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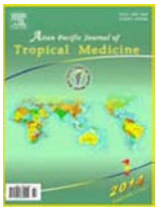

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# Trace elements content in the selected medicinal plants traditionally used for curing skin diseases by the natives of Mizoram, India

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ABSTRACT

**Objective:** To determine the trace elements content in the selected medicinal plants, namely, *Eryngium foetidum* L., *Mimosa pudica* L., *Polygonum plebeium*, and *Prunus cerasoides* D. Don traditionally used by the natives of the Mizoram, one of the north eastern states in India as their folklore medicines for curing skin diseases like eczema, leg and fingers infection, swelling and wound.

**Methods:** A 3 MeV proton beam of proton induced X-ray emission technique, one of the most powerful techniques for its quick multi elemental trace analysis capability and high sensitivity was used to detect and characterized for trace elements.

**Results:** The studies revealed that six trace elements, namely, Fe, Zn, Cu, Mn, V, and Co detected in mg/L unit were present in varying concentrations in the selected medicinal plants with high and notable concentration of Fe, Zn, Mn and appreciable amount of the Cu, Co and V in all the plants.

**Conclusions:** The results of the present study support the therapeutic usage of these medicinal plants in the traditional practices for curing skin diseases since they are found to contain appreciable amount of the Fe, Zn, Cu, Mn, V and Co.

## 1. Introduction

Trace elements are nutrients that are needed for plant, animal growth and health. As the name goes, they are required in minute quantities for their participation in a number of life processes in the body and are intimately involved in the number of physiological function of the entire plant cells and human organ[1]. Besides their role in physiological functions essential for the healthy growth of plants, trace elements are known to play a very important role in the formation of the active chemical constituents present in medicinal plants and therefore they can be responsible for their medicinal properties[2]. The therapeutic usage of plant species in curing of various disease due to presence of metallic elements is already a widespread approach in medicinal purposes. Most of the medicinal plants are found to be rich in one or more individual elements, thereby providing a possible link to the therapeutic action of the medicine[3,4].

The human body requires a number of elements in order to maintain good health. A number of elements essential to human nutrition are accumulated in the different part of plants as it accumulates minerals essential for growth from the environment[5]. It has been reported that for curing of skin diseases and enhancing the immune system, body required small quantity of trace elements, which defend from pathogen and recover quickly from serious infection. Iron (Fe), Zinc (Zn), Copper (Cu), Manganese (Mn), Cobalt (Co) and Vanadium (V) are essential micronutrients involved in many metabolic processes[6], and are reported to involve in various enzymatic activities and immunologic reactions[7,8].

Though, it is well known that certain trace elements are essential for the healthy growth of plants, the uptake of some non essential elements can also enhance the medicinal property in some specific cases[9]. So the quantity of the estimation in the various trace elements contents are important to determin effective and scientific validation

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of therapeutic uses of these medicinal plants. Further, as certain elements at elevated levels are toxic, such assessment would be helpful in regulating their uses. Since last many years, abundant research work has been carried out on the organic constituents of the medicinal plants while little attention has been paid on the role of inorganic elements in the medicinal use of the plants[10].

Mizoram is remote state in northeasten region of India bordering Myanmar and Bangladesh and lies in the Indo-Burma biodiversity hotspots. The state has a rich diversity of medicinal plants and most of them are endemic to this region[11]. The tribal people of this region have a rich heritage about using plants in their folklore medicine in the treatment of various diseases like hypertension, cancer, jaudince, diabetes and cancer *etc*[12]. *Eryngium foetidum* L. (*E. foetidum*), *Polygonum plebeium* (*P. plebeium*), *Mimosa pudica* L. (*M. pudica*) and *Prunus cerasoides* D.Don (*P. cerasoides*) are among the numerous ethnomedicinal plants commonly used by the tribal natives of this region to cure skin diseases. However, there is scarcity of data and sometimes nonexistent data on the trace element content in *E. foetidum, M. pudica P. plebeium and P. cerasoides*. Moreover, trace elements content in the medicinal plants varies from region to region and in different species depending on the type of soil[13]. Here, the trace elements in these four medicinal plants were analyzed by using proton induced X-ray emission technique (PIXE) and their possible role in curing skin diseases has been discussed for the first time. This technique is one way simultaneous, reliable, sensitive, quantitative multielemental and non destructive, on the other way suitable for routine analysis due to minimal sample preparation and less turn over time and it was earlier used for this purpose several times[14-16]. Thus, the objective of the present study was to determine the trace elements present in the four selected ethnomedicinal plants of the northeasten India commonly used as home remedy for curing skin diseases. The result of the study was reported in the present communication.

## 2. Materials and methods

### 2.1. Collection of samples

Table 1 gives the traditional and therapeutic uses of these plants against skin diseases. Previous studies have reported the trace element content in the various medicinal plants of India[17-19].

Fresh plants samples of *E. foetidum* L., *P. plebeium*, *M. pudica* L. and *P. cerasoides* D.Don were collected from their natural habitats of Mizoram, a northeasten state of India during rainy season (May to September) and identified by Dr. H.S. Thapa, a taxonomist in the Department of Botany, Pachhunga University College, a Constituent College of Mizoram University, Aizawl, Mizoram and was deposited at Department of Botany, Pachhunga University College, Mizoram University, Aizawl as herbarium (Voucher specimen No-111, 112, 113 and 114 respectively). For *P. cerasoides*, fresh stem bark was collected by cutting with plastic knife to avoid any metals contamination.

### 2.2. Preparation of samples

The parts of interest of these plants were thoroughly washed with triple distilled water to eliminate contamination due to dust and environmental pollution, air-dried and then oven dried at 60 °C and stored in plastic bags until needed. Samples were then homogenized in an agate mortar. Two grams of each powdered sample was mixed with high purity 0.2 g of graphite powder. The purpose of mixing graphite powder was to monitor the beam current. The mixture was pressed into pellets of 2 mm thickness and 20 mm diameter with a pressure of 30 kPa. Pellets of certified reference materials bovine liver (NIST-1577b) was also prepared in similar way for quantification and verification of the results.

### 2.3. PIXE analysis

The 3 MeV collimated proton beam, obtained from the 3 MV tandem pelletron accelerator at National Centre for Compositional Characterization of Materials, Department of Atomic Energy, Hyderabad, India, was used to irradiate. The scattering chamber consists of a multiple target holder with rotatable to manipulate the beam-target angle. The samples pellets were suspended on an aluminum plate then loaded in multiple target holder ladders and it was oriented at 45° to attained vertical position. The ladder was moved vertically inside PIXE chamber for maintaining to same projectile target inside PIXE chamber under vacuum conditions (10-6 Torr). The irradiation were carried out with maximum beam current $10^{-8}$ amperes, germanium detector as Eurisys Measures Type EGX 100-01, beryllium window of thickness 40 μm and energy resolution of 150 eV at 5.9 KeV ($^{55}$Fe radioactive source), FWHM of 150 eV at 5.9 keV, mylar thickness 40 μm as an absorber and electron suppressor with -900 V in front of the sample was used. The spectral data were analyzed using GUPIX software package for fitting PIXE spectra, which provides the element Kα and Kβ peaks and converts raw spectral data into elemental concentration. The generated data were analyzed by GUPIX and our results was checked against the certified values from the standard reference materials and was found to be good.

**Table 1**

Traditional and therapeutic uses of the selected medicinal plants.

| Local name | Scientific name | Family | Part of the plant used | Method of uses in traditional practices |
|---|---|---|---|---|
| Bahkhawr | *E. foetidum* L. | Apiaceae | Leaves | The plant is crushed and the juice is taken orally for inflammatory gland and plant paste applied in swollen gland. Infusion of the plant is used as a lotion for cut wound healing and swelling. |
| Bakhate | *P. plebeium* | Polygonaceae | Whole plant | Plant ash is used in eczema |
| Hlonuar | *M. pudica* L. | Mimosaceae | Leaves | Juice of leaves or decoction is used in leg infections, especially between the fingers and also taken orally. |
| Tlizawng | *P. cerasoides* D.Don | Rosaceae | Stem bark | Boiled bark water extract is used in swelling |

## 3. Results

The concentration of Fe, Mn, Zn, Cu, Co and V present in the selected medicinal plants *i.e. E. foetidum* L., *P. plebeium*, *M. pudica* L. and *P. cerasoides* D. Don is given in Table 2. PIXE spectrum of the *E. foetidum* L, *P. plebeium*, *M. pudica* L. and *P. cerasoides* D. Don are shown in Figures 1, 2, 3 and 4 respectively while photographs of the part of plants used is shown in Figure 5.

**Table 2**

Trace elements concentrations (mg/L) of the selected medicinal plants.

| Elements | *E. foetidum* (leaf powder) | *M. pudica* (leaf powder) | *P. plebeium* (whole plant powder) | *P. cerasoides* (stem bark powder) |
|---|---|---|---|---|
| Fe | 262.799±7.591 | 308.467±10.488 | 297.620±6.392 | 33.701±2.746 |
| Mn | 21.505±1.797 | 65.664±8.690 | 17.789±3.496 | 79.309±5.593 |
| Zn | 17.639±0.998 | 18.209±5.493 | 11.856±2.557 | 7.930±1.238 |
| Cu | 9.589±1.997 | 10.707±5.593 | 4.355±1.438 | 3.535±0.149 |
| Co | 1.440±0.669 | 2.025±0.679 | 1.093±0.948 | 0.284±0.099 |
| V | 0.157±0.049 | 0.059±0.001 | 0.715±0.039 | 0.199±0.399 |

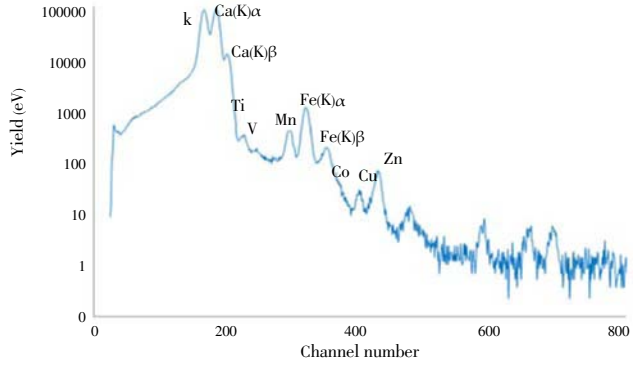


**Figure 1.** PIXE spectrum of *E. foetidum* L.

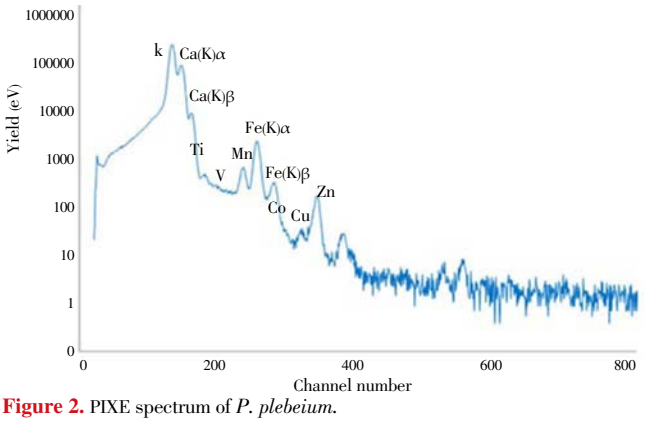


**Figure 2.** PIXE spectrum of *P. plebeium*.

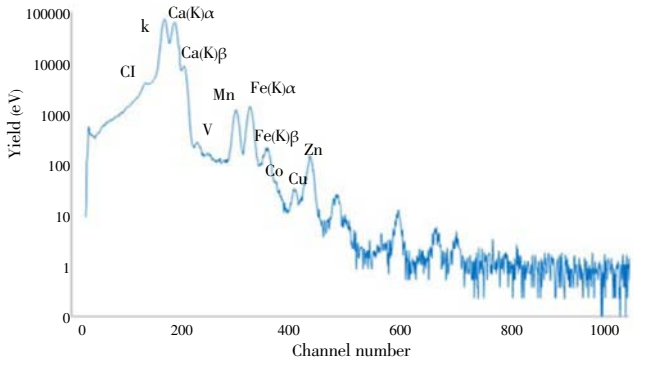


**Figure 3.** PIXE spectrum of *M. pudica*.

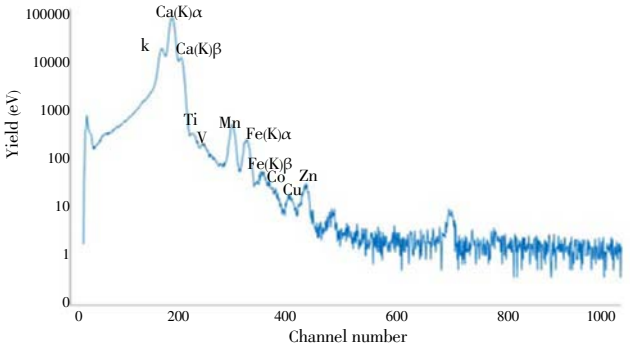


**Figure 4.** PIXE spectrum of *P. cerasoides*.


**Figure 5.** Phtographs of *E. foetidum* L, *M. pudica* L, *P. plebeium*, and *P. cerasoides* D.Don.

Table 2 reveals wide variation in the elemental concentrations of the different plants studied. Analysis of the present data revealed that Fe was observed with the highest concentration in all the medicinal plants studied as compared to other trace elements recorded. The descending order of the concentration of the elements in the medicinal plants studied is Fe>Mn>Zn>Cu>Co>V. The content of the Fe recorded in the medicinal plants were in the range of (33.701±2.746) to (308.467±10.488) mg/L; the highest concentration of the Fe was found in *M. pudica*. The concentration of the Mn recorded in the present study ranged from (17.789±3.496) to (79.309±5.593) mg/L with *P. cerasoid*s containing the highest concentration. Zn was also found to be presented with appreciable amount in the range of (7.930±1.238) to (18.209±5.493) mg/L in all the medicinal plants studied with the highest concentration recorded in *M. pudica*. Cu was recorded to be present in varying concentrations in all the medicinal plants samples in the range of (3.535±0.149) to (10.707±5.593) mg/L with the highest concentration recorded again in *M. pudica*. In the present study, Co and V were also detected in the selected four medicinal plants with varying concentration in the ranges of (0.284±0.099) to (2.025±0.679) mg/L and (0.059±0.001) to (0.715±0.039) mg/L and for Co and V, respectively.

## 4. Discussion

Analysis of the present data revealed that Fe was observed with the highest concentration in all the medicinal plants studied as compared to other trace elements recorded. The highest concentration of the Fe among the studied medicinal plants was found in *M. pudica* [(308.467±10.488) mg/L]. Fe is an element essential for human body in the production of haemoglobin and in the oxygenation of red blood cells. It is needed for healthy immune system and energy production[20]. Several studies have shown the important role of Fe availability correlating with the bactericidal effect of lactoferrin and lysozyme, which can killed Gram-negative bacteria[21]. In view of these positive roles of Fe on immune system, the use of these medicinal plants in the treatment of skin diseases in the traditional practices may be attributed to considerable amounts of Fe present in them.

Like Fe, Mn is also important in regulation of immune responses of the body by breakdown of amino acids, production of energy by regulating the metabolism of vitamin $B_1$, C, E and by activation of various enzymes important for proper digestion and utilization of foods[6]. Mn is also a component of the metalloenzyme manganese superoxide dismutase in the mitochondria and is a constituent of the mitochondrial antioxidant defense system which protect from the free radical generated from the injured cells which is harmful to the skins[22]. The concentration of the Mn recorded in the present study ranges from (17.789±3.496) to (79.309±5.593) mg/L with *P. cerasoid*s containing the highest concentration. In view the positive role of Mn through the enzymes of the antioxidant defense system and immune responses, the traditional use of these medicinal plants for treatment of skin diseases may be attributed to presence of adequate concentration of Mn in them.

Zn is also most important element required for the metabolism of several biochemical reactions. It is found virtually in every tissue of plants and animals and plays a crucial role in maintaining healthy skin by controlling the enzymes that operate and renew the cells in our body[23]. The Zn containing metalloenzymes participates in the metabolism, growth and repair of the tissue and cell membrane stabilization and improves the immune response, especially T-cell mediated response[24]. As expected, Zn was found to be present with appreciable amount between the range of (7.930±1.238) to (18.209±5.493) mg/L in all the medicinal plants studied with the highest concentration of Zn recorded in *M. pudica*, hence the possible use of these medicinal plants in appropriate quantities for treating skin diseases in the traditional practices can be understood.

In the present study, Cu was found to be in varying concentrations in all the medicinal plants samples in the range of (3.535±0.149) to (10.707±5.593) mg/L with the highest concentration of Cu recorded again in the *M. pudica*. Following Zn and Fe, Cu is the third most abundant trace elements in the body. Cu is known to stimulate the immune system to fight infection, repair injured tissues and promote healing[25]. In addition to this, Cu is an essential factor for the formation of the connective tissues such as the cross linking of collagen and elastin[26]. As the Cu affects our immunity and posses anti-infectant properties[27], the presence of the considerable amount of Cu in all the medicinal plants studied further support their use in curing skin diseases by the traditional practitioners of northeasten India.

Further, Co and V were also detected in the selected four medicinal plants with varying concentration in the ranges of (0.284±0.099) to (2.025±0.679) mg/L and (0.059±0.001) to (0.715±0.039) mg/L for Co and V respectively. Co is also essential to the health in human and is a key constituent of cobalamin, also known as vitamin $B_{12}$ and deficiency of it resulted in the less production of red blood cells in the body necessary for the rapid transport of oxygen to injured cells[28]. Their presence in the appreciable amount in all the medicinal plants studied further support the traditional use of these medicinal plants in treatment of skin diseases. Although the biological role of V is limited and available reported literature is mostly on the beneficial role in the management of diabetes mellitus, the function of V will be probably part of the protection system against injury of tissues[29]. Thus, the trace elements like Fe, Mn, Zn, Cu in addition to Co and V are responsible for the defense from pathogen and recovering quickly from the serious skin infections and diseases[30], as evident from the present study where all the trace elements mentioned *per se* were present with appreciable amount in the four selected medicinal plants traditionally used for curing skin diseases by the natives of northeasten India.

In this study, PIXE technique was employed for the trace elemental composition of the selected medicinal plants. It is evident that the various elements present in these medicinal plants have either direct or indirect role in the control and management of the skin diseases. The results of the present study justify the usage of these medicinal plants in the traditional practices for curing skin diseases since they are found to contain appreciable amount of the Fe, Zn, Cu, Mn, V and Co. Moreover, this result can be used to set a new standard of prescribing the dosage of herbal drugs prepared from the plants materials to integrate their medicinal values in the modern system of medicines. More comprehensive studies on these medicinal plants against other diseases can also be carried out in order to find out unexplored efficacy and can be potential sources of chemically interesting and biologically important drug candidates.

## Conflict of interest statement

We declare that we have no conflict of interest.

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