality control,

assessment of safety and effectiveness, safety monitoring and insufficient knowledge of customary, complementary / alternative and herbal medicines within public drug regulatory authorities [3].

Metals with a density of more than 5 g/cm³ are defined as "heavy metals". In another definition, metals that are harmful when they enter the body in high concentrations are called toxic metals or heavy metals. More than 60 metals are in this group, including Pb, Cr, Cd, Co, Ni, Cu, Zn, Hg and Fe. Due to their nature, these elements are generally found in stable compounds or silicates in the form of oxide, carbonate, sulphur and silicate in the earth crust. To maintain their everyday activities, all living things need heavy metals in the environment. Iron (Fe), copper (Cu), manganese (Mn), cadmium (Cd), molybdenum (Mo), silicon (Si) and boron (B) are heavy metals required for plant metabolism. Cu, Co, Fe, Mn, Mo, Zn, Se, and I are also heavy metals needed for animals. Co, Cu, Cr, Fe, Mn, Ni, Mo, Zn, U, V are also toxic substances. The primary sources of heavy metals are mineral fertilizers, some base stones, sewage wastes, biocides, wastewater, urban wastes, motor vehicle exhaust gases and mining [4].

Trace elements play an essential role in the formation of active chemicals in medicinal plants and are also responsible for the toxicity of medicinal plants [5]. The grade of toxic heavy metals in plants can be affected by the geochemical parameters of the soil, air, water pollution and the ability of plants to amass certain elements selectively. Besides, metals may be connected to the geographical origin, harvest or gathering of these plant materials. Some metals (such as Fe, Cr, Mo, Ni, Zn, Co, Mn, Cu, Al) are essential plant nutrients, but at higher concentrations, they are phytotoxic. However, most heavy metals are initially micronutrients, namely, they are necessary (in small amounts) for the expected growth of plants and animals. Manganese (Mn), molybdenum (Mo), copper (Cu), zinc (Zn), and nickel (Ni) are heavy metals required for higher plants. For humans and animals, copper (Cu), Manganese (Mn), cobalt (Co), chromium (Cr), molybdenum (Mo), zinc (Zn), vanadium (V), and selenium (Se) are micronutrient heavy metals. Iron (Fe), which is not generally considered a heavy metal, is essential for both plants and animals. Several other elements, including cadmium (Cd), lead (Pb), arsenic (As), and tin (Sn), could play a significant role at very low concentrations. Toxicities and deficiencies of micronutrients adversely affect animal and plant health, causing declines in growth rate (and yield), obvious physiological stress symptoms, and, in extreme cases, the death of the animal or plant [6].

However, it is well-known that trace elements in medicinal plants are responsible for their toxicity when they are present in large concentrations. The pharmacological properties of these medicinal plants need to be looked into because they could affect human health. Knowing how much of this trace elements are in a plant is important for figuring out how well it can treat different diseases and for understanding how it works as a drug. It also makes it easier to understand how traditional knowledge about the healing power of these plants came to be.

When the metal content of plants is considered, the concentrations of the elements must be determined in order not to exceed the concentration limits set by WHO, to be evaluated as a medicinal plant or food, to be used as a herbal drug and to be utilized ethnobotanically.

In this study, the trace element concentrations of six ethnobotanically important plant species (*A. trichophila*, *A. azurea*, *A. biebersteinii*, *C. iberica*, *A. vestita*, *T. polium*) were determined by inductively coupled plasma-mass spectrometry (ICP-MS) technique. Following is detailed information on the studied plant taxa.

Ultrapure water ($18.3 \text{ M}\Omega \text{ cm}^{-1}$ obtained from the Human power I device) was used in all of the experimental stages. Agilent Technologies (USA) brand multi-element calibration standard was used as the calibration standard for

the elements determined for analysis reliability. In addition to the calibration standard, the internal standard Agilent Technologies brand standard internal mix is used. The nitric acid used is 65% Supra pure Merck (Darmstadt, Germany) brand.

Digestion of the Samples

The dissolution process was done before the samples were analysed with the ICP-MS device. For this, the ground samples were weighed 1 g, and 6 mL of supra pure nitric acid and 2 mL of hydrogen peroxide were added. The prepared samples were dissolved in CEM brand MARS6 ONE TOUCH (USA) model microwave shredder oven. The dissolved samples were diluted to 50 mL with 1% supra pure nitric acid prepared with ultrapure water. Additional dilution was made so that the prepared samples coincided with the standard calibration range.

Instrumentation and Statistical Analysis

One of the most effective methods used to determine the amounts of elements in plants is the inductively coupled plasma-mass spectrometry (ICP-MS) method, an analytical technique in which the molecular bonds are broken, and atoms are ionized by sending argon to a high-temperature plasma. The sample is generally delivered as a solution to the nebulizer and spray chamber via the sample intake system. Here, thanks to the high-velocity argon flow, the sample solution is fogged. Only tiny droplets move into the argon plasma, and others go directly to waste. Plasma at temperatures of 7000 K evaporates and ionizes the sample. Ion flow goes from atmospheric pressure to a high vacuum environment through sample and skimmer cones. The ion stream is then directed through the ion lenses to the mass filter, focusing on the quadrupole. Ions are separated in the mass spectrometer according to their mass to charge ratio and are measured by the detector [7]. Essential components of ICP-MS are sample entry system, ICP torch, interface, vacuum system, lenses, DRC (Dynamic reaction cell), quadrupole, detector, data processing and system controller [8]. ICP-MS is suitable for the determination of trace elements in solution with its fast analysis rate and convenient mass range. Simple spectra, low detection limit and compatibility with isotope ratios are the features that make ICP-MS attractive. The detection limit for most elements is below ng/L. Thanks to its ability to determine multiple elements, it is used in qualitative analysis and determination of isotope ratios, as well as in the quantitative and semi-qualitative analysis of the majority of the elements in the periodic table, including metallic elements, in various samples. Calibration graphs can be drawn between pg/L and mg/L for many elements. For this reason, many elements with different concentrations can be determined at the same time. Since the development of different sample

introduction systems, the ICP-MS technique has been able to analyze solid samples as well as liquid samples. ICP-MS is widely used in wastewater, drinking water, food, hydrogeology, geochemistry, geology, and petrochemistry [9].

When the metal content of plants is considered, the concentrations of the elements must be determined in order not to exceed the concentration limits set by WHO, to be evaluated as a medicinal plant or food, to be used as an herbal drug and to be utilized.

Material and Methods

Preparation of plant samples

Plants were collected from Gulbarga district and Different places of Karnataka. The plants collected were identified and recorded in the herbarium of Agricultural University. The names of the species, their herbarium numbers and the collection sites and times were given in Table 1.

Table 1: list of macro- and microelements determined by using ICP-MS technique

Calcium (C)	11536.31
Magnesium (Mg)	1737.96
Potassium (K)	16945.80
Chromium (Cr)	BDL
Manganese (Mn)	13.89
Iron (Fe)	405.04
Copper (Cu)	405.04
Zinc (Zn)	47.82

Sample preparation for ICP-MS analysis

Collecting samples of various plant components, including leaves, from medicinal plant (Table 1) used traditionally. These samples were extensively cleansed with water, ethanol, and triple-distilled water to eliminate surface contaminants, soil, and foreign particles. The Leaves were then air-dried under shade in the laboratory before being oven dried at 40 degrees Celsius and ground. The fragments were crushed mechanically and pulverized into powder. The leaves were also air-dried separately in the shade before being pulverized into a powder. For subsequent investigation, the powdered plant materials were stored at room temperature away from direct sunlight in sealed, dry plastic bags. For analytical purposes, solvents and substances of analytical grade were utilized. Other solvents, chemicals, and reagents were all of pure quality (S.D. fine chemicals or E. Merck India). Whenever water is specified, distilled water is substituted. Table 1 provides the medicinal plant selected for this study, along with its scientific name and plant sections.

1 g of each sample (1:1:1 weight ratio of various plant

components) was digested in nitric acid/perchloric acid (6:1) using the wet digestion method by slowly heating on a hot plate until white residue was formed. The residue was dissolved in 0.1N nitric acid, and the volume was adjusted to 10 ml. ICP-MS Instrument analysis of the digested sample.

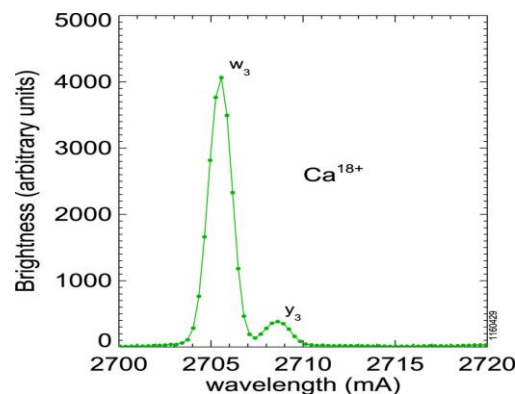


Figure 1:

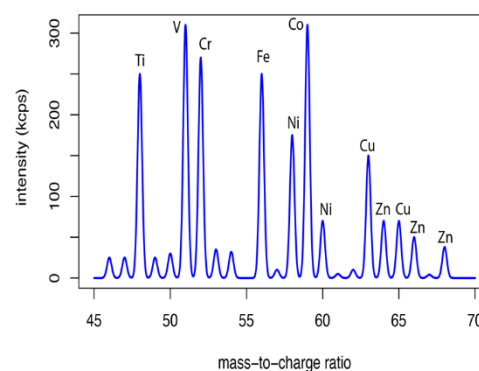


Figure 2:

Result and Discussions

The accumulation and absorption of trace elements in plant tissue depend on several factors [10]. Differences in concentrations of heavy metal elements are due to differences in the structure of certain parts of the plant and the chemical composition of the soil in distinct regions [11]. Besides, the uptake and transfer of heavy metals may vary, counting on the elements' properties and the structure and species of the plant [12-13].

One of the most advanced techniques in heavy metal and mineral analysis is ICP-MS technology. With the advantage of wide concentration, the analysis of low concentrations is more reliable and sensitive than other techniques [14]. For this reason, quantitative and qualitative metal element analyses of plants were made with ICP-MS.

The list of macro- and microelements determined by using ICP-MS technique were given in the Table 1. Totally 8-elements (Mn, Fe, Cu, K, Zn, P, Mg, Ca,) were identified in examined medicinal plant. The concentrations of macro- and microelements that have been determined are presented

in Figure 1.

Conclusion and Future Prospective

Ashwagandha is a plant material that has been used for centuries in traditional Medicinal systems, especially in Ayurvedic medicine. Over the years, research has been conducted examining the various effects of Ashwagandha, and this research has shown that it has several positive effects on various body systems. Human studies have confirmed the ashwagandha's adaptogenic Potential and clinical benefits. In a number of diverse conditions. Cautions should be used when ashwagandha is taken alongside Certain medications. This review focused on the brief overview of ashwagandha, scientific studies on ashwagandha, effects of ashwagandha on Parkinson's disease, effects on CNS, effects on stress induced diseases and various formulations of ashwagandha etc. Al, V, Cr, Ni, Cu, Zn, As, Ag, Cd, Sn, Hg, Pb trace element analysis of aromatic and medicinally consumed plant species

Although there is evidence to supporting the potential therapeutic uses of Ashwagandha, the mechanisms by which it exerts its effects are still not fully understood. In this study, a total of 8 elements (Mn, Fe, Cu, K, Zn, P, Mg Ca,) were determined in the Ashwagandha powder samples by using ICP-MS.

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