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Original Article

Estimation of Antidiabetic Trace Elements in Some Commonly Consumed Plants of West Bengal

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ABSTRACT

Introduction: Trace elements are required by human body in very minute quantities for normal functioning of the body. They are necessary and essential for good health. Trace elements mainly act as cofactors to different enzymatic reactions. Abnormalities in trace element levels in human body can possibly lead to dysfunctions and disorders. Diabetes is a myriad of metabolic disorder characterized by hyperglycemia. Trace elements are involved in different processes in control of diabetes such homeostasis of glucose and regulation of insulin despite being a small part of living tissues. **Objectives:** The present work is focused on determining the amount of zinc, chromium and selenium content of leaves of some commonly consumed plants in the state of West Bengal by using Atomic Absorption Spectroscopy and understanding their role as an anti-diabetic agent. Plants having medicinal properties are used in treatment of large number of diseases, including metabolic and cardiovascular disorders. **Materials and Methods:** Two methods were used for digestion of plant samples: Wet oxidation and Dry ashing followed by AAS analysis. **Conclusion:** The study explored that *Mentha spicata* L. has maximum contribution to diabetes because of its significant content of anti-diabetic trace elements. The result can be useful for nutritional suggestion for diabetes patients as well as for the preparation of herbal formulation for diabetes mellitus in future.

Keywords: Anti-diabetic, Trace elements, Zinc, Chromium, Selenium.

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INTRODUCTION

Micronutrients are of different types, such as vitamins, organic acids and minerals. Minerals can again be classified into macro and trace minerals based on the amount required by the body.[1] While macro minerals are required in large quantities, trace minerals are required in minute quantities. Micronutrients participate in proper physiological functioning of the body. Trace minerals such as zinc, selenium and chromium are needed by the body in adequate quantities for normal functioning.[2]

Deficiency of trace elements can lead to harmful effects such as diseases, disorders and infections.[2] Intake of essential trace elements in inadequate quantities can either cause toxicity or deficiency of the element.[3] Medicinal plants are a good sources of physiologically active components such as phytochemicals and minerals that have significant medical contribution on human body. Such plants are consumed on a day-to-day basis in many parts of India in different forms. COVID-19 highlighted the impact of alternative source of medicaments from plant sources and significant contribution of trace elements for disease management.[4,5]

Diabetes mellitus can be defined as group of metabolic disorders having hyperglycemia as a common symptom. High glucose levels can lead to various health complications. Diabetes mellitus type I and diabetes mellitus type II are the most common forms of diabetes. Majority of diabetic patients suffers from diabetes mellitus type II (90%). Since 1980 the global prevalence of diabetes has increased and according to WHO, by the year 2030 diabetes will be the seventh leading cause of death.[6,7] There are different approaches that are used for management of diabetes. Commonly used therapies include insulin and administration of oral anti-diabetic drugs, although these drugs are reported to possess side effects. Since these therapies have limitations, it is necessary to look for alternative agents for management of diabetes.[6]

Chromium, zinc and selenium plays role in glucose homeostasis by various mechanisms.[8-10] Anti-diabetic trace elements present in commonly consumed plants can be looked as alternative agents for management of diabetes. Since there are a wide variety of plants consumed in West Bengal, quantitative trace element

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profiling needs to be done in these plants, for using them in management of diabetes.

Selection was made based on traditional uses of the selected plants in management of diabetes mellitus.

Commelina benghalensis L. (Kanshira), *Mentha spicata* L. (Pudina), *Paederia foetida* L. (Gandha Prasarini), *Basella alba* L. (Pui Shak) are some of the commonly consumed plants in West Bengal in from of leafy vegetables while *Costus igneus* N. (Insulin plant) is a member of costaceae family that have been introduced in India from South America.

Commelina benghalensis Linn. is a plant belonging to commelinaceae family, commonly known as Bengal dayflower and is a common weed found in India. *Commelina benghalensis* is traditionally used as anti-inflammatory, anti-diarrheal, anti-microbial and anti-diabetic agent etc.

Mentha spicata Linn. (Lamiaceae) commonly called as pudina in India is used for flavouring food because of its remarkable aroma. There are many reported traditional use of *Mentha spicata* such as anti-diabetic, antioxidant, anti-inflammatory, anti-fungal etc.

Paederia foetida Linn. or skunk vine is a plant belonging to Rubiaceae family. The phytoconstituents of skunk vine warrants its diverse use. Available literature have reported its use as anti-diarrhoea, anti-inflammatory, anti-diabetic and hepatoprotective agent.

Basella alba Linn. is commonly known as puishak and is consumed as a leafy vegetables in many parts of India. It is reported to possess antioxidant, anti-inflammatory, anti-cholesterol, anti-ulcer, anti-microbial, anti-hypoglycemic properties.

Costus igneus Nak. is commonly known as insulin plant and is consumed for lowering blood glucose levels.[11]

Therefore, the objective of this study was to determine the levels of anti-diabetic trace elements Zinc, Selenium and Chromium in these five commonly consumed plants by use of Atomic Absorption Spectroscopy.

MATERIALS AND METHODS

Plant materials

Five commonly consumed plants of West Bengal *Commelina benghalensis* L.–[Commelinaceae], *Mentha spicata* L.-[Lamiaceae], *Paederia foetida* L.-[Rubiaceae], *Basella alba* L.-[Basellaceae], *Costus igneus* N.–[Costaceae] were collected from Chandan Nagar, West Bengal.

Chemicals

All chemicals used were of reagent grade and Atomic Absorption Spectrophotometer (Perkin Elmer Model: PinAAcle 500) was used for analysis.

Preparation of plants leaves powder

The acquired leaves were washed with water, then shade dried for few days. After this, the leaves were pulverized to a fine powder. The powder was kept in clean container for further use.

Estimation of anti-diabetic trace element

Preparation of Standard Calibration Curve

To determine the amounts of zinc, selenium and chromium in plant leaves, using Atomic Absorption Spectroscopy calibration curves of these elements were prepared using their stock solutions. 2% Nitric acid solution was used as blank for the analysis.

Samples preparation

To determine the amounts of trace minerals it is necessary to decompose the organic matter present in the leaves. For decomposition of the organic matter, two different methods were used i.e., "wet oxidation" method and "dry ashing" method.

Wet Oxidation method

0.5 g of plant leaf powder was weighed and transferred. To this 10 mL of 65% nitric acid was added and digested on a hot plate at 55-70°C for 30 min. After 30 min the mixture was cooled to room temperature and 5 mL 70% perchloric acid was added. The mixture is digested again until a clear solution is obtained. Following this the mixture is cooled, diluted with deionized water and filtered. The filtrate was then transferred to a 100 mL volumetric flask of and the volume is made up using deionized water.[12]

Dry ashing

5 g of plant leaf powder was weighed and transferred to a crucible. The crucible is then placed in muffle furnace where it is subjected to a temperature of 500°C for 1 hr. The ash of the powder is then digested with a mixture of hydrochloric acid and nitric acid (1:3). Then the digested samples were diluted with water and filtered. The filtrate was transferred to a 50 mL volumetric flask and the volume was made up using double distilled water.[13]

Sample AAS Analysis

The prepared samples were the analyzed to determine the levels of zinc, selenium and chromium using AAS. The values were obtained in unit of mg/L of dry weight of the powdered sample. The mean of three readings were considered and represented as (n=3) mean ± SEM mg/L.

RESULTS

In this study, we looked for estimation of trace elements from the anti-hyperglycemic plants of West Bengal. The deciding factors for selection of the five plants species included their availability and their consumption. Using wet oxidation method

and dry ashing method the powdered leaf samples were digested and trace metals were quantified by use of Atomic Absorption Spectroscopy (Table 1).

DISCUSSION

For good health, trace elements are necessary at adequate levels. Deficiency of trace elements can lead to disorders and dysfunction of the body. Plants are the primary sources of vitamins and minerals needed for a healthy body. Daily consumption of fruits and vegetables have been correlated with lower prevalence of diseases such as diabetes, neurological and cardiovascular disorders.[14-16]

Literature revealed that zinc, selenium and chromium play an important role in maintaining diabetes by different mechanisms. In this study, the concentration of Zinc, Selenium and Chromium in five plants consumed in West Bengal were determined using wet oxidation and dry ashing methods.

Zinc is an important micronutrient that is essential for functioning of hundreds of enzymes.[17] Zinc plays an important role in stabilization of insulin hexamers. Zinc also aids in pancreatic storage of insulin.[18] Zinc is an exceptional antioxidant, and can prevent development of diabetes as oxidative stress is one of the major components in progression of diabetes.

In wet oxidation method, the highest concentration of zinc was found in *Mentha spicata* L. (0.779 mg/L) and the lowest in *Basella alba* L. (0.347 mg/L). In dry ashing method, the highest concentration of zinc was found in *Mentha spicata* L. (1.953 mg/L) and the lowest in *Costus igneus* N. (1.044 mg/L). In both methods *Mentha spicata* L. belonging to Lamiaceae family was evidenced to contain highest concentration of zinc.

Selenium, in form of selenoproteins acts as a potent antioxidant. Selenoproteins glutathione peroxidase, thioredoxin reductases and iodothyronine are best known. Selenium acts as an insulin mimetic and increase glucose transport by translocation of glucose transporters i.e., GLUT-1 and GLUT-2.[19]

In wet oxidation method, the highest concentration of selenium was found in *Basella alba* L. (2.163 mg/L) followed by *Commelina benghalensis* L. (1.984 mg/L). In dry ashing method, the highest concentration of selenium was found in *Commelina benghalensis* L. (2.599mg/L) followed by *Costus igneus* N. (1.148 mg/L). Considering both methods *Commelina benghalensis* L. can be concluded as good source of selenium.

Chromium supplementation have been known to prevent onset of diabetes by increasing synthesis of IGF receptors and replacing failing insulin receptors.[20] Chromium has the ability to directly bind to insulin, and possibly aid in stabilization of the hormone structure. Chromium plays an important role in glucose homeostasis as an element of Glucose Tolerance Factor (GTF).[21]

In wet oxidation method, the highest concentration of chromium was found in *Paederia foetida* L. (0.097mg/L) followed by *Mentha spicata* L. (0.081 mg/L). In dry ashing method, the highest concentration of chromium was found in *Commelina benghalensis* L. (0.486 mg/L) followed by *Mentha spicata* L. (0.455 mg/L).

The results show that the selected plants contain trace element in concentration comparable to established anti-diabetic plants, such as *Gymnema sylvestre* and *Trigonella foenum-graecum*.[22,23] This furthers the thought that they can act as viable source of these trace elements.

Literature showed that dry ashing method is more reliable and reproducible and has the process similarity with the actual processing of cooking the edible plant materials for consumption rather than wet oxidation. In present study, element contents in dry ashing were comparatively higher than those in wet oxidation. Among the trace elements studied, zinc is most potential followed by selenium and chromium. Based on the concentration of trace elements the commonly consumed plants, they can also be recommended for proper supplementation of micro-minerals in diabetes management. Zinc content in dry ashing method was found to be maximum in *Mentha spicata* L. *Commelina benghalensis* L. has the highest content of Selenium among the

Table 1: Anti-diabetic trace element content of plants in mg/L, determined by wet oxidation and dry ashing methods. (*n*=3, mean± SEM).

Plant species	Family	Zinc		Selenium		Chromium	
		Wet oxidation	Dry ashing	Wet oxidation	Dry ashing	Wet oxidation	Dry ashing
Commelina benghalensis L.	Commelinaceae	0.367± 0.00023	1.844± 0.00150	1.984± 0.05184	2.599± 0.16115	0.071± 0.01277	0.486± 0.00184
Mentha spicata L.	Lamiaceae	0.779± 0.00156	1.953± 0.00167	0.338± 0.02595	0.895± 0.08514	0.081± 0.00670	0.455± 0.01040
Paederia foetida L.	Rubiaceae	0.462± 0.00722	1.613± 0.00179	1.271± 0.18375	0.327± 0.10872	0.097± 0.00919	0.277± 0.02653
Basella alba L.	Basellaceae	0.347± 0.00231	1.534± 0.01092	2.163± 0.02231	0.773± 0.00745	0.020± 0.01225	0.390± 0.08098
Costus igneus N.	Costaceae	0.595± 0.00445	1.044± 0.00084	0.652± 0.03028	1.148± 0.03462	0.058± 0.00358	0.351± 0.00848

five species studied. Therefore, the order for recommendation of the plants studied on the basis of their anti-diabetic trace element content can be: *Mentha spicata* L.> *Commelina benghalensis* L.> *Paederia foetida* L.> *Costus igneus* N.> *Basella alba* L.

Though values show that selected plants can be used for management of diabetes, further studies are required for better understanding of absorption, bioavailability and bioactivity of trace elements.

CONCLUSION

Different anti-diabetic trace elements are found to be present in plants. India has a rich history of using plants as medicines in different traditional medicinal systems. Plants are consumed in West Bengal as a part of diet as well as for prevention of different disorders. However, the profiling of different trace elements from these easily available plant resource has not yet been completed. The present study reveals the levels of zinc, selenium and chromium in five different plant leaves that are widely consumed in West Bengal. The outcome of this present study can be used to make dietary recommendations for prevention of diabetes mellitus and other disorders where these elements play a vital role. Going forward, it will be beneficial if elemental profiling of remaining plants having ethnobotanical use are performed. It will be quite beneficial for dietary suggestions and recommendation of micronutrient supplementation for the society with special reference to diabetes in future days ahead.

From this study, it can be concluded that the selected plants from the specific area were safe for consumption, and their consumption does not lead to any toxic effects.

It was observed that micronutrients (Zn, Se and Cr) in plants were well within the prescribed limits and the analysed plants can be considered as potential sources of anti-diabetic trace elements.

While the relationship between diabetes and trace elements is complex, the results obtained from this study can be considered as supplementary to the activities of anti-diabetic phytoconstituents in management of diabetes mellitus.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

ABBREVIATIONS

AAS: Atomic Absorption Spectroscopy; **GLUT:**Glucose Transporters; **IGF:** Insulin-like Growth Factor; **GTF:** Glucose Tolerance Factor.

AUTHORS' CONTRIBUTION

Bhargab Sarma: Conceptualization, data acquisition, data analysis, data assembly, writing, review and editing. **Prerona Saha:** Conceptualization, data analysis, review, statistical expertise, administrative support, data assembly. **Sourav Deka:** Data acquisition, data analysis, data assembly.

SUMMARY

Leafy vegetables are consumed in different parts of India, including West Bengal. Many such plants are reported to possess medicinal properties. This research work estimated the anti-diabetic trace elements (Zn, Se and Cr) in leaves of five plants consumed in West Bengal, to validate the recommendation of leafy vegetables for management of diabetes and support the development of alternative anti-diabetic agents. The studied plants contained the selected trace elements within safe limits and can be recommended for management of diabetes.

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