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# PIXE ANALYSIS FOR ELEMENTAL STUDY OF PHARMACOLOGICAL IMPORTANT PLANT, *ABROMA AUGUSTA*

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**Abstract**

Recently medicinal plants have been popular for curative purpose of different diseases in Bangladesh, even worldwide. One of the frequently applied medicinal plants was investigated in Van de Graaff Accelerator Laboratory, Atomic Energy Centre, Dhaka, using Ion Beam Analytical Technique PIXE. The collected plant was washed and dried for making sample to be burnt with high accelerated proton beam. The emitted X-rays from the sample were measured by Lithium Drifted Silicon [Si(Li)] detector. Scattering chamber and MAESTRO-32 software were used to collect data and collected data were analyzed using GUPIX software. Medicinal plant *Abroma augusta* (Ulotkambol) was studied and atoms of different elements such as Ca, K, Mn, S, P, I, Cd, Ti, V, Sc etc. were detected in a sufficient amount.

***Keywords:*** Medicinal, elemental, PIXE, Si (Li) detector, MAESTRO, GUPIX.

## Introduction

Bangladesh, the darling child of nature, nourishes different types of trees among which some of them play a vital role in using for the medicinal purpose. Over thousands of years, plants have been used by our ancestors for soothing different types of ailments. In this modern world, we also follow them blindly without knowing details about the elements contained in the parts of plants used for treating ailments. Medicinal plants have charismatic power on human health to prevent and to heal illness. Some are really helpful to gain energy after coming round from diseases. Plants contain number of atoms of different elements which are responsible for important physiological functions in human body (Nielsen, 1990). Based on concentrations contained in a plant, few elements show poisonous effect on human health too (Rajurkar and Damame, 1998). That's why elemental analysis of any material of physicochemical, biological or environmental origin

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shows a complete picture about the internal quality of the material to be used and or consumed in different sectors of national economy. Otherwise, the accumulation or deficiency of various elements may stimulate an alternate pathway which might produce diseases (Prashanth *et al.*, 2015). Also, assessments show that nine nonmetallic elements are responsible for making up of about 98% of the body mass of a man (Kien, 1977). Sodium, magnesium, potassium, and calcium constitute about 1.98%, while 11 other trace elements constitute the rest 0.02% of an average human body (Frieden, 1972). Sometimes heavy metals are stored in the herbal plants from the soil, polluted water and atmosphere. Using these plants may cause serious health hazard for the man who take it as a healing purpose. For this reason various major, minor and trace element's concentrations are significant for determining potency of medicinal plants in treating various ailments and to comprehend their therapeutic action (Hossen *et al.*, 2014)**.**

**Materials and Methods**

Table 1 shows the local name, English name, scientific name, family, part of plant use and medicinal uses of frequently applied medicinal plant, Ulotkambol. Leaf of this plant wascollected from Jahangirnagar University situated 32 km North West from the Dhaka city. Geographically this campus is situated at 30°16´N latitude and 90°52´E longitudes. It encircles about 697.56 acres of land with different green environment (source: JU diary, 05). The average height of this place is about 39 ft. from sea level and the soil of this locality is full of with pebbles, very acidic, and reddish in color. The climate of the locality can be categorized by summer and winter. The summer is very hot, rainy and humid with maximum temperature $33.9^0$C in March-April. And the winter is dry and cool with minimum temperature $14.1^0$C in January. Humidity swings between 55-78% (source: Meteorological Dept., Dhaka).

Plant sample was collected in rainy season in order to avoid air pollution as Savar area is full of with industries that emit lots of smoke containing different heavy metals. Leaf was taken as sample from a healthy Ulotkambal plant and was washed completely with distilled water so that all minute particles can be removed. After drying in the sun the leaf samples were desiccated at $(50\text{-}80)^0$C for about 48 hours with an electric oven, model no. "Memmert Schutzart DIN 40050–IP 20". Until getting completely moisture free the leaves were monitored regularly by taking their weight with an electronic balance for being sure about a constant weight. The samples were made into powder form after drying. An Agate Mortal Pester was used to grind samples into fine powder. And in order to avoid the cross contamination the pester was cleaned with acetone ($CH_3$-CO-$CH_3$). Then the 0.25 gm of powdered sample was mixed with two drops of Polyvinyl alcohol $(-C_2H_4O)_n$ and was pelletized using hydraulic press with pressure 125 kg/cm$^2$. The pellets were 7 mm in diameter and 2mm in thickness. The sample was then mounted in the

aluminum target of scattering chamber for PIXE experiment. Nuclear-based analytical method, Proton Induced X-ray Emission (PIXE) has established an important role in the elemental analysis of different specimen in the fields of material science, biology, geology and others. Sven Johansson *et al*. at the department of Physics, Lund University first introduced this technique in the early 1970s (Johanson and Campbell, 1988)**.** Proton Induced X-ray Emission (PIXE) is an X-ray spectrographic technique, which can be used for the non-destructive, simultaneous elemental analysis of solid, liquid or aerosol filter samples. The X-ray spectrum is initiated by energetic protons exciting the inner shell electrons in the target atoms. The expulsion of these inner shell electrons results in the production of X-rays. The energies of the X-rays, which are emitted when the created vacancies are filled again, are uniquely characteristic of the elements from which they originate and the number of X-rays emitted is proportional to the mass of that corresponding element in the sample being analyzed (Khaliquzzaman *et al.*, 1983, Khaliquzzaman *et al.*, 1989, Johansson *et al.*, 1981). In PIXE technique during concentration calibration process the H value method described in (Shariff *et al.*, 2002) was followed which is based upon the equation:

$$Y(Z,M)=Y_1(Z,M)QC_ZT(Z)\varepsilon_ZH$$

where, Y (Z, M) is the measured X-ray yield computed by the fitting program;

$Y_1$ (Z, M) is the theoretical X-ray yield per unit beam charge, per unit solid angle and per unit concentration computed from the GUPIX database. It includes the matrix correction and secondary fluorescence for the thick targets;

Q is the measured beam charge or some value proportional to the charge;

$C_Z$ is the concentration of the element quoted by the manufacturer or measured by some other method;

T (Z) is the fractional transmission of X-ray through any absorbers;

$\varepsilon_Z$ is the intrinsic detector efficiency;

H is the product of detector solid angle and any correction factor for the charge measurement.

In PIXE method, for elemental measurement of samples CuS was used as standard samples for the calibration of a Si(Li) detector (Maenhaut and Raemdonck, 1984). The concentration calibration is defined as the number of X-ray per ppm of the element of interest per micro coulomb vs. its atomic number. The concentration

calibration curves were constructed from the average peak areas obtain from the irradiation of 0.025 gm standard pellets of CuS. The typical calibration curves obtained from these standards for 20μC irradiation with 2.5 MeV proton beam. Fig. 1 displays a typical spectrum from a PIXE analysis of CuS specimen, illustrating characteristic feature of PIXE spectra.

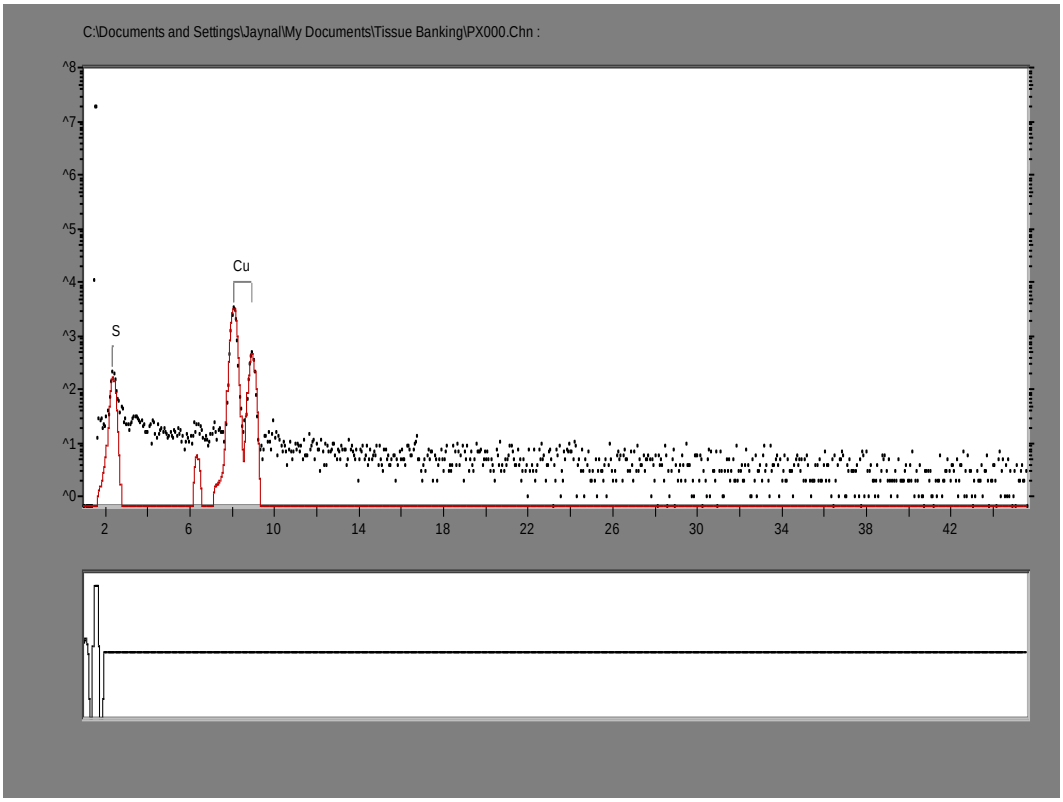


**Fig. 1.** Typical spectrum of standard CuS sample.

For PIXE method MAESTRO software was used to collect and save the signals in a specific file format (ORTEC) and the data were analyzed into concentration of different elements present in the samples with GUPIX software.

**Results and Discussion**

Sample was bombarded with 2.5 MeV proton beam at the current intensity of (10-20) nA. Total ten atoms of different elements namely P, S, K, Ca, Sc, Ti, V, Mn, Cd and I have been detected in the plant. The elemental concentrations in the medicinal plant are represented with bar chart in Fig. 2.

**Table 1. Plant's Local Name, English Name, Scientific Name, Family, Part of the Plants Used and Their Particular Usage in Treating Diseases**.

| Features | Corresponding Informations |
|---|---|
| Local Name | Ulotkambol |
| English Name | Devil's Cotton |
| Scientific Name | *Abroma augusta* |
| Part Used | Leaves |
| Medicinal Uses | Bronchitis, diabetes, gonorrhea, menses scanty, menstrual disorder, pneumonia etc. |

According to the experimental concentration of the elements found in the medicinal plants, it is observed that among the other elements, the concentration of sulfur is the mostly tracked out with a concentration of 390799.2 ppm. Sulfur element is less toxic for man whatever their concentration is, while sulfur compound may cause serious toxic effect on animal tissues (Gough, 1997). Sulfur is an important part of amino acids which perform different enzyme reactions and protein synthesis.

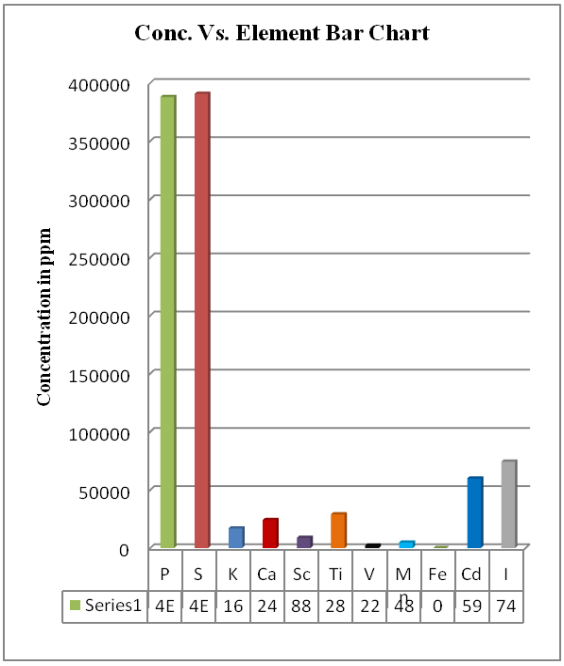


**Fig. 2.** Bar chart of obtained elements and their concentrations (ppm)

Phosphorus, another important element, plays important role in DNA synthesis, energy metabolism and calcium absorption (Food and Nutrition Board). The amount of phosphorus found in this study is 387925 ppm and it has no toxic effect on human body.

The measured concentration of potassium is 16972.5 ppm. Potassium has remedial power against renal disorder and diarrhoea. It is also used to prevent stroke and treat high blood pressure by maintaining water balance in the body (He and MacGregor, 2008). Potassium works as some enzymes and coenzymes activator which are helpful in the normal growth and muscle function.

Calcium, an essential nutrient, is important for bone and teeth growth, different body functions, i.e., muscle contraction, blood clotting, neurotransmitter secretion, digestion and structural role outside of skeleton e.g. in organelles and membranes (Theobald, 2005). The estimated amount of calcium in this research is 24090.2 ppm.in *Abroma augusta.*

Scandium is called the rare earth element and is of little concern about its physiological and toxicological effect, but it is evident that Sc is responsible for chronic renal failure (Cristina *et al.*, 2013). The concentration of Sc is 8838 ppm found in this study.

Titanium is considered as safe metal for human health and is vastly used in dental implantation and orthopedic surgery (Frisken *et al.*, 2002). Titanium has no biological role to play in human body. The Concentration of Ti is 28974.1 ppm in *Abroma augusta.*

The estimated concentration of vanadium is 2271.5 ppm. It is an essential trace element and small amount is needed for normal bone growth in human body. V has lower blood sugar levels and can upgrade sensitivity to insulin. In addition, different vanadium salts can normalize blood pressure, regulate cholesterol and triglyceride levels in blood (Gruzewska *et al.*, 2014).

*Abroma augusta* contains 4815.4 ppm manganese (Mn) in it. Mn like other trace minerals needed in very small amount in human body to perform as an activator of enzyme and as a component of metalloenzymes. It has a role to play in fatty acids and cholesterol metabolism and urea cycle (Rehnberg *et al.*, 1982).

Cadmium (Cd) is also trace element found in this research and the concentration of this element is 59816.4 ppm. Cd is considered as nonessential element for animals (Gough *et al.*, 1979).

Another important microelement Iodine (I) is also found in this study and the estimated concentration for *Abroma augusta* is 74352.9 ppm. This micronutrient is

required for all the stages of life. Iodine is the constituent of thyroxin hormone and is important for functioning of the parathyroid glands. Moreover, iodine provokes usual maturation of reproductive system and development of the body (Prashanth *et al.*, 2015).

## Conclusion

Ion beam analytical technique PIXE was implemented to quantify the concentrations of different elements contained in a plant (*Abroma augusta*) having vital medicinal importance at Van de Graaff Accelerator Laboratory, Dhaka Bangladesh. This study is a source of biologically important elements which can be used as partial data base or reference for future research.

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