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Study of Some Micronutrients in Selected Medicinal Plants

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Momordica charantia, Eugenia Jambolanum, Allium Sativum and Trigonella foenum graecum are commonly used vegetables and seeds. For several decades, these food materials have been successfully applied to some aspects of primary health care [1-3], especially as anti-hyperglycemic agents. Gymnema sylvestre and Adiantum Capillus Veneris are also some of a few very commonly used anti-diabetic plant products. These medicinal plants are extensively studied, but, in terms of organic constituents, however, their metal contents may play important roles. These species were selected to investigate their metals content, specifically, those which have a significant role in carbohydrate metabolism. Chromium, iron, manganese and zinc were investigated for this study. The level of the various metals was generally low and within statutory limits. Trigonella foenum-graecum was found to be the most suitable of all.

INTRODUCTION

High fiber diets are uniformly recommended for diabetics [4,5]. Particularly important is soluble fiber, found mainly in fruits, vegetables and some seeds [6]. The diet can be more fruitful by choosing quality whole foods, especially those containing water-soluble fiber, such as beans, oatbran, psyllium husks, pears, apples and vegetables, which slow down the digestion and absorption of carbohydrates preventing rapid rises in blood sugar [7-8]. Research shows that vegetarian and vegan diets reduce the risk of both types of diabetes mellitus and that low animal protein diets lower kidney damage and improve glucose tolerance [9].

Over 200 pure phytochemicals are known to be hypoglycemic, but metabolic or hepatic toxicity for most of them is also reported [10].

Adiantum Capillus Veneris is reported to have antihyperglycemic properties. Water extract of the aerial parts and leaves reduces glucose-induced hyperglycemia in mice [11]. Momordica charantia (bitter melon) may improve blood sugar control in people with NIDDM [12]. Eugenia Jambolana significantly lowers blood and urinary sugar, inhibits liver glycogen depletion and potentiates the hypoglycaemic action of insulin in alloxan-induced diabetic rats [13]. Gymnema sylvestre extract may assist the pancreas in the production of insulin in NIDDM and improve the ability of insulin to lower blood sugar in type 1 and 2 diabetics [14]. Garlic has been reported as controlling blood sugar, for both hypoglycemia (low blood sugar) and hyperglycemia (diabetes) and has also been reported as being able to help reduce the amount of insulin needed [15]. Trigonellafoenum-graecum is another Ayurvedic tradition proven effective. Its seeds contain the alkaloid trigonelline, nicotinic acid and coumarin, which help to stabilize blood glucose levels [16-18].

Deficiencies of essential minerals, particularly those which involve the metabolism of carbohydrates, for example, chromium, manganese, zinc, potassium and magnesium, are found in diabetics. Interestingly, these nutrients are all depleted in refined grains [19-21]. Chromium helps to lower cholesterol and triglyceride levels and increases insulin sensitivity [22]. The excess iron can cause oxidative stress and damage the pancreas and, thus, affect insulin secretion. Manganese is involved in energy metabolism. High levels of zinc may increase glycosylation [23].

The importance of these medicinal plants are considered in terms of organic constituents. However, their metal content has also a significant role to play in biological activity, either with organic molecules, such as metallo-enzymes, or, independently, like redox or

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Table 1. Dosage of selected herbs, recommended for the treatment of diabetes Mellitus.

Sample ID				
Full Name	**Abbreviated**	**Part Used**	**Dose/Day (g)**	**Way of Using**
Adiantum Capillus Veneris	ACV	Bark	0.7 – 1.75 g	Water extract
Momordica charantia	MC	Fruit	3 – 15 g	Dried powder
Eugenia Jambolana	EJ	Seeds	2 – 5 g	Powder
Gymnema sylvestre	GS	Leaves	0.4 – 0.6 g	Water extract
Allium Sativum	AS	Cloves	2 – 4 g/0.008 g	Fresh/essential oil
Trigonella Foenum Graecum	TFG	Seeds	15 g/10 – 100 g	Powdered solid/water extract

catalytic reaction. Those parts of the plants, which are most commonly used, were especially examined (Table 1).

MATERIALS AND METHODS

All the chemicals and reagents were of analytical-reagent grade, purchased from Merck or BDH Laboratory supplies. Appropriate quality assurance procedures and precautions were carried out to ensure the reliability of the results. Samples were generally carefully handled to avoid any contamination. Glassware was properly cleaned.

Reagent blank determinations were used to correct the instrument readings. Calibration standards were made by dilution of the high purity commercial BDH metal standards for atomic absorption analysis.

Samples of all medicinal plants were purchased from the local markets of Karachi. Samples were cleaned and oven-dried at 105°C [24] and sub-sampled for heavy metal analysis. Accurately weighed samples were mineralized (wet ashing), according to the recognized method reported by AOAC [24].

A Hitachi model Z 8000 Atomic Absorption Spectrophotometer, equipped with a hollow cathode lamp and Zeeman background correction, was used. Iron, manganese and zinc were analyzed, using an air-acetylene flame, by standard calibration techniques, whereas chromium was investigated by a graphite furnace, using argon gas and a standard addition method (Table 2).

Three replicates were run for each sample to get the accuracy of results.

RESULTS

The metals selected for this study in the above mentioned medicinal plants were chosen on the basis of their significant function in carbohydrate metabolism [21]. Six commonly used medicinal plants were investigated for this purpose to find the intake of metals through them (Table 2). Since the medicinal plants are either taken as a solid or as extract, the acid digested and water extracts were examined by Atomic Absorption spectroscopy for important metal content (Figures 1 and 2).

Table 2. Standard conditions for Hitachi Z-8000 atomic absorption spectrophotometer.

S. #	Metals	λ (nm)	SBW (nm)	Flame Gases	Max. Lamp Current mA
1.	Cr	359.3	1.3	Ar*	7.5
2.	Fe	248.3	0.2	A - Ac**	10
3.	Mn	279.6	0.4	A - Ac	7.5
4.	Zn	213.9	1.3	A - Ac	10

* Argon; ** Air acetylene flame.

All these medicinal plants contained chromium, but the highest amount was found in Trigonella foenum-graecum (TFG) (0.023 mg/g), while Gymnema Sylvester (GS) has nearly the same amount (0.02 mg/g). The other four have low and nearly the same amount of Cr (0.006-0.009 mg/g). In the case of water extracts, GS has the highest concentration of chromium (0.0018 mg/g), while MC and SJ showed similar values.

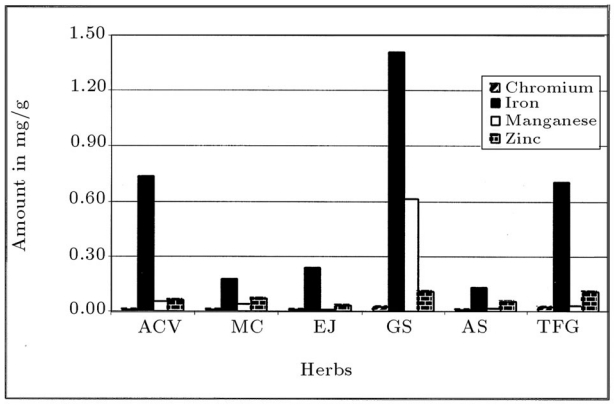

Figure 1. Amount of essential metals found in acid extracts.

Table 3. Amount of essential metals found in acid extracts of selected antidiabetic medicinal plants.

Sample ID	Chromium		Iron		Manganese		Zinc	
	Quantity Found mg/g ± SD	RSD %	Quantity Found mg/g ± SD	RSD %	Quantity Found mg/g ± SD	RSD %	Quantity Found mg/g ± SD	RSD %
ACV	0.0090 ± 0.002 (4)	0.5	0.7383 ± 0.036 (2)	1.2	0.0565 ± 0.004 (4)	1.3	0.0620 ± 0.004 (3)	1.6
MC	0.0070 ± 0.001 (3)	0.4	0.1723 ± 0.040 (2)	2.5	0.0363 ± 0.004 (3)	2.8	0.0723 ± 0.007 (2)	2.4
EJ	0.0060 ± 0.001 (3)	0.4	0.2348 ± 0.000 (2)	0.0	0.0095 ± 0.001 (2)	0.3	0.0278 ± 0.9 (4)	0.9
GS	0.020 ± 0.0016 (2)	2.0	1.4068 ± 0.040 (2)	0.7	0.6123 ± 0.003 (3)	0	0.1070 ± 0.003 (2)	0.7
AS	0.0060 ± 0.0003 (2)	1.2	0.1320 ± 0.009 (2)	1.7	0.0178 ± 0.018 (3)	2.5	0.0573 ± 0.002 (2)	0.9
TFG	0.0230 ± 0.0016 (3)	1.8	0.7023 ± 0.030 (2)	1.1	0.0280 ± 0.013 (2)	1.8	0.1108 ± 0.013 (3)	2.9

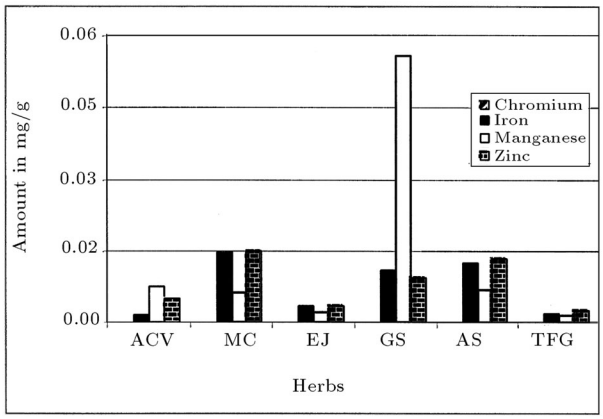

Figure 2. Amount of essential metals found in water extracts.

ACV and AS have one third and fenugreek has one ninth than that of Gymnema (Table 3).

In case of iron, the richest species is GS (1.4068 mg/g) and the lowest is AS (0.1320 mg/g). It is interesting to note that if the water extract of these medicinal plants is taken, the richest source of iron among all these is MC (0.0147 mg/g), ten times less than its acid digested sample (Table 3). The lowest iron concentration was found in TFG (0.0018 mg/g).

The highest concentration of manganese was found in GS in acid digested samples (0.6123 mg/g), as well as in water extract (0.0559 mg/g). The least value was found in EJ in acid digested samples, whereas in water extract samples, TFG is the lowest (0.0016 mg/g); EJ has, also, nearly the same value (0.0023 mg/g) (Table 3).

In case of zinc, in acid digested samples, TFG showed the highest value (0.1170 mg/g), GS has, also, nearly the same (0.1070 mg/g), whereas the least value was found in Eugenia (0.0278 mg/g). In water extracts, the least value was found for TFG (0.0024 mg/g) and the highest for MC (0.0149 mg/g). Allium and Gymnema also showed high values (0.0135 and 0.0092 mg/g) (Table 4).

DISCUSSION

Most of the medicinal plants were used after soaking in water and, thus, only this water extract is taken for the cure of disease. However, some are taken as a whole in the form of powder, cooked or eaten as a fruit. The metals from these may be extracted in the stomach after the action of acid. Therefore, these acid extracts may provide information related to metals available from these medicinal plants for biological research. With respect to the dosage recommended, it is obvious that TFG (methi/fenugreek) is best in the supply of Cr, among other samples, if taken as a solid, as its acid digested sample gives 0.3-0.5 gm/dose of Cr (Table 5). Its acid extract also provides the required amount of Zn and Mn found to be affective in diabetes [21].

A very minor negative point with TFG is that it also provides a large amount of iron (within limits), which may cause indigestion. This effect may be minimized by using either lemon juice or any vitamin C rich supplement, which may reduce this iron into bioavailable iron (Fe_{II}).

In acid digested samples, all the metals showed obvious results in GS. While, in MC, zinc was present in a reasonable amount and a slight excess of chromium was also shown.

ACV showed an average concentration of all these metals. While AS and TFG both have chromium and zinc in considerable amounts, iron was found in significant amounts, only in GS. Trigonella foenum-graecum, which are very commonly used seeds in Pakistan and India, known as Methi, are not used as antidiabetics. However, the seeds, as well as the leaves, of this plant are used for a number of other diseases and found to be very effective. The above results show that they have the same metallic combination as found

Table 4. Amount of essential metals found in water extracts of selected antidiabetic medicinal plants.

Sample ID	Chromium		Iron		Manganese		Zinc	
	Quantity Found mg/g $\times 10^3$ ± SD	RSD %	Quantity Found mg/g ± SD	RSD %	Quantity Found mg/g ± SD	RSD %	Quantity Found mg/g ± SD	RSD %
ACV	0.0683 ± 0.090 (2)	0.8	0.0014 ± 0.001 (5)	1.3	0.0075 ± 0.007 (3)	1.9	0.0049 ± 0.0064 (3)	2.4
MC	0.2088 ± 0.390 (5)	2.4	0.0147 ± 0.001 (2)	0.1	0.0061 ± 0.004 (2)	1.3	0.0149 ± 0.015 (2)	2.0
EJ	0.1112 ± 0.270 (2)	4.7	0.0035 ± 0.004 (2)	0.6	0.0023 ± 0.004 (4)	2.1	0.0035 ± 0.001 (2)	0.6
GS	0.2108 ± 0.016 (2)	2.0	0.0110 ± 0.003 (3)	0.5	0.0559 ± 0.02 (4)	0.7	0.0092 ± 0.008 (5)	1.7
AS	0.0417 ± 0.050 (4)	0.6	0.0125 ± 0.009 (2)	1.4	0.0067 ± 0.002 (3)	0.6	0.0135 ± 0.002 (4)	0.3
TFG	0.0940 ± 0.460 (6)	1.5	0.0018 ± 0.001 (6)	2.0	0.0016 ± 0.000 (2)	0.0	0.0024 ± 0.001 (3)	0.1

Table 5. Amount of metals consumed by daily recommended dosage (mg/recommended dose/day).

Sample ID	Chromium	Iron	Manganese	Zinc
ACV (WE)	0.96 – 0.20	0.007 – 0.02	0.03 – 0.08	0.02 – 0.05
MC (AE)	0.02 – 0.115	0.51 – 2.60	0.10 – 0.55	0.081 – 0.41
EJ (AE)	0.01 – 0.03	0.45 – 1.18	0.019 – 0.05	0.05 – 0.14
GS (WE)	0.0005 – 0.001	0.004 – 0.006	0.02 – 0.03	0.003 – 0.005
AS (AE)	0.02 – 0.03	1.05 – 1.32	0.14 – 0.18	0.45 – 0.58
TFG (AE)	0.34 – 0.50	10.5 – 15.0	0.40 – 0.65	166 – 2.0
(W.E)	0.15 – 2.50	0.05 – 0.90	0.90 – 1.0	0.10 – 1.5
Daily Intake*	0.09 – 0.13	8 – 18	2 – 3	10 – 15

* Recommended daily intake (mg/70 kg/body weight)

in Gymnema Sylvester(Gurmar), which is known to be the best herb for the cure of diabetes. Fenugreek is even better, as it does not have an excessive amount of iron, which is present in GS. Its water extract has 11.0 ppm iron, while Fenugreek has 1.8 ppm. It is already known that the presence of iron may not help in anti-diabetic activity.

CONCLUSION

It is found that the species most effective in the cure of diabetes may have a combination of zinc, chromium and Manganese. A water extract of Gymnema can provide chromium, zinc and manganese. Momordica and Allium can also provide zinc. Excessive amounts of iron are reported to be harmful for diabetics (Mooradian, Failla & Hoogwerf, 1992), thus, if taken as a solid, iron may be ingested in high amounts, otherwise water extracts of all these medicinal plants were found to be iron free. It is also observed that a daily prescribed dose of ACV may provide an excess amount of Cr; therefore, a prolonged use of this herb may produce cancer, which is observed in some cases.

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