Investigation of Elemental Concentration in Indian Trumpet

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Abstract— Conservation and sustainable use of the habitats of medicinal plants are imperative for ensuring continued availability of genuine herbs used to address the health needs of the majority of the world's population. Indian trumpet has been one kind of medicinal plants and investigated by using the Energy Dispersive X-ray Fluorescence (EDXRF) detection technique to observe elemental concentration. In Indian trumpet leaves, potassium was the largest concentrated element, and calcium, sulphur and phosphorous were the second largest elements. Iron, copper, strontium, zinc, rubidium and manganese were trace elements. In Indian trumpet fruits, potassium was also the largest concentrated element, and calcium, phosphorous, sulphur and iron were the second largest elements. Copper, manganese, rubidium, zinc and strontium were found as trace elements. In Indian trumpet barks, potassium and calcium were the largest concentrated elements, and sulphur was the second largest element. Other elements such as iron, strontium, copper, rubidium, manganese, and zinc were trace elements. The uses of Indian trumpet and its elements were discussed.
Keywords— Concentration, EDX-7000, Energy Dispersive X-ray Fluorescence, FP balance, Folk remedies, Indian Trumpet

INTRODUCTION

Presently there is an increasing interest worldwide in herbal medicines accompanied by increased laboratory investigations into the pharmacological properties of the bioactive ingredients and their ability to treat various diseases. Demand for medicinal plants is increasing in both developing and developed countries due to growing recognition of natural products, being non-narcotic, having no side-effects and easily available at affordable prices. Indian trumpet (***Oroxylum indicum***) is a species of flowering plant belonging to the monotypic genus *Oroxylum* and the family Bignoniaceae, are commonly called midnight horror, oroxylum, Indian trumpet flower, broken bones, Indian caper, or tree of Damocles. It can reach a height of 18 metres (59 ft). Various segments of the tree are used in traditional medicine.

The large leaf stalks wither and fall off the tree and collect near the base of the trunk, appearing to look like a pile of broken limb bones. The pinnate leaves are approximately 1 metre (3.3 ft) in length and comparably wide, borne on petioles or stalks up to 2 metres (6.6 ft) in length, making this the largest of all dicot tree leaves, which are quadripinnate (leaflets display four orders of branching).

The tree is a night-bloomer and flowers are adapted to natural pollination by bats. They form enormous seed pods – the fruits – are up to 1.5 metres (4.9 ft) long that hang down from bare branches, resembling swords. The long fruits curve downward and resemble the wings of a large bird or dangling sickles or swords in the night, giving the name "tree of Damocles". The seeds are round with papery wings.

O. indicum is native to the Indian subcontinent, the Himalayan foothills with a part extending to Bhutan and southern China, Indochina and the Malesia regions. In Vietnam, the tree and specimens can be found in Cat Tien National Park.

It is visible in the forest biome of Manas National Park in Assam, India. It is found, raised and planted in large number in the forest areas of the Banswara district in the state of Rajasthan in India. It is reported in the list of rare, endangered and threatened plants of Kerala (South India). It is also found in Sri Lanka.

Several of the compounds are under preliminary research to identify their potential biological properties. The tree is often grown as an ornamental plant for its strange appearance. Materials used include the wood, tannins and dyestuffs.

The plant is used as marriage rituals in Nepal, Thai and Laos. In the Himalayas, people hang sculptures or garlands made from *O. indicum* (Skr. shyonaka) seeds from the roof of their homes in belief they provide protection. It is a plant with edible leaves and stems. The large young pods, known as *Lin mai* or *Lin fa* in Loei, are eaten especially in Thailand and Laos. They are first grilled over charcoal fire and then the bitter inner pulp is usually scraped and eaten along with lap. *O. indicum* seeds are used in traditional Indian Ayurvedic and Chinese medicines. Root bark is one of the ingredients thought to be useful in compound formulations in Ayurveda and other folk remedies.

In the present research work, Indian trumpet leaves, fruits and barks were collected from Myanmar Aerospace Engineering University (MAEU), Meiktila Township, Mandalay Region in Myanmar. They were dried in shaded area and analysed by Shimadzu EDX-7000 Spectrometer located at Taungoo University, Bago Region in Myanmar. The elemental concentrations in each sample were presented.

I. FUNDAMENTAL OF MATERIAL CHARACTERIZATION

X-rays, Roentgen rays, are electromagnetic radiations having wavelengths roughly within the range from (0.05 to 100) $\mathring{A}$. At the short-wavelength end, they overlap with gamma rays, and at the long-wavelength end they approach ultraviolet radiation. X-rays were discovered in 1895 by Wilhelm Conrad Roentgen at the University of Warzbur, Bavaria.

When a beam of X-ray photons interacts with matter, the different interactions occur. The intensity of incident X-ray beam is attenuated due to these interactions. Two basic processes in the XRF analysis are the photoelectric effect and X-ray scattering. The sub-interactions included in the photoelectric effect are the characteristic X-ray emission, the photoelectron ejection and the Auger electron ejection. Also, both coherent scattering and incoherent scattering can occur. These interactions are strongly influenced by the spectral distribution of the incident X-ray beam and the sample composition. Detailed information on the interactions can be found elsewhere.

In the photoelectric interaction, a photoelectron is emitted when the incident photon energy E is greater than the binding energy ϕ of the electron in the atom. The atom becomes unstable due to the removal of a bound electron and undergoes a rearrangement to reach the normal state. The transition of an electron from an outer shell to inner shell emits energy as X-ray photons. These X-ray photons can either escape from the atom or be absorbed to eject an outer shell electron (Auger electron).

When a charged particle (e.g. electron, proton, etc.,) or photon is incident an electron of the inner shell in an atom, if its energy is larger than the binding energy of that atom, the inner shell electron is ejected from that shell and it becomes a vacancy. This vacancy is immediately filled by electrons falling into them from outer shells. The energy given up by the electrons in changing shells is released as X-rays and the energy of these X-rays is characteristic energies of the electron shells and hence of the electron shells and hence of the atoms themselves. These X-rays are called characteristic X-rays.

Characteristic X-ray lines are emitted from each chemical element when excited by higher energy radiation, by which is fast above the absorption edge of the element interest. Each element emits its characteristic spectra and for each transition series K, L and M, there is a simple relationship between the energy of the characteristic X-ray line and atomic number. By measuring the energy and intensity of these characteristic lines one can recognize what element and how much are present in a sample. This X-ray fluorescence spectrometry is utilized for routine quantitative and qualitative analysis. Sensitive available for most elements reach the low parts per million ranges and the method is equally applicable at high or low concentration levels.

The production of characteristic X-ray involves of the orbital electrons of atoms in the target material between allowed orbits, or energy states, associated with ionization of the inner atomic shells. When an electron is ejected from the K shell by electron bombardment or by the absorption of a photon, the atom becomes ionized and the ion is left in high-energy state. The excess energy of the ion has over the normal state of the atom is equal to the energy (the binding energy) required to remove the K electron to a state of rest outside the atom. If this energy vacancy is filled by an electron coming from an L level, the transition is accompanied by the emission of an X-ray line known as K_{α} line. This process leaves a vacancy in the L shell. On the other hand, if the atom contains sufficient electrons, the K shell vacancy might be filled by an electron coming from an M level that is accompanied by the emission of the K_{β} line. The L or M state ions then remains may also give rise to emission if the electron vacancies are filled by electrons falling from further orbits.

In recent years, the "fundamental" approaches have been developed to deal with the matrix effects in XRF analysis. The fundamental parameters method can be applied mostly to relatively simple situations. Hai Fe has developed a quantitative procedure which can be used on a personal computer for EDXRF that can handle nearly any sample from and matrix and provide accurate results even if only a limited number of standards are available.

The X-ray fluorescence spectrometer consists of three main parts of the excitation source, the specimen presentation apparatus and the X-ray spectrometer. The function of the excitation source is to excite the characteristic X-ray in the specimen via the X-ray fluorescence process. The specimen presentation apparatus holds specimen in a precisely defined position during analysis and provides for introduction and removal of the specimen from the excitation position. The X-ray spectrometer is responsible for separating and counting the X-ray of various wavelengths or energies emitted by the specimen. The term X-ray spectrometer denotes the collection of components used to disperse, detect, count and display the spectrum of X-ray photons emitted by the specimen. When referring to the entire instrument, including excitation source, sample preparation apparatus, and X-ray spectrometer, the term of X-ray fluorescence spectrometer will be used.

For the excitation of characteristic X-ray, X-ray tube and radioactive sources are used. Commonly X-ray tube is used not only in primary energy dispersive system but also in secondary target energy dispersive spectrometer. In X-ray tube, a filament with adjustable current control is heated to generate free electrons. The electrons are accelerated to the anode (Rh or W) where they generate X-rays. If the X-rays have enough energy, an atom in the sample may absorb the energy and emit a characteristic X-ray. The X-ray leaves the sample and travels to the detector. In giving bias to X-ray tube; tube voltage must be set higher than the highest absorption edge energy. The range of tube voltage is (4 to 50) kV with the increment of 1 V and the tube current is (0.01 to 0.99) μA with the increment of 0.01 μA. Sometime, filter is used between the X-ray tube and the sample to reduce background in energy region, to estimate X-ray tube characteristic lines, which overlap with an element of interest and to transmit X-rays of sufficient energy for the excitation.

Computerized data handling has become on established part of analytical practice. Mainly, there are two main steps in the analytical process of using step, computer can control the instrument and process signal and can transform raw-data into meaningful results such as concentrations. Next one is the interpretation relevant to the problem under investigation. Moreover, it could be possible to remove errors in measuring.

In present research work, Indian trumpet leaves, fruits and barks were analyzed by the energy dispersive X-ray fluorescence (EDXRF): Shimadzu EDX-7000 system. The fundamental parameter (FP balance) method was used to determine the concentration of elements that contained in the samples. The FP method has been an important analysis method. Based on this, the Shimadzu EDX-7000 is provided with high performance FP software as standard measurement and others are deliberate, using specifications that anticipate your paper as one part of the entire proceedings, and not as an independent document. Please do not revise any of the current designations.

II. Sample Preparation

Indian trumpet leaves, fruits and barks were dried at room temperature. The dried samples were crushed and ground in order to get fine powder by using grinding machine. They were ground fine enough so as to meet the conditions for homogeneous dense materials, and to ensure reproducibility in measurements. And then, each powder was poured into a sample cell in which the bottom of it is covered with film (mylar). The diameter of the sample cell is 31.6 mm.

Sample preparation is important in the EDXRF analysis because it is required to get homogeneous fine powder for best results. Generally, biological samples are heterogeneous and so making sample to be dried, ground and homogenized. To obtain reliable results in X-rays emission spectrometry, sample preparation is a very important process prior to actual experiment.

Sample preparation needs to be done carefully not to contaminate from grinding devices. We should take care of the grinding process in order to minimize the particle size effect. The guiding principles for specimen preparation techniques are reproducibility, accuracy, simplicity, low cost and rapid of preparation.

(a) (b)

Figure 1. Indian trumpet (a) tree and (b) leaves, fruits and barks

(a) (b)

Figure 2. Sample preparation for Indian trumpet (a) leaves and (b) fruits

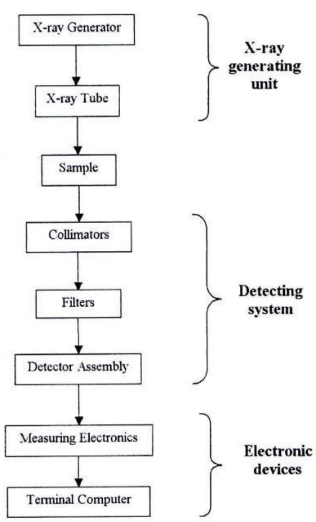

Figure 3. Schematic diagram of a sequential EDXRF Analysis

Specimen preparation is crucial to the relationship between spectral line intensity and the element concentration. Factors such as surface roughness, particle shape, particle size, homogeneity, particle distribution, and mineralization can affect this relationship.

III. Results and Discussion

The EDXRF analysis gave qualitative and quantitative results. The energy dispersive has been superior resolution and had high counting rates. The measuring time was 100 s in air. It was found that potassium was the largest concentrated element, and calcium, sulphur and phosphorous were the second largest elements in Indian trumpet leaves. Iron, copper, strontium, zinc, rubidium and manganese were trace elements. In Indian trumpet fruits, potassium was also the largest concentrated element, and calcium, phosphorous, sulphur and iron were the second largest elements. Copper, manganese, rubidium, zinc and strontium were found as trace elements. In Indian trumpet barks, potassium and calcium were the largest concentrated elements, and sulphur was the second largest element. Other elements such as iron, strontium, copper, rubidium, manganese, and zinc were trace elements. The concentrations of elements contained in these samples were described in Fig. 5, Fig. 6, Fig. 7, and Table 1, Table 2 and Table 3.

Potassium helps regulate the heartbeat and is vital for electrical signaling in nerves. **Calcium is** found in bones and teeth. Ironically, calcium's most important role is in bodily functions, such as muscle contraction and protein regulation. **Sulfur** is found in two amino acids that are important for giving proteins their shape.

Phosphorous is found predominantly in bone but also in the molecule ATP, which provides energy in cells for driving chemical reactions. **Iron** is a key element in the metabolism of almost all living organisms. It is also found in hemoglobin, which is the oxygen carrier in red blood cells.

Zinc is an essential trace element for all forms of life. Several proteins contain structures called "zinc fingers help to regulate genes. Zinc deficiency has been known to lead to dwarfism in developing countries. The additions of **Rubidium** or Cesium (Cs) to potassium-deficient diets prevent the lesions characteristic of potassium depletion in rats and supports near normal growth for short periods of time. **Manganese** is essential for certain enzymes, in particular those that protect mitochondria — the place where usable energy is generated inside cells — from dangerous oxidants.

Figure 4. Photograph of the Shimadzu EDX-7000 Spectrometer at Material Science Lab, Taungoo University

IV. Conclusion

Indian trumpet leaves, fruits and barks were investigated by using the Energy Dispersive X-ray Fluorescence (EDXRF) detection technique. In this research, elements contained in each sample were discussed and their corresponding benefits were discussed. So, Indian trumpet supports not only for food but also for medicinal use. Recent studies have focused mainly on its antiinflammatory, antiulcer, antimicrobial, antiarthritic, hepatoprotective, immunostimulant, photocytotoxicity, antimutagenic, antiproliferative and antioxidant activities.

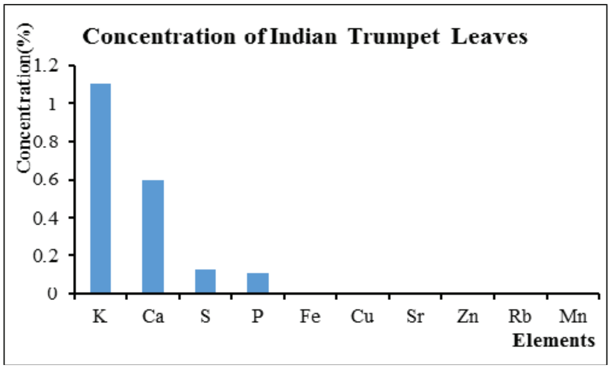

Figure 5. Elemental concentration of Indian trumpet leaves

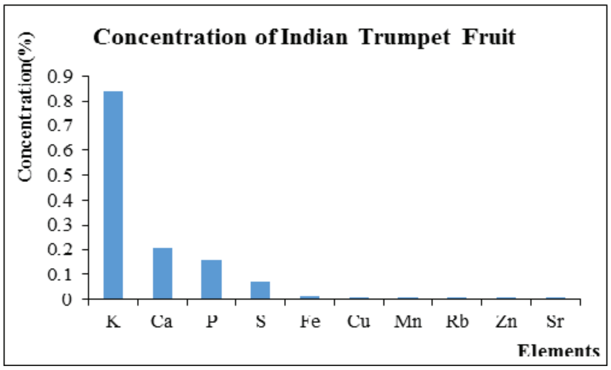

Figure 6. Elemental concentration of Indian trumpet fruits

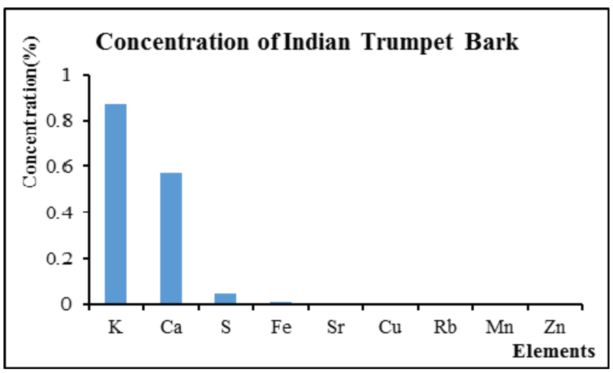

Figure 7. Elemental concentration of Indian trumpet barks

Table I. ELEMENTAL CONCENTRATION OF INDIAN TRUMPET LEAVES

Element	Concentration (%)
K	1.105
Ca	0.601
S	0.127
P	0.108
Fe	0.005
Cu	0.004
Sr	0.002
Zn	0.002
Rb	0.001
Mn	0.001

Table II. ELEMENTAL CONCENTRATION OF INDIAN TRUMPET FRUITS

Element	Concentration (%)
K	0.838
Ca	0.21
P	0.159
S	0.071
Fe	0.011
Cu	0.003
Mn	0.003
Rb	0.002
Zn	0.001
Sr	0.001

Table III. ELEMENTAL CONCENTRATION OF INDIAN TRUMPET BARKS

Element	Concentration (%)
K	0.873
Ca	0.571
S	0.043
Fe	0.009
Sr	0.003
Cu	0.002
Rb	0.001
Mn	0.001
Zn	0.001

O. indicum is used in the manufacture of various Ayurvedic preparations for a range of ailments and its non-drying oil used in perfume industry.

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