



Research Journal of
**Medicinal
Plant**

ISSN 1819-3455



Academic
Journals Inc.

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Quantification of Trace Elements in Some Multi-herbal Formulations

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ABSTRACT

Popularity of herbal products is increasing worldwide for control and management of several diseases and disorders. They are studied extensively for their organic macro and micro nutrients. However less emphasis is given to their inorganic counterparts or Trace elements. To evaluate the presence of such inorganic micronutrients or trace elements in some herbal formulations, present study is undertaken. Elemental analysis was carried out by using Particle induced X-ray Emission (PIXE) technique. Four multi-herbal formulations commercially available for control and management of Diabetes mellitus were procured for the present study. Elements like potassium, calcium, vanadium, manganese, iron, copper, zinc, rubidium, strontium have been quantified in these herbal formulations. They are found to contain varied proportions of these elements. Although rubidium and strontium have been detected in these multi-herbal formulations, the role of these elements in management of diabetes mellitus is lacking and needs further detailed investigation. The present study may be helpful for better understanding of the possible curative effect of the trace elements present in the herbal formulations for management of the diabetes mellitus. The PIXE method constitutes a promising analytical tool, which has the potential for routine testing of herbal products.

Key words: Herbal formulation, diabetes mellitus, trace elements, PIXE

INTRODUCTION

Diabetes Mellitus (DM) has really become a common metabolic disorder in the modern world. Presently the number of diabetics worldwide is 285 million and by the year 2030 it is projected to reach 439 million. The prevalence of DM will be more in the developing countries than in the developed world (Shaw *et al.*, 2010). DM is characterized by hyperglycemia caused due to biochemical alterations of glucose metabolism (Abdelatif *et al.*, 2012). Diabetic patients are categorized either as Type I (T1D) or Type II diabetes (T2D) based on their etiology (ADA, 2004). T1D is a chronic condition resulting from the destruction of the beta-cells in the pancreas. The pathophysiology of T2D involves defects in pancreatic beta-cell function and insulin sensitivity (Lempainen *et al.*, 2012; Rajavashisth *et al.*, 2012). Those with T2D represent 90-95% of all people with diabetes (Dokken, 2012). Maintaining normal glycaemic levels remains a top priority for the effective management of DM and to avoid chronic complications (Nathan *et al.*, 2009).

Several classes of oral and injectable therapies have been available commercially to manage diabetes mellitus. However the treatment of diabetes mellitus is becoming increasingly complex. More than half of DM patients require two or more medications to achieve glycemic control (Bennett *et al.*, 2012). Despite having more options, substantial differences in efficacy and safety of treatments within the same drug class is observed. Some DM patients do not respond to

treatment and remain in poor glycaemic control, may experience drug-related side effects, resistance to the current available drugs after prolonged use and/or develop secondary complications (Vaag and Lund, 2011).

According to World Health Organization (WHO), herbal medicines are being used by about 80% of the world population for the treatment of numerous diseases and disorders (Tiwari and Rao, 2002). In developing countries cure of diseases through herbal medicines is always preferred because of better cultural acceptability, cheaper cost, better compatibility with human body and lesser side effects. In India, many indigenous medicinal plants and their formulations with other plant or plant parts are used in herbal medicines to manage and control diabetes (Grover *et al.*, 2002). Due to the biodiversity of the medicinal plants their active principles differ from one to other, which pertains to their distinct physiological action on human body. The curative property of the herbal medicines is due to pharmacologically active organic compounds and some essential Trace Elements (TE), which can be available to the human body from consumption of herbs and their formulations (Rajurkar and Damame, 1998). To enhance the pharmacological effect many of these herbs are formulated into multi-herbal preparations/formulations. The Multi-herbal Formulations (MHF) are often prescribed for the management of diabetes, while their safety and efficacy in terms of trace element content is yet to be investigated (Yeo *et al.*, 2011). Many chemical elements have narrow range of suitability for humans. At lower concentration they show deficiency symptoms and at higher concentration they exhibit toxicity to the human body. Hence it is of special importance to determine their concentrations in the MHF. The present study was undertaken for the estimation of trace elements in MHF by utilizing PIXE technique.

MATERIALS AND METHODS

Four samples of MHF, namely Glucolev, Diabet, Niddwin, Glymin, prescribed for the management and control of diabetes are received from Dr. M. Sahoo, Ayurvedic Physician, for the determination of the TE content. These MHF were powdered by using an agate mortar and pestle. Each of the powdered samples was mixed with pure graphite in 1:1 ratio by mass. The mixture is homogenized and pressed in a hydraulic press to prepare thick targets of 13mm diameter and about 2 mm thickness (Ray *et al.*, 2006). In a similar manner thick target of certified reference material (CRM) of NIST-tomato leaves (NIST-1573) from National Institute of Standards and Technology (USA) was prepared and irradiated for quantification and verification of results.

The PIXE measurements were performed at Institute of Physics, Bhubaneswar, India with a 3 MV tandem pelletron accelerator. The thick targets were placed inside a PIXE chamber and irradiated in vacuum (10^{-6} torr) with collimated 3 MeV proton beam (Rautray *et al.*, 2007). With respect to the beam direction the sample normal is located at 45° and the Si (Li) detector is at 90° . The characteristic X-rays were detected by a Si (Li) detector with a resolution of 170eV at 5.9 keV energy (Sattar *et al.*, 2012). The spectra were recorded with a PC based Multi Channel Analyzer (MCA), calibrated with ^{56}Fe X-ray source. The PIXE spectra corresponding to different multi herbal formulations were analyzed by using the GUPIX-2000 software package (Campbell *et al.*, 2000). This software package has provision to convert the X-ray peak intensities into elemental concentrations. Using this software package different elements presents in each MHF and in NIST-tomato leaves were quantified in parts per million (ppm). The present analytical results of the CRM are in good agreement with the NIST certified values.

RESULTS

The compositions of multi-herbal formulations contain four or more individual plant or plant parts along with some inorganic preparations (Table 1). The PIXE spectrum of multi-herbal

Table 1: Composition of Multi-herbal formulations

Glucolev (capsule)	Diabet (capsule)	Niddwin (capsule)	Glymin (tablet)
Amlaki	<i>Gymnema sylvestre</i>	Guduchi	Pitika
Shilajit	<i>Tinospora cordifolia</i>	Asana	Jambu
Jasad bhasma	Asphaltum	Meshasringi	Asana
Methika beej	Yasad bhasm	Bogunvillia	Meshasringi
Jambu beej	<i>Melia azadirachta</i>	Asphaltum	Guduchi
Madhunasini	<i>Ocimum basilicum</i>	Gokshura	Amla
Aswagandha		Aswagandha	Haridra
		Amlaki	Silajit-bhasmam
		Haritaki	
		Vibhitaki	
		Kapikatchu	
		Bala	

Table 2: Concentration of TE expressed in ppm in Multi-herbal formulations

Elements	Glucolev	Diabet	Niddwin	Glymin
K	5794	8991	7620	11118
Ca	25839	9282	23542	11433
V	8.22	12.35	23.34	7.25
Mn	55.32	10.21	28.09	1451.31
Fe	569.57	150.09	391.36	52.92
Cu	1.175	97.53	1.31	10.05
Zn	13.01	1272	16.26	23.25
Rb	11.17	7.44	14.89	29.78
Sr	60.71	24.28	36.43	56.71

formulation Niddwin sample indicated the presence of TE like Vanadium (V), Manganese (Mn), iron (Fe), Copper (Cu), Zinc (Zn), Rubidium (Rb), Strontium (Sr) along with major elements potassium (K) and Calcium (Ca) (Fig. 1). The concentrations of different major and trace elements obtained from analysis of multi-herbal formulations for each element were expressed in parts per million (Table 2). The concentration of the elements potassium and calcium varies from 5794 to 11118 ppm and 9282 to 25839 ppm, respectively. Iron concentration varies in the range 52.92 to 569.57 ppm. Zinc and rubidium are present in the concentrations between 13.01 to 1272 ppm and 7.44 to 29.78 ppm, respectively. The results were the mean value of two independent measurements of replicate samples and the standard deviations are below 10%.

DISCUSSION

TE constitute less than 0.01% of the body weight. They play important roles in many metabolic, structural and reproductive tasks in human body (Schumann, 2006). Disrupted homeostasis of TE is observed in diabetic patients. The levels of calcium and zinc in the blood are lower in diabetic patients due to hyper-zincuria, whereas the level of Cu becomes significantly higher (Abou-Seif and Youssef, 2004). Insulin is produced by the beta cells of the pancreatic islets and without insulin, muscle, fat and liver cells cannot transport glucose from the blood to the intracellular space. Zn in the islet cells is involved in the synthesis, storage and secretion of insulin (Chaumer, 1998). Zn deficiency can cause diabetic symptoms like hypsomia, hypogeusia. K, Ca and trace amount of Cr are responsible for the secretion of insulin (Ray *et al.*, 2004). Mn is an essential TE found in all

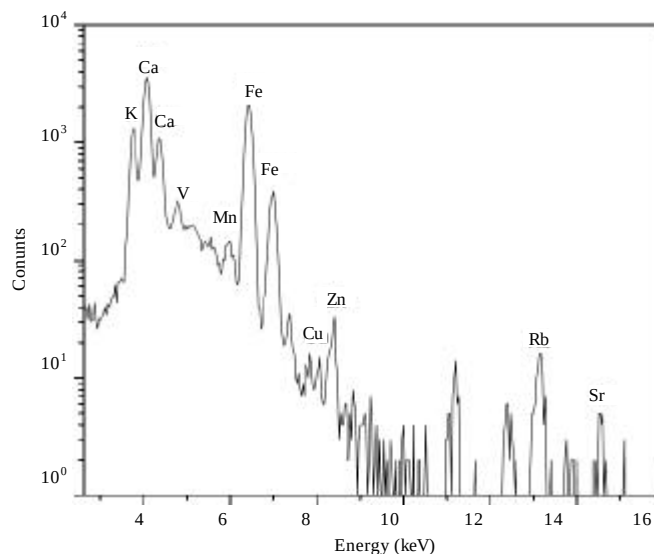


Fig. 1: PIXE spectrum of Niddwin sample

tissues. Inadequate dietary intake of manganese leads to impaired lipid and carbohydrate metabolism (Aschner and Aschner, 2005). Iron overload in the interstitial pancreatic cells leading to insulin deficiency and impaired glucose tolerance (Papanikolaou and Pantopoulos, 2005). Vanadium compounds exhibit insulin-mimetic effect. Together with the inhibition of glycogenesis, glycogenolysis and the stimulation of lipogenesis, they stimulate glucose intake into cells and a lowering of the blood glucose level (Rehder, 2003).

The above discussions indicate that the minor elements such as V, Mn, Fe, Cu, Zn along with major elements K and Ca may play significant roles in the management and control of DM. In multi-herbal formulations, trace elements are found to contain in varying proportions. Highest amounts of V, Cu and Sr are present in the herbal drugs Niddwin (23.4 ppm), Diabet (97.5 ppm) and Glucosev (60.7 ppm) respectively. Glymin sample contains potassium (11118.8 ppm) and manganese (1451.3 ppm) in highest amounts. To exhibit pharmacological action they may be in the bio-available form in these multi-herbal formulations. Although rubidium and strontium have been detected in these multi-herbal formulations, the role of these elements in management of diabetes mellitus is lacking and needs further detailed investigation.

CONCLUSION

The concentrations of TE in multi-herbal formulations were determined by utilizing multi-elemental capacity of PIXE. These MHF were found to contain trace elements like V, Mn, Fe, Cu, Zn, Rb, Sr in different concentrations, which may pertain to their pharmacological action. However their therapeutic potential along with adverse side effects for the management of diabetes needs further detailed investigation. Toxic heavy elements like Cd, Hg are not detected in these samples studied. Thus, the elemental concentration obtained for these MHF using PIXE technique is of great help for both practitioner and the manufacturer with respect to the safety, efficacy and for understanding their possible curative effect. The PIXE method constitutes a promising analytical tool, which has the potential for routine testing of herbal products.

ACKNOWLEDGMENT

We wish to express our appreciation to the Ion Beam Laboratory (IBL) staffs. Thanks are due to Dr. M. Sahoo, medical officer (Department of AYUSH), National Rural Health Mission (NRHM), Govt. of India, for providing the Ayurvedic multi-herbal formulations used for management and control of diabetes.

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