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Research Article

MEDICINAL PLANTS: THEIR ANTI-DIABETIC POTENTIAL

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ABSTRACT

Trace and major elemental analysis in some medicinal plants of North East India having anti-diabetic properties have been studied using Proton Induced X ray Emission (PIXE) and Proton Induced Gamma ray Emission (PIGE) techniques. Plant samples were excited with a proton beam of energy 2.5-3 MeV from a 3 MV Tandetron accelerator and the spectral data were recorded for analysis using a PC based MCA analyzer. The accuracy and verification of results were confirmed by analyzing the Certified Reference Materials (CRMs).The major and trace elemental content in the studied plants have been correlated with their curative medicinal values.

Keywords: PIXE, PIGE, anti-diabetic medicinal plants, trace elements.

INTRODUCTION

Diabetes Mellitus is a global health problem characterized by having excessive levels of glucose in the blood and rapidly increasing worldwide irrespective of socio economic condition and geographic location of the population. Insulin, a hormone that is produced in sufficient quantities in the beta cells of the islets of Langerhans in the pancreas is the major regulator of the glucose content in the blood. In diabetes the body metabolic process is completely disturbed either due to lack of insulin or due to ineffectiveness of insulin that can produce[1]. According to World Health Organization the diabetic population is likely to increase up to 300 million or more by the year 2025[2]. The available therapies for diabetes include insulin and various oral anti-diabetic agents such as sulfonylureas, biguanides and glinides that have been reported a number of serious adverse effects. Aldose reductases, a key enzyme in the polyol pathway catalyze the reduction of glucose to sorbitol. Accumulation of sorbitol in the body causes various complications including cataract, neuropathy and nephropathy[3]. Several studies have been demonstrated that marked alterations in trace elemental concentrations in the human body are associated with the occurrence of DM [4-6]. Hence regulation of trace elemental concentration has been proposed as a potential preventive and treatment strategy for DM. Recently medicinal plants have been reported to be useful in diabetes worldwide and these traditional medicines offer great potential for the discovery of new anti-diabetic drugs that expected to have no side effects on prolonged use[7]. However in most of the research work, the anti-diabetic activity of medicinal plants is attributed to the presence of organic compounds like polyphenols, flavonoids, terpenoids, carotenoids etc. which show reduction in blood glucose levels, while little attention has been paid on the elemental composition of the plants[8-11]. Medicinal plants contain active chemical and a number of trace elements in terms of which the efficacy for their curative purposes is often accounted for. Trace elements play important role in the formation of bioactive chemical constituents in medicinal plants and are therefore responsible for both their medicinal and toxic properties[12]. So a quantitative estimation of trace and major elements in medicinal plants is very important in explaining their pharmacological activities.

In the present study, an elemental analysis of only five widely used medicinal plants of North East India having anti-diabetic properties was done by Proton Induced X-ray Emission (PIXE) and Proton Induced Gamma ray Emission (PIGE) techniques. PIXE and PIGE are rapid, simultaneous, non-destructive multi-elemental analysis techniques. PIXE provides multi- element quantitative determination of elements with atomic no. (Z) >11 down to parts per million (ppm) levels while PIGE is a complementary technique and enables sensitive determination of elements up to Z<20.

MATERIALS AND METHODS

Fresh samples of selected medicinal plants having anti-diabetic properties were collected from various areas of Manipur, a North Eastern Region of India for the present study. The list of studied medicinal plants with their local names and the corresponding parts of the plants used for analysis is given in Table1. The plant samples were thoroughly washed with distilled water and dried in an oven at 60°C for about 48 hours. The dried samples were ground into fine powder by using an agate mortar. The powdered samples were thoroughly mixed with high purity graphite powder in the ratio 4:1 by weight for charge integration with better accuracy. The samples were further mixed with binder 200µl of polyvinyl alcohol liquid, dried under an IR lamp and then pressed into pellets of 2mm thickness and 13mm diameter with a pressure of 30 kNm^{-2}. Pellets of Certified Reference Materials cabbage (GBW 08504, China) and wheat flour (8436MS Dept. of Comm. NIST Gaithersburg MD 20899) were also prepared with the same procedure to check the accuracy of PIXE-PIGE setup and verification of the results [13].

PIXE and PIGE measurements were performed at Surface and Profile Measurement Laboratory at National Centre for Compositional Characterization of Materials (NCCCM), Department of Atomic Energy (DAE) Hyderabad, Government of India using 3MV Tandetron accelerator. In PIXE measurements, proton beam of energy 2.5MeV collimated to a beam of 3mm diameter and current 5-7 nA was used to irradiate the target (samples). The irradiation was carried out under vacuum (10^{-6} torr). The X-rays were detected by using a planar high purity germanium (HPGe) detector (Eurisys Measures type EGX 100-01, Be window thickness 40µm, FWHM of

150 eV at 5.9keV) placed at 45° to the beam axis. A 25μm mylar foil was served as X-ray exit window. The data was recorded on a PC based MCA.

The obtained PIXE spectral data corresponding to the studied plants were analyzed using GUPIX software package [14] which provides non linear least square fitting of the spectrum and converts raw spectral data into elemental concentration. Using this software package, concentrations of different elements present in each of the medicinal plants were calculated. For quantitative PIGE analysis the concentration $C_{x,samp}$ of an element x in the analyzed sample was measured using the following equation [15,16].

$$Cx,samp = Cx,ref \frac{Yx,samp (E_0)\ Ssamp (E_0)}{Yx,ref (E_0)\ Sref (E_0)}$$

where Y_x is the yield of the measured gamma ray of the element x at proton energy E_0 and S is the stopping power. The ratio of the stopping powers of the sample and reference material is taken one as their matrix elements are chosen same.

RESULTS

The various concentrations of different elements in the studied plants are presented in Table 3. The elements K, Ca, Sc, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se and Br were detected with different concentrations (in ppm level) by PIXE while F, Na, Mg, Al, P and Cl by PIGE technique in the studied plants. The elements K, Ca, P, Mg and Cl were present at major concentration levels as compared to the rest of other trace elements. It is observed from Table1 that *Glycine Max* contains the highest amount of Mn(30.9ppm), Fe(122ppm), K(44828ppm), Ca(2820ppm), Mg(4305ppm) and Cl(10121ppm) among the studied plants.

DISCUSSION

Trace elements play a critical role in the various metabolic processes in human. As DM is a disease of metabolic abnormality, elements as such or as a component of enzymes may play a significant role in the development and control of DM. The elements K, Ca, Cr, Mn, Cu and Zn are responsible for the secretion of insulin from beta cells of the islets of Langerhans and are involved in potentiating insulin action[17,18]. Appreciable amount of potassium is found in all the anti-diabetic medicinal plants. Normal concentration of potassium are required for optimal secretion of insulin[19]. Serum potassium below optimum levels can also cause insulin resistance[20]. Sufficient levels of calcium are required for release of insulin[21]. Calcium plays an important role in glucose tolerance factor (GTF), which decreases the blood glucose level by utilizing insulin. Studies have shown chromium a critical cofactor in the action of insulin. It is an active component of GTF which is required for optimal glucose utilization by the cells[22]. Deficiency of chromium can cause impaired action of GTF and subsequent hyperglycemia and glycosuria[23]. Chromium supplements may reduce blood sugar as well as the amount of insulin needed by people with diabetes[24]. Chromium is present in all the studied plants with concentration ranges from 0.17ppm in *Orthosiphon spiralis* to 2.9ppm in *Glycine Max*. Manganese was detected in all samples with varying concentrations. It was found least (4.5ppm) in *Orthosiphon spiralis* and highest (30.9ppm in *Glycine Max*. Appropriate manganese levels are required for normal synthesis and secretion of insulin[25]. People with diabetes have significantly lower levels of manganese in their bodies than people without diabetes[26]. Concentration of copper in the analyzed medicinal plants varies from 2.07ppm in *Ficus bengalensis* and 135.72ppm in *Orthosiphon spiralis*. Copper possesses insulin like activity and its deficiency leads to glucose intolerance, decreased insulin response and increased glucose response[27]. Zinc plays an important role in production, storage and regulation of insulin. Insulin is stored in the pancreatic beta cells as insulin–zinc complex and deficiency of zinc can lead to increased insulin resistance and hyperglycemia[28].

Table 1: **List of Anti- diabetic medicinal plants analyzed**

Sl.No.	Plant Species	Common Name	Part used
1	*Glycine Max*	Nunghawai(M), Bhatwar(H),Garjkalai(B)	Fried beans
2	*Ficus bengalensis*	Khongnangtaru(M), Bar(H), Bot(B)	Leaves
3	*Jasminum Sambac* Linn	Laphu(M), Kela(H),Kala(B)	Unripe fruit
4	*Orthosiphon spiralis*	Warak leikham(M)	Leaves
5	*Ficus glomerata*	Heibong(M), Gular(H), Dumur(B)	Roots

Symbol codes: M-Manipuri; B- Bengali; H- Hindi

Table 2: Elemental concentrations (in ppm) of the analyzed anti-diabetic medicinal plants

Elements	*Glycine Max*	*Ficus bengalensis*	*Jasminum Sambac*	*Orthosiphon spiralis*	*Ficus glomerata*
K	44828	8914	20128	8655	12549
Ca	2820	125	1821	368	2646
Sc	193	9.4	180	22.2	119.2
V	0.00	0.08	0.00	0.00	0.00
Cr	2.90	0.34	1.81	0.17	0.24
Mn	30.9	11.2	22.3	4.5	15.6
Fe	122	16	85	74	110
Co	3.04	5.03	1.19	0.30	0.10
Ni	0.00	1.77	0.00	0.00	0.00
Cu	7.70	2.07	9.48	135.72	8.03
Zn	41.6	6.5	19.1	43.9	32.9
As	1.26	0.53	0.11	0.14	0.00
Se	0.32	0.34	0.21	0.05	0.29
Br	148.00	6.06	1.20	3.19	1.20
F	250	181	53	212	237
Na	238	264	126	195	253
Mg	4305	4010	1696	3192	3081
Al	9	11	3	6	10
P	4020	4521	5055	7297	4190
Cl	10121	4381	2890	1075	986

Note: the typical uncertainty in the measurements is about ±10%. ND: Not Detected

Zinc is present in all the studied plants and concentration ranges from 6.5 ppm in *Ficus bengalensis* to 43.9 ppm in *Orthosiphon spiralis*. The studied plants contained essential elements that have been proposed as a preventive measure in the control of diabetes and can be considered as a good potential of natural supplements of these trace elements. No toxic heavy elements such as Hg, Pb, Cd were detected and the levels of trace elements present in the plants were also around the permissible range for consumed herbs as defined[29]. This explains the scientific reason for the traditional use of these plants as anti-diabetic.

CONCLUSION

In the elemental analysis of the studied anti-diabetic medicinal plants the presence of appreciable amount of elements K, Ca, Cr, Mn, Cu and Zn which are responsible for potentiating insulin action could be attributed to explain the pharmacological activity of the plants. The studied plants can also be suggested for providing the various elements to the body in a balanced manner with almost no harmful effects. This finding may support as an important resource for further studies in anti-diabetic medicinal plants.

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REFERENCES

1. BV Raman, A Naga Vamsi Krishna, B Narasimha Rao, M Pardha Saradhi, MV Basaveswara Rao. Plants with antidiabetic activities and their medicinal values. Int Res J Pharm 2012; 3(3): 11-15.
2. Sy GY, Cissé A, Nongonierma RB, Sarr M, Mbodj NA, Faye B. Hypoglycaemic and antidiabetic activity of acetonic extract of Vernonia colorata leaves in normoglycaemic and alloxan-induced diabetic rats. Journal of Ethnopharmacology. 2005; 98(1-2):171-5.
3. Lee HS, Rat lens aldose reductase inhibitory activities of Coptis japonica root-derived isoquinoline alkaloids. Journal of Agricultural and Food Chemistry. 2002; 50(24):7013-6.
4. Kimura K. Role of essential trace elements in the disturbance of carbohydrate metabolism. Nippon Rinsho 1996; 54(1): 79-84.
5. Scott, D.A and A.M Fischer. The insulin and zinc content of normal and diabetic pancreas, Journal of Clinical Investigation.1938; 17(6): 725-728.
6. Underwood, E.J. Trace Elements in Human and Animal Nutrition 4th edition. Academic Press, New York.1977 p. 255.
7. Hamzah, A.C.W. Beh, S. B. Sarmani, J. Y. Liow and I. Abugassa. Studies on elemental analysis of Chinese traditional herbs by neutron activation technique and their mutagenic effect. Journal of Radioanalytical and Nuclear Chemistry 2004; 259(3): 499-503.
8. Malviya N, Jain S, Malviya S. Antidiabetic potential of medicinal plants. Journal of Radioanalytical and Nuclear Chemistry 2010; 67(2):113-8.
9. Jung M, Park M, Lee HC, Kang YH, Kang ES, Kim SK. Antidiabetic agents from medicinal plants. Current Medicinal Chemistry 2006; 13(10):1203-18.
10. Singh LW. Traditional medicinal plants of Manipur as anti-diabetics. Journal of Medicinal Plant Research 2011; 5(5): 677–687.
11. Grover JK, Yadav S, Vats V. Medicinal plants of India with anti-diabetic potential. Journal of Ethnopharmacology 2002; 81(1):81–100.
12. NS Rajurkar, MM Damame, Mineral content of medicinal plants used in treatment of diseases resulting from urinary tract disorders. Applied Radiation and Isotopes 1998; 49: 773.
13. Marino, F., G. Calzolai, S. Caporali, E. Castellano, M. Chiari, F. Lucarelli, V. Maggi, S. Nava, M. Sala, and R. Udisti. PIXE and PIGE techniques for the analysis of Antarctic ice dust and continental sediments. Nuclear Instruments and Methods in Physics Research B 2008; 266, 2396 – 2400.
14. J.A.Maxwell, J.L.Campbell, W.J.Teesdale. The Guelph PIXE software package II. Nuclear Instruments and Methods B 1995; 95, 407–421.
15. A. Savidou, X. Aslanoglou, T. Palladellis, M. Pilakouta, Proton induced thick target c-ray yields of light nuclei at the energy region Ep 1.0±4.1 MeV. Nuclear Instruments and Methods. 1999; B 152: 12.
16. R.K. Bhanisana Devi, H. Nandakumar Sarma, J. Arunachalam, Sanjiv kumar, Trace element analysis of some medicinal plants of Manipur using PIXE and PIGE techniques Indian Journal of Physics. 2005; 79: 417.
17. Anderson R. A Nutritional factors influencing the glucose/ insulin system: chromium. Journal of American College of Nutrition 1997; 16: 404-410.
18. Kimura, K. Role of essential trace elements in the disturbance of carbohydrate metabolism. Nippon Rinsho 1996; 54: 79-84.
19. Underwood, E.J, Mertz, W. Trace elements in Human and Animal nutrition. Volume1 Academic press, New York,1986 p. 255.
20. Helderman, J.H, Elahi, D, Anderson DK, Raizes GS, Tobin JD, Shocken D, Andres R. Prevention of the glucose intolerance of thiazide diuretics by maintenance of body potassium. Diabetes. 1983; 32: 106-111.
21. Mooradian AD, Morely JE, Micronutrient status in diabetes mellitus. American Journal of Clinical Nutrition.1987;45: 877-895.
22. Hambidge KM, Chromium nutrition in man American Journal of Clinical Nutrition.1974; 27: 505-515.
23. Rajurkar NS, Pardeshi BM. Analysis of some herbal plants from India used in the control of diabetes mellitus by NAA and AAS techniques. Applied Radiation and Isotopes 1997; 48:1059-1062.
24. Anderson RA Chromium, glucose tolerance, diabetes and lipid metabolism. Journal of Advanced Medicine 1995; 8: 37-49.
25. Freeland Graves, J, Behmardi, F Bales, C W Daugherty, V Lin, P. H, Crosby, JB Trickett, PC, Metabolic balance of manganese in young men consuming diets containing five levels of dietary manganese Journal of Nutrition 1988; 118: 764-773.
26. EI Yazigi A, Hannan N, Raines DA, Urinary excretion of chromium, copper and manganese in diabetes mellitus and associated disorders. Diabetes Research. 1991;18: 129-134.
27. Mooradian AD, Morely JE, Micronutrient status in diabetes mellitus. American Journal of Clinical Nutrition. 1987; 45: 877-895.
28. Kinlaw WB, Levine AS, Morley JE, Silvis, SE, McClain, CJ, Abnormal zinc metabolism in type II diabetes mellitus American Journal of Medicine. 1983; 75: 273-277.
29. Levine, AS, McClain, CJ, Hardwerger, BS, Brown, DM, Morely, JE, Tissue zinc status of genetically diabetic streptozotocin induced diabetic mice. American Journal of Clinical Nutrition. 1983; 37: 382-386.

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