International Journal of Scientific Research in _____ Research Paper
Chemical Sciences
Vol.7, Issue.6, pp.21-25, December (2020) **E-ISSN:** 2455-3174

Trace Element Analysis of Some Indigenous Antidiabetic Medicinal Plants of Assam

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Available online at: www.isroset.org

Received: 17/Sept/2020, Accepted: 14/Oct/2020, Online: 31/Dec/2020

Abstract-Medicinal plants contain different trace elements in bioavailable form. Various trace elements are reported to have very important role in the maintenance of normal blood glucose level. Elemental analysis was done in three selected indigenous antidiabetic plants namely: *Catharanthus roseus*, *Ficus racemose*, and *Swertia chirata*. Eight elements (Fe, Cu, Ni, Mn, Zn, Cr, Na, and K) were estimated using Flame Photometry and Atomic Absorption Spectroscopy (AAS) techniques. The mineral contents in the antidiabetic plants are at different levels. This present investigation has established that these antidiabetic plants contain appreciable quantities of some of the elements associated with blood glucose lowering effects.

Keywords- Diabetes mellitus, blood glucose, medicinal plant, trace element, mineral, micronutrients.

I. INTRODUCTION

Diabetes mellitus is mainly a metabolic disorder especially in the endocrine system. Diabetes is one type of degenerative disease. Diabetes is gradually becoming a serious threat to all mankind health. Diabetes is mainly a chronic disorder in the metabolism of carbohydrates. It has now become almost an epidemic. Hyperglycemia is a very common symptom of diabetes. Diabetes mellitus is associated with various long-term complications such as stroke, nephropathy, cardiovascular disease, angiopathy, high blood pressure and several others [1, 2]. Diabetes affects the nervous system, retina, membranes of small vessels, kidney, liver and many other tissues [3]. Diabetes is found to be the most common cause of kidney failure. Diabetes is also known as *Madhumeha* which means excessive amount of urine having sweet taste like honey [4]. Diabetes is classified into two main types, Type I and Type II. Monitoring of blood glucose is an essential task for diabetic patients. Regardless of the type, controlling the blood glucose level is the most important for diabetic patients.

Medicinal plants are usually naturally grown around all over the world. Some of them are wild, found only in dense forests and many of them are easily cultivated. Medicinal plants are getting increased scientific as well as commercial attention [5]. The influence of these herbs towards the society and mankind is immense. These plants are used in the controlling of a large number diseases [6]. Over the centuries, the use of different medicinal plants has become an essential part of daily life despite the tremendous progress in modern pharmaceuticals research. The use of various herbal medicines are also described in different ancient text books. In India, a large number of plant species are mentioned in different ancient literature (Ayurveda) for the treatment and cure of diabetic conditions. Traditional medicine may include herbal medicines or phytomedicines. Phytomedicines are found to be the main active ingredients in different herbal preparations. The plant materials include all types of plant parts including flowers, seeds, berries, roots, stem, leaves, bark etc. A large number of drugs used in conventional modern medicines were originally derived from plant kingdom. The synthetic oral antidiabetic drugs are associated with various side effects and in many cases these are found to be not so much effective in large section of diabetic patients. A large number of medicinal plants are available in nature having potential antidiabetic properties. A total of more than 400 plant species are reported to display antidiabetic effects, but only few of them have been properly investigated scientifically [7]. Plant based products are gradually becoming very popular in the treatment of diabetes.

Catharanthus roseus is an herbaceous sub-shrub, grown as an ornamental plant in the gardens of all over India. *Catharanthus roseus* is an important medicinal plant. This is a plant of apocynaceae family. It is widely grown at subtropical area. The flowers are found to be white to dark pink. This plant has possessed potential antibacterial, antidiabetic, antimicrobial, antioxidant and antiviral activates. This plant is also called periwinkle in India. The medicinal values of this plant have been clearly described in *Ayurveda*. Juice of fresh leaves of this plant can reduces the glucose level of normal and experimental diabetic

rabbits. It is reported that rural community are using *Catharanthus roseus* leaf for the management of diabetes and related symptoms in herbal folk medicines [8].

Ficus racemosa is a large-sized, evergreen tree. *Ficus* is a very much large genus. All parts of this plant have medicinal importance. This plant is reported to be used in the treatment of diarrhea, jaundice, diabetes, dysentery and inflammatory [9]. The fruits are generally found to be matured from March to July. The fruits are reported to be highly antidiabetic. The fruit is considered as a very good remedy for diabetes mellitus [10]. *Swertia chirata* (Family - *Gentianaceae*) is well known for its diverse medicinal properties. Different parts of this plant are used as antipyretic, hypoglycemic and antibacterial drugs [11]. *Swertia chirata* contains various therapeutic phytochemicals which have remedial effect against large number of ailments such as chronic fever, skin diseases, malaria, cough, bronchial asthma, neurological disorders, liver disorders, urogenital tract disorders, certain type of mental disorder and diabetes [12]. Swerchirin, a xanthone compound from *Swertia chirata* is a potent antidiabetic agent. *Swertia chirata* is reported to have very high antidiabetic activity [13, 14]. This plant is used for the treatment and management of diabetes.

The objective of the present study was to evaluate the content of trace elements in three selected antidiabetic medicinal plants namely: *Catharanthus roseus, Swertia chirayta and Ficus racemose.* Fruits of *Ficus racemose* and leaves of *Catharanthus roseus* and *Swertia chirayta* were used for analysis. Flame Photometry and Atomic Absorption Spectroscopy (AAS) techniques were used for the analysis of concentrations of elements.

II. MATERIALS AND METHODS

2.1 Plant materials

The fresh leaves of *Catharanthus roseus* and *Swertia chirayta* were randomly collected from one individual single tree of each. Fresh ripe fruits of *Ficus racemose* were also collected. The plant parts were carefully separated and washed thoroughly in sufficient deionized water in order to remove dust, soil materials, unwanted foreign particles as well as all other surface contamination.

2.2 Sampling area

The plant materials were collected from the Nalbari district of Assam, India. The plant parts were collected from local village area of Barbhag Revenue Circle of Nalbari district. The plant materials were authenticated from the department of Botany, Royal Global University, Guwahati, Assam. District Nalbari is situated between 91°E and 91°47′E longitude and 26°N and

27°N latitude. Nalbari is a district of Assam located in the north bank of the river Brahmaputra in its lower part. The plant parts were collected during the month of July to August.

2.3 Procedure for sample preparation for analysis in Atomic Absorption Spectroscopy and Flame Photometry

After drying, the plant parts were ground into fine powder using electric grinder. Powder of plant materials were weighed separately and taken in ceramic crucible and heated in electric Muffle furnace at 500 °C for six hours. Ashing have destroyed almost all the organic materials present in the plant sample. The crucibles containing ash sample were then taken out of the muffle furnace and kept in desiccator. Then the ash materials were cooled and their exact weights were taken. Then a mixture of HNO_3, HCl and H_2SO_4 acid in a 1:2:4 ratio was added in portions to the ash samples of the plant parts. The mixture was properly digested over an electric hot plate taking in a porcelain basin for almost three hours till all the black colour of the residue vanished. The pasty colourless resultant residue was dissolved in 12 ml of 1:1 conc. HCl and H_2O mixture. The resultant mixture was allowed to stand for overnight and then filtered into a 100 ml volumetric flask through whatman 40 filter paper to remove the trace amount of colourless insoluble solid residues still present, and the volume was made upto exactly 100 ml mark. The resultant solution so prepared was then taken for analysis in Atomic Absorption Spectroscopy and Flame Photometry.

2.4 Atomic Absorption Spectroscopy

In the present study, the concentrations of different elements were analyzed using Atomic Absorption Spectroscopy. Perkin Elmer AAnalyst200 model was used in the investigation. Hollow cathode lamp was used in the present analysis. Elemental analysis was done by relative method using A.R. grade solutions of various required elements. The analysis was done in the department of Chemistry, Gauhati University.The standard conditions for the measurements are represented in the following Table.

Table 1. Standard conditions for Atomic Absorption Spectroscopy measurement

Element	Wavelength (nm)	HC Lamp current (mA)	Slit width (nm)	Optimum working range (ppm)	Types of Flame
Fe	248.3	5	0.2	0.06-15.0	Air-C_2H_2
Cu	324.8	4	0.5	0.02-3.0	Air-C_2H_2
Zn	213.9	5	1.0	0.01-2.0	Air-C_2H_2
Ni	232.0	4	0.2	0.1-20.0	Air-C_2H_2
Mn	279.5	5	0.2	0.02-5.0	Air-C_2H_2
Cr	357.9	7	0.2	0.06-15.0	Air-C_2H_2

2.5 Flame Photometry (FP)

For the estimation of Na and K Flame Photometry was used. Elico Flame Photometer of CL-361 Model was used

for the analysis of Na and K in our present study. The analysis was done in the department of Chemistry, Gauhati University.

III. RESULTS

Table 2. Weight of the crude and ash samples.

Sample	Weight of dried powdered crude sample	Weight of the ash sample
Catharanthus roseus leaves	3.0 g	0.188 g
Swertia chirayta leaves.	3.0 g	0.193g
Ficus racemose fruits.	3.0 g	0.149 g

Table 3. Concentrations of elements by AAS and Flame Photometry in ash sample of *Catharanthus roseus* leaves.

Elements	ppm in 100 ml of aqueous extract of the ash
Fe	0.728
Cu	0.029
Ni	0.11
Mn	0.058
Zn	0.365
Cr	0.199
Na	1.47
K	9.2

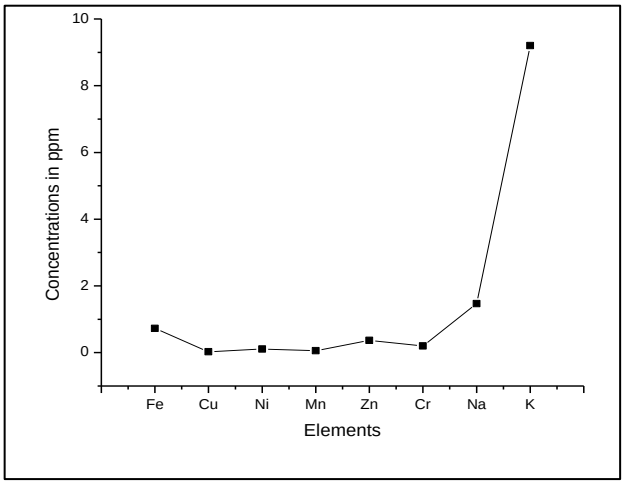

Fig. 1. Concentrations of elements in ash sample of *Catharanthus roseus* leaves.

Table 4. Concentrations of elements by AAS and Flame Photometry in ash sample of *Swertia chirayta* leaves.

Elements	ppm in 100 ml of aqueous extract of the ash
Fe	0.721
Cu	0.031
Ni	0.15
Mn	0.31
Zn	0.09
Cr	0.12
Na	1.03
K	8.23

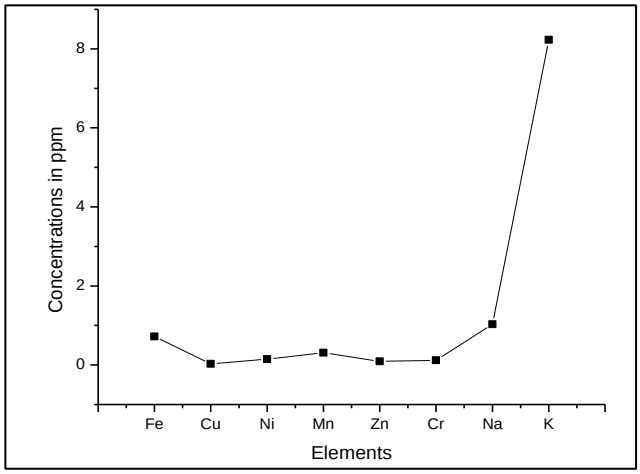

Fig. 2. Concentrations of elements in ash sample of *Swertia chirayta* leaves.

Table 5. Concentrations of elements by AAS and Flame Photometry in ash sample of *Ficus racemose* fruits.

Elements	ppm in 100 ml of aqueous extract of the ash
Fe	0.928
Cu	0.041
Ni	0.18
Mn	0.39
Zn	0.89
Cr	0.08
Na	2.03
K	4.23

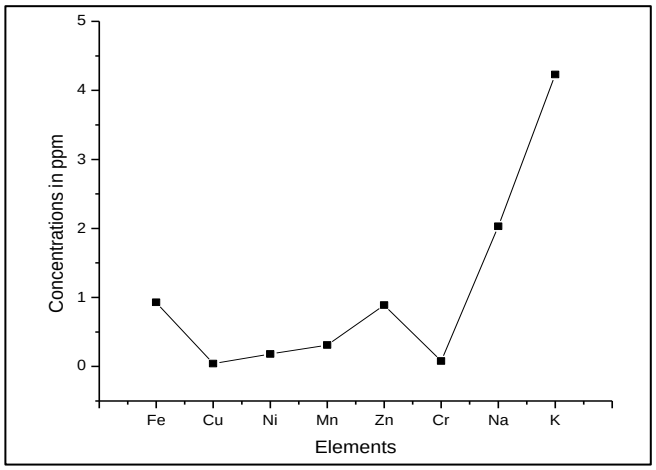

Fig. 3. Concentrations of elements in ash sample of *Ficus racemose* fruits.

IV. DISCUSSION

Medicinal plants are found to contain both organic as well as inorganic constituents. Sufficient research works are already done on the investigation of various plant constituents [15]. However, the investigation of elemental compositions has got relatively less attention. Different minerals essential to human bodies are accumulated in various parts of plants as it accumulates these minerals important for the growth from the surrounding environment. Determination of concentration of mineral

elements in medicinal plants is very much important. The estimation of concentrations of different trace elements is very much important to establish their pharmacological action [16]. A large number of mineral elements are reported to play an essential role in metabolism. They have important role as co-factors in various enzymes. They are also equally important for the maintenance as well as for regulation of cell cycle, gene and membrane functions. Deficiency or excess of different elements may cause various types of disorders. Several attempts have been made to estimate the concentration of macro and micro-nutrient contents of medicinal plants from various countries all over the world.

Many trace elements are reported to play vital role in the maintenance of normal blood glucose level. Diabetes has been found to be associated with abnormalities in the metabolism of various micronutrients, especially chromium, copper, zinc, magnesium, manganese etc. [17]. Various trace elements are reported to antidiabetic activities [18]. Elements like potassium, zinc, calcium, chromium, magnesium etc. play an important role in the maintenance of normal blood glucose-tolerance and also in the secrection of insulin from beta cells of islets of langerhans [19]. Medicinal antidiabetic herbs are known to contain many essential and nutritional elements which are helpful for diabetic patients.

Iron influences the insulin action. Iron facilitates insulin binding as well as helps in lowering the the glucose levels [20]. From our present study it has been found that the concentration of Fe was 0.728 ppm in *Catharanthus roseus* leaves, 0.721ppm in *Swertia chirayta* leaves and 0.928 ppm in *Ficus racemose* fruits. Potassium is one of the primary ions in intercellular fluid. Potassium together with sodium is involved in the regulation of water balance in our bodies. Sodium (Na) is reported to have role in the transport of glucose into the body cells. Potassium supplementation is found to improve the insulin sensitivity and secretion [21]. Na concentrations varied from 1.03 to 2.03 ppm. The fruits of *Ficus racemose* showed the highest concentration of Na. The average concentration K was 8.23 ppm in *Swertia chirayta* leaves, 9.2 ppm in *Catharanthus roseus* leaves and 4.23 ppm in *Ficus racemose* fruits.

Ni is required in very trace amount. Ni is mainly present in the pancreas and it has an important role in the production of insulin. Deficiency of Ni may causes disorder in the function of liver [22]. Nickel concentrations varied from 0.11 to 0.18 ppm. The fruits of *Ficus racemose* showed the highest concentration of Ni that is, 0.18 ppm. Chromium (Cr) has the ability of regulating blood sugar levels. Chromium concentrations were in the range 0.08 - 0.199 ppm. *Catharanthus roseus* leaves have the highest Cr concentration and *Ficus racemose* fruits the lowest.
Copper is involved in the process of energy production. It influences the protein metabolism. Copper is found to be possessed an insulin-like activity [23]. Abnormality in copper metabolism can lead to diabetic complications [24]. Cu concentrations varied from 0.029 to 0.041ppm. *Ficus racemose* fruit has the highest Cu concentration. Manganese (Mn) can help the diabetic people by involving in the carbohydrate metabolizm. Manganese is important for glucose metabolism. The average concentration Mn was 0.058 ppm in *Catharanthus roseus* leaves**,** 0.31 ppm in *Swertia chirayta* leaves and 0.39 ppm in *Ficus racemose* fruits.

Zinc has important role in glucose metabolism. Zn is used as a cofactor in the enzymes involved in glucose metabolism [25]. Zinc has an important role in the secretion of insulin [26]. Zinc also has a protective role against β-cell destruction. Zinc also influences the activities of the enzyme called glyceraldehyde-3-phosphate dehydrogenase which is involved in the process of glycolysis [27]. The Zn concentrations varied from 0.09 to 0.89 ppm. *Ficus racemose* fruit has the highest Zn concentration and *Swertia chirayta* leaves the lowest. Hypoglycaemic agents and trace elements are becoming an important part of diabetic treatment [28]. The analysis of different elements in the antidiabetic plants indicated that Fe, Cu, Ni, Mn, Zn, Cr, Na, and K were present in all the investigated samples. These elements have a vital role in the control and management of diabetes.

V. CONCLUSION

In the human body, various trace elements are found to be take part in different physiological and biochemical events. The results of elemental analysis have shown that these medicinal plants contain different elements having antidiabetic activity. It can be concluded that these plants may be considered as important source of various essential elements having antidiabetic activities. The present study has supported the traditional usage of these medicinal plants in the management of diabetes.

ACKNOWLEDGEMENTS

The author wish to thank the authority of Royal Global University, Assam for providing constant encouragement and support. The author would also like to thank the Department of Chemistry; Gauhati University, Assam, India for giving instrumental facilities for this study.

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