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Elemental Analysis of *Caesalpinia decapetala* Leaves

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ABSTRACT

By using Energy Dispersive X-ray Fluorescence (EDXRF), fifty elements (Sodium to Uranium) were determined from leaves powder of *Caesalpinia decapetala.* Toxic elements like Arsenic (As), Silver (Ag), Mercury (Hg) were not found in leaves powder but biologically active elements like S, K, Si, Ca, and P were found to more extent. The concentration of Ca (2969.87 ppm) was the highest among all the elements. Si (1076.19 ppm), K (880.06 ppm), S (1500.55 ppm), and Sr (1059.66 ppm) were also detected in significant amounts. The presence of a higher concentration of Ca, S, Si, and P reflect that the plant is a source of nutrient elements. S and Cl elements are found which show the medicinal importance of this plant. Such information could be helpful for the standardization of herbal drugs.

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INTRODUCTION

Herbal medicines have become important in the universe and have made an impact on the world's health as well as the international market in the last decade.[1] World Health Organization (WHO) recommends and supports conventional herbal remedies in natural health care programs as these drugs are easily available at low cost and safe. Medicinal plants are also used as a source of food to maintain good health. It is necessary to know the specific constituents in the herbal medicines which are helpful in the different therapies. Many pieces of evidence prove that herbal plants are used in the different conventional systems. It realized that Herbal medicines are more reliable and secure hence are used in medicine.[2]

Due to good climatic conditions and various ecosystems, different plant species are found abundantly in India. In diet, various seasonal plants are used by Indian peoples.[3] Some heavy elements are required in very small quantities for the human body. If they are present in large amount, it is fetal to the body. It can disturb the functions of important organs like the kidney, liver, and brain in the human body.[4] Medicinal plants get contaminated due to heavy elements because these elements are absorbed by roots from soil or plant surface get directly deposited with these elements from the surrounding.[5]

Minerals contribute only 4 - 6 % of total human body weight but they are important in the diet. Organic ligands form complexes with some minerals by chelating and making them bioavailable to the body system.[6] Deficiency or excess of minerals affects human health and they plays important role in physiological reactions in the body.[7] An element is considered to be most important because of two reasons (1) when the reduction of element exposure below a specific limit consistently results in a reduction in a physiologically important function of the body and (2) when the element is an integral part of an organic structure and play a vital role in that organism.

Whether the element is essential or not can be defined by two criteria; (1) first, the absence of that element from diet affects not only the normal growth and metabolism but also the development of pathological symptoms. (2) Secondly, the replacement of that element eliminates the pathological symptoms.[8]

Medicinal plants play a vital role in drug development and in pharmacological research because plants parts are used as therapeutic agents and starting materials for the synthesis of the drugs. Therefore, the concentration of trace elements is very important in them.[9]

Herbal medicines contain heavy metals and other impurities hence they may have a toxic effect. Therefore, precautions should be taken when they are used to treat different diseases. So, it is essential to control the contaminants in medicinal raw material.[10] In combating diseases, trace elements have a curative as well as precautionary role.[11]

In metabolism, enzyme reaction, and in nutrition, inorganic compounds are required in a very small amount.[12] 40 elements are necessary for the survival of mammals and plants.[13] Inorganic elements like sodium, potassium, phosphorous, and calcium plays important role in human health.[14-16] Functioning of cells and the survival of organisms are governed by heavy elements. Heavy metals are also important for biological functioning and physiological reactions in the body. Oxidative damage occurs due to excess of these elements.

Cadmium (Cd)), lead (Pb), and mercury (Hg) are more toxic even at very low concentrations. They are non-essential elements. Heavy metals can easily enter into the organisms through the air, water, and soil. Literature survey shows that various metals like lead (Pb), iron (Fe), nickel (Ni), arsenic (As), chromium (Cr), copper (Cu), and cadmium (Cd) plays important role in Oxidative damage.[17] Herbal plants are useful for medicinal properties. It contains carbohydrates, proteins, and lipids which are essential for the growth of humans. For proper metabolic processes, inorganic micronutrients like Fe, Co, Cr, Cu, Mg, Zn, Mn, etc. are essential. Biochemical functions of the human body get disturbed due to the excessive or deficient nature of micronutrients.[18-20] So it is compulsory to analyze micro as well as macronutrients in medicinal plants.

The techniques like electrothermal atomic absorption spectrometry (ETAAS), atomic absorption spectrophotometry (AAS), energy dispersive X-ray fluorescence (EDXRF), Inductively coupled plasma-atomic emission spectrometry (ICP-AES), inductively coupled plasma - mass spectrometry (ICP-MS), and electrothermal atomic absorption spectrometry (ETAAS) have their own advantages and limitations with respect to specificity, sensitivity, precision, and accuracy. The introduction of ICP-MS and ICP-AES with multi-element capabilities has reduced the AAS/AES market. Still, AAS/AES technology is reputed in the analytical field.[21]

Caesalpinia decapetala traditionally uses against various types of diseases. It is widely distributed in the tropical and subtropical regions of Asia. The plant shows an array of phytochemicals including shikimic acid derivatives, amino acid derivatives, tannins, glycosides, flavonoids, alkaloids, isoprenoids coumarins, and triterpenoids. It is highlighted

that the wood and leaves of the plant possess antioxidant, anti-inflammatory, analgesic, antibacterial, antitumor, antidiabetic, antifungal, antipyretic, antimicrobial, antiviral, trachoma, and anti-diarrheal properties.

The present study was aimed to determine the presence of metallic elements and their quantification in leaves of *Caesalpinia decapetala* plant using XRF technique.

MATERIALS AND METHODS

a. Sample preparation: The plant material was separated and washed thoroughly with water to remove soil, foreign particles, and all other surface contamination. The plant leaves are allowed to dry at room temperature. The plant materials were air-dried, cut into small pieces, and grind into a fine powder using a grinder. The powdered leaves sample was sieved through a 0.5 mm diameter sieve. 5.0 gram powdered sample was used for XRF studies[22, 23].

b. Energy DispersiveX-Ray Fluorescence (XRF) Analysis: Energy Dispersive X-ray Fluorescence (XRF) spectroscopy was used for trace element analysis of the powdered plant material. The elemental analysis was carried out by Geology Department, of SPPU, Pune, India. The elemental range for XRF spectroscopy is from Sodium to Uranium. The elemental contents were determined by using SPECTRO XPOS (Ametek material analysis division, Germany) with silicon drift detector SDD with a resolution of 145 eV at 10000 pulses[22, 23].

Table 1: Metal Content in Powdered Leaves of *Caesalpinia decapetala*

Atomic number	Symbol	Element	Concentration (ppm)	Atomic number	Symbol	Element	Concentration (ppm)
14	SiO_2	Silicon	1076.19	39	Y	Yttrium	12.11
13	Al_2O_3	Aluminum	43.84	40	Zr	Zirconium	0.47
19	K_2O	Potassium	880.06	41	Nb	Niobium	0
20	CaO	Calcium	2969.87	42	Mo	Molybdenum	3.26
22	TiO_2	Titanium	18.84	47	Ag	Silver	0
11	Na_2O	Sodium	0	48	Cd	Cadmium	3.02
12	MgO	Magnesium	93.22	50	Sn	Tin	11.57
15	P_2O_5	Phosphorus	993.90	51	Sb	Antimony	5.80
25	MnO	Manganese	41.60	52	Te	Tellurium	9.09
26	Fe_2O_3	Iron	872.89	53	I	Iodine	0
16	S	Sulfur	1500.55	55	Cs	Cesium	4.59
17	Cl	Chlorine	276.69	56	Ba	Barium	0
23	V	Vanadium	0	57	La	Lanthanum	5.07
24	Cr	Chromium	8.20	58	Ce	Cerium	0
27	Co	Cobalt	1.55	68	Er	Erbium	0
28	Ni	Nickel	8.58	70	Yb	Ytterbium	0
29	Cu	Copper	40.61	72	Hf	Hafnium	1.40
30	Zn	Zinc	88.54	73	Ta	Tantalum	0
31	Ga	Gallium	2.81	74	W	Tungsten	3.15
32	Ge	Germanium	0	80	Hg	Mercury	0
33	As	Arsenic	0	81	Tl	Thallium	0
34	Se	Selenium	4.00	82	Pb	Lead	4.66
35	Br	Bromine	16.99	83	Bi	Bismuth	0
37	Rb	Rubidium	89.91	90	Th	Thorium	0
38	Sr	Strontium	1059.66	92	U	Uranium	14.22

RESULTS AND DISCUSSION

Now a day's different analytical techniques are used for the analysis of metal content. One of these is X-ray fluorescence (XRF), in which a source of X-ray photons is used to study the elemental composition of materials. XRF is one of the rapid analytical techniques used to study the elemental composition of medicinal plants and their parts. Heavy and trace elements can be determined qualitatively and quantitatively by using these methods. By using XRF spectroscopy concentration of elements in the powdered plant leaves of *Caesalpinia decapetala* from sodium to uranium was determined. The concentrations of major elements Calcium, Potassium, Silicon, Phosphorous, Iron, Sulfur, Copper, Zinc, Rubidium, and Strontium in plant samples were performed using X-ray fluorescence spectrometry. The concentration and percentage of a total of fifty (50) elements were determined in the leaves powder of *Caesalpinia decapetala* by using XRF spectroscopy. The elements S, K, Si, Ca, and P were found in higher amounts. The present study shows that the medicinal plant *Caesalpinia decapetala* is a source of biologically active elements, which may play important role in biological properties.

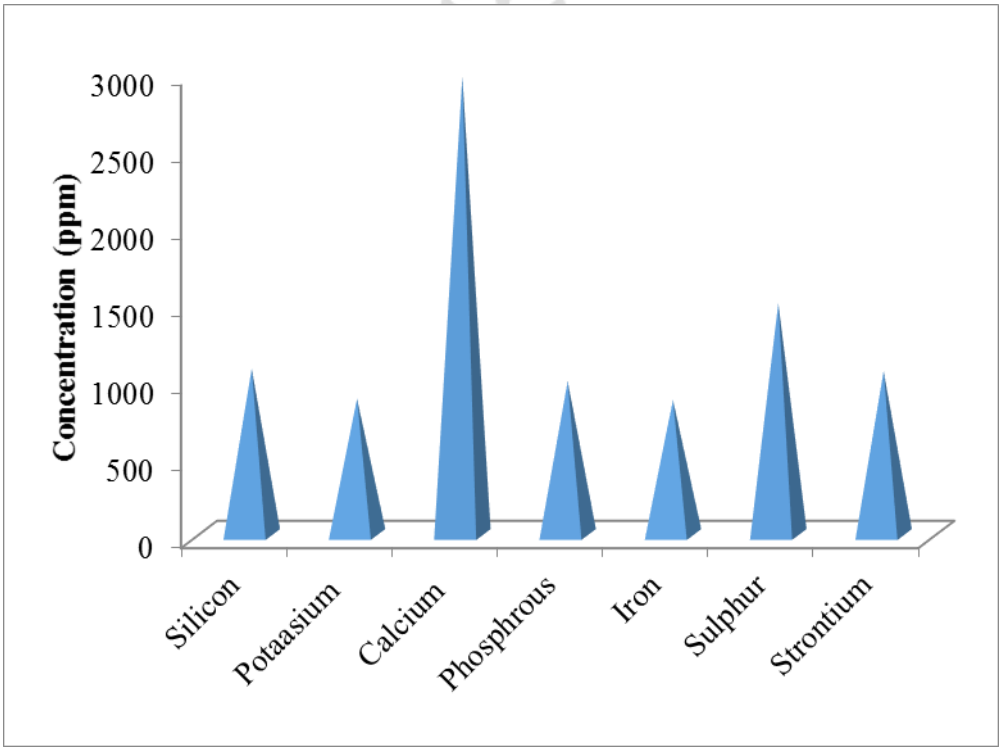

Fig. 1. XRF elemental analysis of *Caesalpinia decapetala* leaves.

CONCLUSION

The elemental profile of the *Caesalpinia decapetala* medicinal plan was determined using the XRF technique. All of the elements detected from leaves of *C.decapetala* are below the WHO acceptable levels. The concentration of Ca, S, Si, P, and K indicate that the plant is the source of nutrient elements. The present research work may be helpful for the standardization of medicinal drugs.

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