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Evaluation of elemental content of leaves of *Madhuca longifolia* by X-ray fluorescence spectroscopy (XRF)

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ABSTRACT

The elements present in medicinal plants play an important role in the treatment of diseases as described in Ayurveda. XRF technique is one of the most powerful and quick multi elemental analysis with high sensitivity. This technique has been applied for quantitative analysis of multielements present in dried leaves of Madhuca longifolia (Koenig) linn. Fifteen elements were detected. It indicates the association of 5 macro elements, 6 micro elements and 3 heavy elements.

Keywords *Madhuca longifolia*, trace elements, XRF.

INTRODUCTION

Madhuca longifolia, belongs to the family Sapotaceae It is a medium sized deciduous tree distributed in Nepal, India and Srilanka (1).The generic name *Madhuca* and the popular name **Indian butter tree** are apparently derived from the Sanskrit word `*Madhu'* meaning honey. The plant parts used in ethno medicine for wide variety of illness, such as epilepsy(2), diabetes mellitus, analgesic activity (3),anthelmintic,pneumonia,piles,skin diseases (4),anti-inflammatory (5),antiulcer activity(6) have been reported.

Importance of Elements.

The macro elements refer to the main elements that are required by the plants for their basic functions. Microelements are also known as trace elements (7). Mn, Fe, Cu and Zn seem to be activator of the enzymes, It can be assumed that higher percentage of extracted elements Cu, Fe than of Mn and Zn is linked with easy formation of complexes with phenolic substances and flavonoids in extract, which mostly affect inflammatory process in human being (8, 9).The monitoring of metals in this plant is of some therapeutic and prophylactic importance. The contamination of drug by toxic elements as Pb, Hg, Cd, As, and also the influence of these elements on plant growth were already discussed [10].Moreover some publications deal with determination of elements content in infusions and also the content of biologically active substances (11-13).There are however, no standards for medicinal raw plant materials which establish a permissible level of metals in such materials. The World Health Organization mentions maximum permissible levels in raw plant materials only for arsenic, cadmium and lead, amounting to 1.0,

0.3, and 10 mg.kg−1, respectively (14). The present work includes quantitative determination of various elements from the leaf of *Madhuca longifolia* by using X-ray fluorescence technique.

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Various techniques.

Determination of the elements content is often linked with preconcentration of elements in the sample. Various techniques have been applied for determination of elements in plants (15, 16). Among them, the most common are atomic absorption spectrometry (AAS) (17), inductively coupled plasma spectrometry (ICP-MS) (11) and neutron activation analysis (NAA) (17) and X-ray fluorescence analysis (XRF) (11,15,18) nuclear methods. The advantage of XRF is poly component character of the analysis; the method is nondestructive, fast and accurate. The reduction of detection limit can be achieved by the sample preparation.

MATERIALS AND METHODS

Plant collection.

The plant leaves of *Madhuca longifolia* (Koenig) Linn were collected from Thirumalasamutram, Thanjavur District. The plant was identified by Dr.Ravichandran, Botanist, Centre for Advanced Research in Indian systems of medicine, SASTRA University, Thanjavur, Tamilnadu India.

Preparation of plant extract.

Hydro Alcoholic Extract.

Madhuca leaves was collected, dried and suitably made in to coarse powder in an extractor. About 3 times the quantity of raw material was taken in 50% aqueous alcohol and was refluxed at a temperature of 80-85^{0}C for 3-4 hours. The extract was filtered, (preferably 10 µm pore size) filter in to a suitable sized vessel. The leaves were extracted, repeatly three times and the extract was filtered into the same vessel. The combined filtrate was concentrated to a syrupy consistency and dried under vacuum (between 400-600 mm of Hg) at a temperature not exceeding 80^{0}C till the moisture was below 5 percent. The mass was milled and the powder was sieved through 500 µm mesh to obtain the extract and packed. The yield obtained is about 25 percent.

Instrumentation.

The XRF measuring system consisted of multichannel analyzer ORTECR, semiconductor detector Si/Li (thickness of beryllium window = 0.25 mm, diameter of beryllium window = 5 mm) and radionuclide source of radiation 238Pu (A = 370 MBq,E = 12 – 22 keV, T. = 86.4 years) made by AMERSHAM in form of planar disk source. All the measurements were performed in non-coaxial geometrical arrangement of source, sample and detector and acquisition time was 2000 seconds.

Table-1.Evaluation of elemental content of leaves *Madhuca longifolia* by X-ray fluorescence spectroscopy (XRF).

S.No	Elements	%	Concentration(ppm)
1	K	0.345	112.9
2	Ca	0.535	665.8
3	Cl	0.478	93.2
4	Mg	0.819	140.4
5	S	0.623	35.6
6	Si	1.26	50.6
7	P	1.43	42.5
8	Na	3.88	490.7
9	Fe	2.61	101.2
10	Rb	3.75	72.0
11	Br	7.44	71.6
12	Ru	18.4	153.8
13	Sr	7.32	48.5
14	Cu	11.8	71.8
15	Zn	13.2	64.9

RESULTS AND DISCUSSION

In this study, the concentration and percentage of fifteen elements were determined in the leaf extract of *Madhuca longifolia* by using XRF spectroscopy. The result showed various concentrations and available percentage of five macro elements: K, Ca, Mg, Cl, P.Six microelements (trace elements): Si, Na, S, Br, Rb, Sr, Three heavy elements:

Fe, Zn, Cu. are given in Table 1. Elemental analysis by XRF reveal presence in order of Ca>K>S>Fe>Sr> .The analysis indicated the higher concentration of K, Ca, Mg, Cl, P elements. Mineral composition of alcoholic extracts of *M.longifolia* revealed the presence of all the mineral elements, the interaction of trace minerals composition present in the medicinal plants have great importance to understand their functions in the human body.

Strontium 7.32% was reported in *M.longifolia* leaves extract *in* XRF studies. Strontium commonly occurs in nature, and it is the 15th most abundant element on earth, chiefly found in the form of SrSO4 and SrCO3 Its occurrence in plants is a due to many factors, type and chemical composition of soil, rainfall, agricultural practice and kind of plant. Several salts of strontium such as Strontium carbonate or Strontium citrate are often presented as natural therapies and sold at a dose that is several hundred times higher than the usual Strontium intake. And such salts can still be sold in United States under the Dietary Supplements Health and Education Act of 199435. So occurrence of Strontium in leaves of *M.longifoia* will not affect any way to the drug quality.

Potassium is essential for smooth flow of communication signals from cell to cell and its deficiency can contribute to diseases like stroke, heart problem, diabetes and hypertension. It is important, mainly in the intercellular fluid as the primary ion. Potassium together with sodium helps to regulate the water balance within the body. It regulates the transfer of nutrients to the cell, transmits electrochemical impulses and is necessary for normal growth enzymatic reactions *etc*.

Calcium used in the development and maintenance of bone structure. It plays function in the clotting process, nerve transmission, hormone function and metabolism of vitamin D *etc*.

Magnesium supply located in the bones together with calcium and phosphorus, while it is found in cellular fluids and some soft tissue. It is involved with energy production of glucose, protein and nucleic acid synthesis, the formation of urea, muscle impulse transmission and neurotransmission. Mg plays important role in enzyme activity, deficiency interfere with transmission of nerve and muscle, impulses, causing irritability and nervousness, prevent heart diseases.

Phosphorus role a part in almost every chemical reaction within the body because it is present in every cell. It forms calcium phosphate with calcium in the bones & teeth in a 2-1 ratio. It is important in the utilization of carbohydrates, fats, and proteins for the growth and maintenance in the body. Phosphorous is estrogenic, immuno stimulant and anti-osteoporotic.

Chlorine helps to regulate acid alkali balance, stimulate production of hydrochloric acid, stimulate the liver to function as a filter for wastes and helps to distribute hormones etc.

Iron sufficient in all studied medicinal plants, it make body tendons and ligaments, certain chemicals of brain are controlled by the presence or absence of iron, it is essential for the formation of hemoglobin, carry oxygen around the body.

Zinc plays a major role as catalytic roles in over 200 enzymes and capable of influencing immune system. Zinc maintains various reactions of the body which help to construct and maintain DNA, required for the growth and repair of body tissues, important element of ligaments and tendons.

Copper was an important component of many enzyme systems such as cytochrome oxidase, lysyl oxidase and ceruloplasmin an iron oxidizing enzyme in blood. Cu deficiency has been associated with cardiac abnormalities in human and animal, cause's anemia and neutropenia. In the human body, many trace elements take part in numerous physiological and biochemical events. (22-30)

CONCLUSION

The requirements for analysis of pharmaceutical and plant derived products for purity are becoming increasingly demanding. The XRF analytical methods discussed above have been shown to be effective in detecting and measuring a number of elements in *M.longifolia* at extremely low concentration levels. An important part of the use of these methods is to understand and to recognise their capabilities and limitations to estimate their suitability for the analytical task. With further improvements in the available techniques still lower measurements can be achieved.

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