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PARTICLE INDUCED X-RAY EMISSION [PIXE]

A. RAJENDRA PRASAD[1*], BUNTY RANI ROY[1], K. JYOTHI[2], A. S. NAGESWARA RAO[1].

[1]Dept. of Physics, Kakatiya University, Warangal-506009,
Telangana State, India.
[2]Dept. of Physics, Government College, Rajahmundry-533103,
Andhra Pradesh, India.
*E-mail: rp.abboju@gmail.com

A. Rajendra Prasad

ABSTRACT

In the modern world, popularity of various medicinal plants and plant therapies in treating various diseases is increasing. Trace elemental analysis employing Particle Induced X-ray Emission (PIXE) technique was carried out in two selected medicinal plants used in the preparation of anti-diabetic drugs. The elements K, Ca, Ti, Cr, Mn, Cu, Zn, Rb and Pb were established by using GUPIX software. Among these elements Potassium (K) and Calcium (Ca) have been established in percentage level where as other elements are quantified in (mg/kg) ppm level. Comparisons of results for similar materials found in the literature were presented.

INTRODUCTION

Diabetes mellitus is the world's largest chronic metabolic disease with presently over 160 million diabetic patients [1]. It is estimated that by the year 2025, the world will have more than 300 million people with this endocrine disease, being India ranked top with around 57 millions [2]. Though various anti-diabetic drugs are available commercially for the management and control of diabetes mellitus, these are expensive and in certain specific cases, their efficacy decreases after prolonged use [3].

However, in India, medicinal plants are the major form of medicines being utilized in crude form or powered form by many tribal people [4].Another advantage of using anti-diabetic agents with plant origin is that it can control diabetics without side effects. Potassium, calcium and trace amount of chromium are responsible for the secretion of insulin from β-cells of islets of Langerhans. Zinc complex is the store house of insulin secreted from pancreas [5], which plays an important role in normal glucose metabolism. Chromium has important role along with zinc, calcium and manganese in glucose tolerance factor [GTF], which decreases the blood glucose level by utilizing insulin[6].Furthermore, deficiency of chromium can cause impaired action of GTF and hence can cause diabetes mellitus [7].In optimal insulin secretion, normal potassium concentration is required [8].Potassium also helps in protein and carbohydrate metabolism of the body and its deficiency causes diabetic acidosis [9].

Subnormal zinc level can cause several liver diseases and its deficiency can cause diabetic symptoms like hypsomia, hypogeusia or coma[10].Apart from this, for maintaining healthy metabolism [11] and control of body weight, Fe,Ca and Zn are necessary. Furthermore, the WHO expert committee [12] has recommended the through study of medicinal plants dealing with diabetes mellitus.In India medicinal plants have mostly been studied for their organic content and little are known about their trace element distribution, and so, using non-destructive technique like proton Indiced X-Ray Emission [PIXE].

The present preliminary study was undertaken aiming at verifying the usefulness of PIXE technique for quantifying the trace elements, and also observe, if possible the degree of distribution of these elements.

Sample irradiation and Data Analysis

A 3MeV collimated proton beam of diameter 2mm obtained from the 3 MeV Tandem _PelletronAccelerator at Institute of Physics, Bhubaneswar, India, was used to irradiate the targets under vacuum condition [10^{-6}torr] inside the PIXE chamber Fig.1.The targets were mounted on a multiple target holder ladder, oriented 45° to the beam axis and positioned vertically. The target holder was surrounded by a cylindrical electron suppressor held at negative potential with respect to the target.

The ladder was moved vertically in the PIXE chamber for selecting the different targets maintaining the same projectile – target – detector geometry. Measurement was carried out with a low beam current of 20nA -30nA range in order to avoidpile up. For the detectionof trace elements 50 μmaluminum was used as an absorber to suppress prominent low energy K X-rays like Ca & a beam current of 40nA was used for it.

A Si (Li) detector [EG & GORTEC, active area30mm^2, beryllium window thickness of 12μm, cooled at liquid nitrogen temperature i.e., 77K] with full width half maximum [FWHM] of 180 eV at 5.9 keV placed at 90° to the beam axis, was used to detect the characteristic X-rays emitted from the targets.

X-rays exist the PIXE chamber through a 25μmylar window before entering the detector. Spectrum was recorded using a PC based MCA in 2K channel mode after being calibrated it with the Mn X-rays from the ^{55}Fe radioactive source.

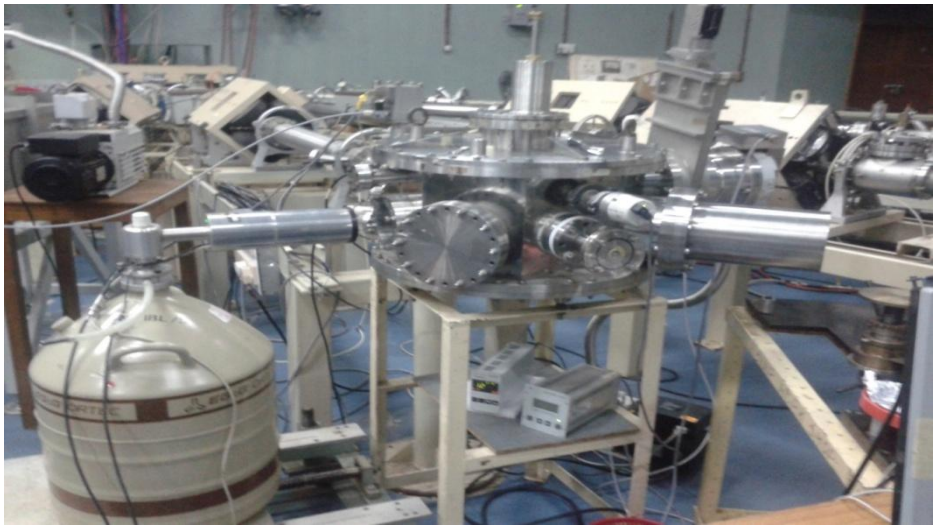

Fig.1.Experimental set up at Institute of Physics, Bhubaneswar, India.

Materials and Methods

Fresh leaf samples ofoscimumsanctus (Tulsi) and AzadiractaIndica (Neem) plants were collected from various places of Warangal [Telangana State]. The leaves were washed thoroughly with water and then dried in an oven at temperature 60°C for about 24 hrs and subsequently ground by an agate mortar. The sample powder was mixed homogeneously with the graphite powder in the 1:1 ratio. The mixture was pelletized into a thin pellet of uniform thickness having 10mm in diameter under a pressure of 100kg / cm^2. A graphite pellet was also made with the same process by taking 100mg of its powder to make necessary correction.

The spectral data were analyzed using the GUPIX 96 software [13],which provides non-linear least square fitting of the spectrum together with subsequent conversion of X-ray peak intensities to elemental concentrations.

Typical PIXE spectra of some samples are shown in figures 2 and 3. The trace elements present in the samples were estimated from PIXE spectra and the results are reported in Table 1 and Table 2 respectively.

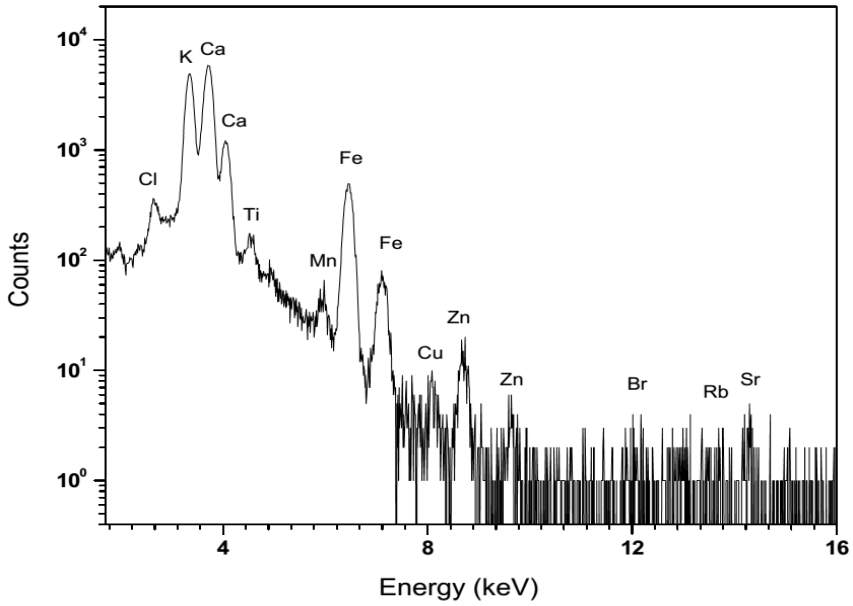

Fig.2: Typical Spectra of Tulsi Medicinal Plant

Table.1: Trace elements (ppm) in Tulsi medicinal Plant.

Element	Warangal-Telangana	North East India
K	26200	33800
Ca	14500	17600
Ti	7.66	_
Cr	0.68	_
Mn	77.26	25.44
Fe	254.26	384.12
Cu	23.80	21.99
Zn	51.04	49.56
Br	32.68	_
Rb	27.50	31.96
Sr	34.42	109.46
Pb	0.18	_

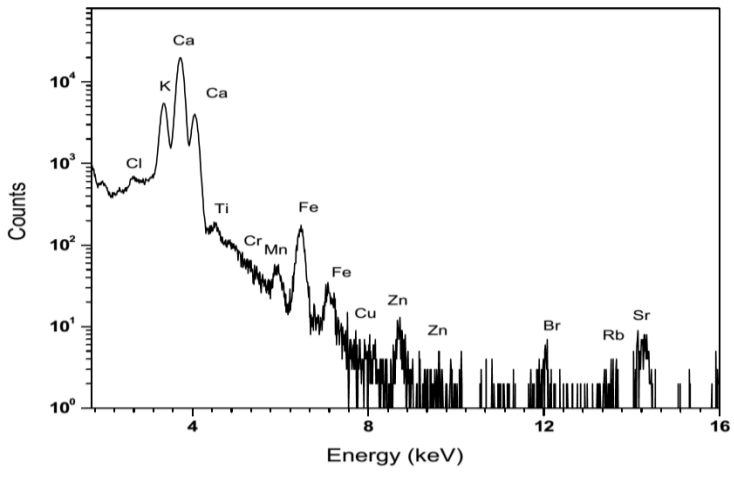

Fig.3: Typical Spectra of Neem Medicinal Plant

Table.2: Trace elements (ppm) in Neem medicinal Plant.

Element	Warangal-Telangana	Manipur
K	34700	9678.7
Ca	61300	19984.4
Ti	10.57	_
Cr	1.04	_
Mn	113.01	60.3
Fe	99.55	569.5
Ni	_	4.1
Cu	2.80	9.5
Zn	16.02	51.6
Br	26.84	9.3
Rb	18.33	_
Sr	24.74	124.6
Pb	0.11	_

RESULTS AND DISCUSSION

The PIXE spectrum obtained from the Tulsiand Neem leavessamples presented in Fig.2and Fig.3 respectively, which indicates the attendance of trace elements like, K, Ca, Cr, Mn, Fe, Cn, Zn, Rb, Sr and Pb appears prominently in the above medicinal plants. The variation of concentration of different elements in given plants is shown in table 1 and table 2 respectively.

The analysis of present investigation documents a wide range of variation elemental concentration of Tulsiand Neem plant samples. K and Ca are found to be present as major elements in both samples. The different trace elements in the different medicinal plants will have their, definite role, for management and controlling of diabetic mellitus.

CONCLUSIONS

The trace elements in the medicinal plants had been detected by PIXE technique as it is one of the most powerful technique for its multi elemental analysis capability, high sensitivity and good detection limit.

It is concluded that the levels of trace elements in the given medicinal plants lies within the permissible range supported by WHO[14-15]. It is suggested to grow in and around your surrounding the Tulsi and Neemmedicinal plants and intake the leaves directly to control diabetes.

In the present preliminary study, it was observed that, elementary concentration of same medicinal plant is different that of other region like Manipur or North East region. It will be helpful to develop an approach towards directly between elemental content and its curative probability, having coherence with traditional use. It will be useful, if one can find that molecular structure of compounds, containing trace elements in the medicinal plants which control diabetic mellitus.

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REFERENCES

[1] S.Yadav, V.Vats, Y.Dhunoo and J.K.Grover,J.Ethnopharmacology82 [2002] 111.

[2] H.king, R.E.Aubert and W.H.Herman, Diabetes Care 21 [1998] 1414.

[3] V.Valkevik and G.Modchini ,Analysis of Biological Materials for Trace Elements using X-ray Spectroscopy [BocoRoton, Florida, CRC Press] [1989].

[4] A.K.Singh, AS.Raghubanshi and J.S.Singh, J.Ethnophamacology 81 [2002] 31.

[5] A.Kar, B.K.Chowdhury and N. G. Bandyopadhyay, J.Ethnopharmacology,64 [1999] 179.

[6] C.T. Gurson and G.Saner, J.Clinical Nutrition,24 [1971]1313.

[7] N.S.Rajurkar and B.M.Pardeshi, Appl. Radiat. Isot.48 [1997]1059.
[8] E.J.Underwood and W.Mertz, Trace Elements in Human and Animal Nutrition [New York Academic] 1 [1988] 255.
[9] A.R. G. Rao, The Pharmacotherapeutics, [2nd edn.] [Current technical Literature Co.] [1973].
[10] S.Gala, Diabetes and hypertension [India navneet Publication] [1984].
[11] V. Singh and A.N.Garg Appl. Radiat.Isot.48 [1997] 97.
[12] WHO research Needs for Health for All by the year 2000 [SEARO Technical Publications 2] World Health Organization, Regional Office for South –East Asia, New Delhi [1983] 8.
[13] J.A. Maxwell, W.J.Teesdale and J.L.Cambell the Guelph PIXE Software Package II, Nuc. Instr. Meth. B. 95 [1995] 407.
[14] World Health Organization, 1998.Quality control methods for medicinal plant materials. Published by WHO, Geneva.
[15] WHO., 2005. Quality Control Methods for Medicinal, Revised, Geneva.