Estimation of Trace Elements in Azadiracta indica from Mining area by EDXRF technique

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Abstract. The effect of mining activity on environment has one of the major concerns for public health. The Present study deals with the elemental analysis of selected medicinal plant of Azadiracta indica from mining area by EDXRF technique. EDXRF is one of the most powerful, non-destructive, multi-elemental and high sensitive analytical method. The thirteen elements such as P, S, Cl, K, Ca, Mn, Fe, Cu, Zn, Se, Br, Rb and Sr were identified and their elemental concentrations were determined. The results were compared with control sample and NIST1515 apple leaves, it shows various elements found to present in deferent quantities in same plant from different areas. High elemental concentrations were found in Azadiracta indica from coal mining area, this may be due to of coal mining area has been associated with enhancement of heavy toxic elements absorbed by soil. The analysis of this study also gives the presence of elements in the environment pollution from mining area plant sample. Thus we have recommended that the people living in mining areas are to be very cautious in daily life processes due to the exposure of heavy metals and toxic chemical elements from coal mining area has harmful affect on human health.

Keywords: Ex-3600 spectrometer, Elemental analysis, Trace elements, Azadiracta indica, Medicinal plants, various diseases.

1. Introduction
Coal mining is one of the most important sources of emitting toxic elements in the environment. Generally mining releases heavy toxic elements such as As, Pb, Cd and Hg. These metals have potential to accumulate in different organs of the body for long period of time causes toxicity and unwanted effects on human health. The adverse effects of mining on the environment and human health have been observed in many countries [1]. Natural environment is an integral system and any change in one of its components such as water, air, soil and plants is bound to affect the environment as a whole. Heavy metal are emitted from several pollutants released into the environment as a results of industrial and agriculture practices, combustion of fossil fuels and vehicular emissions may contaminate the ambient environment of an area [2]. Some of these industrial activities release trace elements to the environment of the region in which plants grow. Traditional medicine is an integral part of Indian culture and has been practiced by various ethnic groups long before the introduction of modern medical system in to the country. Medicinal plants are used by millions of people around the world. The usage of medicinal plants is either singly or in combination to treat various diseases [3]. Most of the studies revealed that atmospheric pollution, resulting from industrial, vehicular emissions and coal mining areas results are major environmental risk factors for the onset of various ailments, ranging from common cold to cancer [4]. The elemental content present in selected medicinal plant are very important because some of these elements are closely related to human health [3].
Medicinal plants contain large amount of micronutrients and trace elements, which can play a significant role in maintaining health and preventing various diseases. Medicinal plants are used in the preparation of various herbal medicines. Both organic and inorganic constituents are present in medicinal plants [5]. Herbal medicines have been derived from rich traditions of ancient times and scientific heritage. Throughout the world in every culture herbal drugs are consisting medicinal plant preparations have been used for curing ailments.

Elements exist in various forms in the Nature, these trace elements are very essential for the body to perform a number of functions. Trace elements play a specific role in the cell functions at biological, molecular and chemical levels. In normal levels, the stabilization of the cellular structures occurs at normal levels of trace elements and deficiency of trace elements may cause various diseases. However they can be toxic for human health when their concentrations are higher or lower than the needed for biological functions [6]. These essential trace elements have scientific implication and these can be measured by different analytical techniques. The knowledge of trace elemental content in medicinal plant is very important because some of these elements are essentially related to human health.

The main objective of this present study is to determine the elemental concentrations in Azadiracta indica medicinal plant sample from mining area and control area. The traditional medicinal plants do not pose any health risk.

2. Materials and Methods

2.1. Sample collection and preparation

Azadiracta indica plant leaves were collected from Ramagundam coal mining area, and control sample (Azadiracta indica leaves) was collected from forest region, Karimnagar district, Telangana, India. The selected leaves of Azadiracta indica medicinal plant were washed under tap water and rinsed thoroughly with double distilled water, initially air-dried at room temperature, again dried in an oven at about 60°C overnight and subsequently powdered to fine homogeneous powder using Agate mortar and Pestle, stored in butter paper for elemental analysis. A quantity of pure 150 mg of each powder sample was weighted and compressed using a 150 ton hydraulic press machine and made into pellets of 13 mm diameter and about 1 mm thickness. Triplicates of each sample were done. These pellets were used as targets for the EDXRF experiment. The efficiency and accuracy of this analytical method was checked by certified reference material of apple leaves (NIST 1515).

2.2 Experimental set up

Several sophisticated techniques, namely AAS, PIXE, XRF, ICP-MS, ICP-AES and NAA, are used for the analysis of elements present in minor quantity at the level of parts per million or parts per billion or in other words trace elements. With this motivation the Kolkata Centre of UGC-DAE Consortium for Scientific Research has initiated several research schemes in the fields of trace element sciences, using various techniques, EDXRF being one among them. Some of these works are discussed in this presentation. EDXRF has a multidimensional application and can be used effectively in studying the trace elemental profile in different types of systems and matrices – biological, environmental, agricultural sciences etc. The EDXRF spectrometer at UGC-DAE CSR, Kolkata Centre can be used for both thick (pellet) and thin samples effectively with appropriate sample preparation. The set-up consists of a Xenemetrix (previously Jordan Valley) EX-3600 EDXRF spectrometer. This consists of an X-ray tube with a Rh anode as the source of X-rays with a 50 V, 1 mA power supply, Si(Li) detector with a resolution of 143 eV at 5.9 keV, Mn X-ray and 10-sample turret enables mounting and analyzing 10 samples at a time. The quantitative analysis is carried out by the in-built nEXT software.

3. Results and Discussion

In the present research work, the trace elemental analysis was carried out in Azadiracta indica medicinal plant, collected from mining area as well as control area. Thirteen elements such as P, S, Cl, K, Ca, Mn, Fe, Cu, Zn, Br, Se, Rb and Sr were determined and measured their elemental concentrations by using EDXRF method. Table 1 presents the results of average elemental
concentrations with Standard Deviation of each element investigated by EDXRF technique. Figure 1 shows EDXRF spectrums of *Azadiracta indica* from mining and control areas. From the results of EDXRF measurements for the determination of the concentration of Major and minor or trace elements are presented in Table 2. The results obtained from present study of the plant samples shows wide variation in their trace elemental concentrations in same plant sample from different environments, the elemental concentrations may be vary according to the geographical regions, attributed to mineral composition of the soils in which the plant grows and geochemical soil characteristics. These results compared with standard certified material NIST 1515 apple leaf and control area (*Azadiracta indica*) sample. Analysis of present investigation documents a wide range of variation in their elemental concentrations in different plant species. Toxic elements namely Cd, Pb, Hg and Sn were not detected in present selected medicinal plants.

**Table 1.** Average Elemental concentrations (in ppm) of *Azadiracta indica* medicinal plant

| Elements | Azadiracta indica Mining Area | Standard Reference Material Control Area | Apple leaves (1515) |
|----------|------------------------------|----------------------------------------|-------------------|
| P        | 390.45                       | 558.12                                 | 1590              |
| S        | 1521.75                      | 1189.77                                | 1800              |
| Cl       | 1372.04                      | 1802.28                                | 579               |
| K        | 7101.86                      | 8170.78                                | 16100             |
| Ca       | 29097.47                     | 19204.05                               | 15260             |
| Mn       | 42.34                        | 25.16                                  | 54                |
| Fe       | 221.4                        | 135.18                                 | 83                |
| Cu       | 3.16                         | 3.8                                    | 5.64              |
| Zn       | 6.20                         | 10.02                                  | 12.5              |
| Se       | 0.13                         | 0.69                                   | 0.05              |
| Br       | 16.17                        | 20.75                                  | 1.8               |
| Rb       | 7.2                          | 12.57                                  | 10.2              |
| Sr       | 190.61                       | 186.10                                 | 25                |

**Table 2.** Maximum and minimum concentrations (in ppm) of essential elements of *Azadiracta indica* medicinal plant sample

| Elements | Maximum concentration | Minimum concentration |
|----------|-----------------------|-----------------------|
| S        | 1521.75 (MAP)         | 1189.77 (CP)          |
| Mn       | 42.34 (MAP)           | 25.16 (CP)            |
| Ca       | 29097.47 (MAP)        | 19204.05 (CP)         |
| Fe       | 221.4 (MAP)           | 135.18 (CP)           |
| Sr       | 190.61 (MAP)          | 186.10 (CP)           |
| Cl       | 1802.28 (CP)          | 1372.04 (MAP)         |
| K        | 8170.78 (CP)          | 7101.86 (MAP)         |
| P        | 558.12 (CP)           | 390.45 (MAP)          |
| Zn       | 10.02 (CP)            | 6.20 (MAP)            |
| Cu       | 3.8 (CP)              | 3.16 (MAP)            |

MAP-Mining area plant sample, CP- Control area plant sample

The concentration of Cl, Ca, Fe, Se, Br and Sr are present at higher level and remaining elements are present at minor level in present plant sample from different areas. Among all the trace elements such as K, Ca, Mn, Fe, Cu, Zn and Se are essential micronutrients are required for various body function.

Present results show that, all the analyzed elements are present at higher concentrations in the coal-mining area than in the control area although not all elements showed significantly higher values. The highest concentration of Cl (1372.04ppm), Ca (29097.47ppm), S (1521.75ppm), Mn (42.34ppm), Fe
(221.4ppm) and Sr (190.61ppm) in *Azadiracta indica* plant sample. The concentration values of some essential trace elements present in *Azadiracta indica* from coal mining area shows wide variation than the control sample. Some of the elements including iron, zinc and copper are essential for human physiological actions. The concentration of Fe is maximum in mining area plant sample. The iron is an important component of succinate dehydrogenase as well as a part of the hemoglobin, myoglobin and cytochromes.

![Figure 1. EDXRF spectrums of Azadiracte indica (NM-mining area plant sample and AZI- control area plant sample)](image1.png)

4. Conclusion
The trace elemental analysis was carried out in the selected medicinal plant of *Azadiracta indica* by using EDXRF technique. The elements like P, S, Cl, K, Ca, Mn, Fe, Cu, Zn, Se, Br, Rb and Sr were determined. The control sample gives a good agreement with the Standard reference material and the mining area plant sample has present higher concentrations than the control sample. Total five elements (Cl, Ca, Mn, Fe, and Sr) have higher concentrations in plant from coal mining area compared with control area plant sample. The variation in elemental concentrations of *Azadiracta indica* in both areas depends on the chemical and physical nature of the soil and the absorption capability of the plant grows and that may be a cause of sample preparation and the preferential uptake of a particular
plant for certain elements. The various trace elements present in *Azadiracta indica* has either direct or indirect role in the control and management of the many common ailments. Thus, the expected role of trace elements will enable to understand the etiopathogenesis of cancer and provide a rapid diagnostic facility and also create effective treatment modalities. Thus we have recommended that the people living in mining areas are to be very cautious in daily life processes due to the exposure of heavy metals and toxic chemical elements from coal mining area which is harmful effect on human health.

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**References**
[1] Bolormaa Oyuntsetseg, Katsunori Kawasaki, Makiko Watanabe and Batkhishig Ochirbat 2012 *ISRN Analytical Chemistry* **2012** 1-9
[2] Ravikumar M, Sarita P, Naga Raju G J, and Bhuloka Reddy S 2013 Journal of Environmental Reasearch and Development, **7(3)** 1209-1215
[3] Majid A. A B, Sarmani S, Yusoff N I, Wei Y K, Hamzah F 1995 *Journ. Of Radio. And Nucl. Chem* **195(1)** 173-183
[4] Ames B N, Gold L S, and Willett W C 1995 *Proc. Nat. Aca. Sci.*, USA, **92(12)** 5258-5265
[5] Abdul Sattar, B. Seetharami Reddy B, Koteswara Rao V, Ramnarayana K, G.J.Naga Raju G J, Bhuloka Reddy S, K.DPhanisree T K D and P.V.Madhusudhana Rao P V 2012 *X-ray spectrum,* **41** 111-116
[6] Chrzan A 2016 *Environmental Earth Sciences,* **75 (160)** 786(1-8)