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Among Few Commonly Used Anti-diabetic Herbs: Fenugreek is the Best

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Abstract: Adiantum Capillus Veneris, Momordica charantia, Eugenia Jambolanum, Gymnema sylvestre, Allium Sativum and Fenugreek has long history of use as anti-hyperglycemic agent. These herbs are extensively studied, but in terms of organic constituents however their metal contents may play important role. Chromium, iron, manganese, magnesium and zinc which play an important role in carbohydrate metabolism were investigated in these herbs by atomic absorption spectroscopy. Since chromium is present at ppb level, it is examined by graphite furnace atomic absorption spectrophotometer equipped with zeeman background correction. None of these species contain metals above the toxic limit. Fenugreek was found to be rich source of metal specially chromium.

Key words: Antidiabetic plant products, metals, atomic absorption spectrophotometer, graphite furnace

INTRODUCTION

A large number of indigenous plants used as foods and medicines, around the world, are known for their ability to lower blood sugar levels^[1]. The World Health Organization^[2] estimates that 4 billion people, or 80% of the world's population, use herbal medicine for some aspect of primary health care^[3]. Herbal medicines are economic as well effective^[4,5].

High fiber diets are uniformly recommended for diabetics^[6], particularly important is soluble fiber, found mainly in fruits, vegetables and some seeds^[7]. Over 200 pure photochemical are known to be hypoglycemic, but metabolic or hepatic toxicity for most of them is also reported by Marles *et al.*^[1].

Gymnema Sylvestre (GS)^[8,9] Momardica charantia (MC)^[10], Syzygium Jambolana (SJ)^[11] Adiantum Capillus Veneris (ACV)^[12] Allium Sativum (AS)^[13,14]. Trigonella Foenm-graecum having general name Fenugreek (F)^[15-17], are the traditional remedies for diabetes mellitus from the ancient time.

The importance of these herbs is considered in terms of organic constituents, however their metal contents have also significant role in the biological activity either with organic molecules such as metallo-enzymes or independently like redox or catalytic reaction. For example Cr, a key constituent of the Glucose tolerance factor is vital to proper blood sugar. Chromium supplementation can break the cycle of overeating sweets, at the same time chromium breaks down glucose and fatty acids more

efficiently within the body^[18]. Eating sweets (sugar and high-fructose foods and beverages) can causes chromium deficiency while simultaneously causing drastic increase in insulin and glucose levels^[19,20]. On the other hand Zinc, Manganese and Magnesium has also significant role in carbohydrate metabolism, whereas excessive iron absorption can cause oxidative stress and damage the pancreas which release insulin^[21-24].

Fruits and vegetables are an important component of human diet. Considering the significance of metals and consumption of these species, this investigation was carried out to monitor the levels of selected commodities.

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 reliability of the results. Samples were generally carefully handled to avoid any contamination. Glassware were properly cleaned and the reagents (Nitric acid and distilled water) were of analytical grade, purchased from Sigma.

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 herbs were purchased from local markets of Karachi. Samples were cleaned, smashed and oven-dried at 105°C^[25] and sub-sampled for heavy metal

analysis. Accurately weighed samples were mineralized (wet ashing) according to the recognized method reported by AOAC^[26].

A Hitachi model Z 8000 Atomic Absorption Spectrophotometer equipped with hollow cathode lamp and Zeeman background correction was used. Iron, Magnesium, Manganese and Zinc were analyzed, using air-acetylene flame, by standard calibration technique (Table 2a) whereas Chromium was investigated using nitrous oxide and standard addition method by graphite furnace (Table 2b).

RESULTS

Metals selected for this study in the above mentioned herbs are chosen on the basis of their significant function in carbohydrate metabolism^[23] Six commonly used herbs were investigated for this purpose to find the intake of metals through them (Table 1). Since the herbs are either taken solid or as extract, the acid digested and water extracts were examined by Atomic Absorption spectroscopy for important metal contents.

All these herbs contained chromium but the highest amount was found in Fenugreek (FG) (0.02 mg g⁻¹), whereas Gymnema Sylvester (GS) has nearly same (0.02 mg g⁻¹). Other four has low and nearly same amount of Cr (0.006-0.009 mg g⁻¹). In case of water extracts, GS has highest concentration of chromium (0.0002 mg g⁻¹), whereas MC and SJ showed similar values. ACV and AS has one third and fenugreek has one ninth than Gymnema (Table 3).

Table 1: Dosage Recommended

Sample ID	Part Used	Dose day ⁻¹ (g)	Way of Using
GS	Leaves	0.4 - 0.6	Water extract
MC	Fruit	3-15	Dried powder
SJ	Seeds	2-5	Powder
ACV	Bark	0.7-1.75	Water Extract
AS	Cloves	2-4 / 0.008	Fresh / essential oil
FG	Seeds	15 / 10-100	Powdered solid/water extract

Table 2a: Standard Conditions for Hitachi Z-8000 Atomic Absorption Spectrophotometer

Metals	λ(nm)	SBW (nm)	Flame Gases	Maximum lamp Current mA
Cr	359.3	1.3	*NO	7.5
Fe	248.3	0.2	**A - Ac	10.0
Mg	285.2	1.3	A - Ac	7.5
Mn	279.6	0.4	A - Ac	7.5
Zn	213.9	1.3	A - Ac	10.0

*NO = Nitrous Oxide and **A - Ac = Air Acetylene Flame

Table 2b: Conditions for chromium estimation in water extract by AAS using Graphite Furnace

Process	Temperature°C	Time (sec)
Drying	50-65	30
	60-75	30
	80-180	30
Ashing	700	30
Atomization	2900	10
Cleaning	3000	02
Cooling	0	30

In case of iron, the richest specie is GS (1.40 mg g⁻¹) and the lowest is AS (0.13 mg g⁻¹). It is interesting to note that if the water extract of these herbs is taken the richest source of iron among all these is MC (0.01 mg g⁻¹), ten times less than its acid digested sample. The lowest iron concentration was found in FG (0.002 mg g⁻¹) (Table 4).

Table 3: Chromium in Selected Herbs

Sample ID	Chromium in Acid Digested Samples		Chromium in Water Extract of Samples	
	Quantity found (mg g ⁻¹ ±SD)	RSD (%)	Quantity found (mg g ⁻¹ ±SD)	RSD (%)
GS	0.020±0.016	2.0	0.00021±0.016	1.5
MC	0.007±0.001	0.4	0.00021±0.39	1.1
SJ	0.006±0.001	0.4	0.00011±0.27	2.6
ACV	0.009±0.002	0.5	0.00006±0.09	4.1
AS	0.006±0.003	1.2	0.00004±0.05	2.7
FG	0.023±0.016	1.8	0.00009±0.46	2.2

Table 4: Iron In Selected Herbs

Sample ID	Iron in Acid Digested Samples		Iron in Water Extract of Samples	
	Quantity found (mg g ⁻¹ ±SD)	RSD (%)	Quantity found (mg g ⁻¹ ±SD)	RSD (%)
GS	1.4068±0.040	0.7	0.0110±0.003	0.5
MC	0.1723±0.040	2.5	0.0147±0.001	0.1
SJ	0.2348±0.000	0	0.0035±0.004	0.6
ACV	0.7383±0.036	1.2	0.0014±0.001	1.3
AS	0.1320±0.009	1.7	0.0125±0.009	1.4
FG	0.7023±0.030	1.1	0.0018±0.001	2.0

Table 5: Magnesium in Selected Herbs

Sample ID	Magnesium in Acid Digested Samples		Magnesium in Water Extract of Samples	
	Quantity found (mg g ⁻¹ ±SD)	RSD (%)	Quantity found (mg g ⁻¹ ±SD)	RSD (%)
GS	9.0650±0.003	0.2	2.1916±0.011	0.8
MC	3.9875±0.017	0.8	1.4719±0.017	1.6
SJ	0.3723±0.001	0.1	0.0347±0.00	0
ACV	2.3075±0.004	0.4	0.1421±0.011	0.6
AS	1.3125±0.002	0.2	0.6255±0.002	0.5
FG	2.5312±0.006	0.3	0.0914±0.002	0.2

Table 6: Manganese in Selected Herbs

Sample ID	Manganese in Acid Digested Samples		Manganese in Water Extract of Samples	
	Quantity found (mg g ⁻¹ ±SD)	RSD (%)	Quantity found (mg g ⁻¹ ±SD)	RSD (%)
GS	0.6123±0.003	0	0.0559±0.02	0.7
MC	0.0363±0.004	2.8	0.0061±0.004	1.3
SJ	0.0095±0.001	0.3	0.0023±0.004	2.1
ACV	0.0565±0.004	1.3	0.0075±0.007	1.9
AS	0.0178±0.018	2.5	0.0067±0.002	0.6
FG	0.0280±0.013	1.8	0.00157±0.00	0.0

Table 7: Zinc in Selected Herbs

Sample ID	Zinc in Acid digested Samples		Zinc in Water Extract of Samples	
	Quantity found (mg g ⁻¹ ±SD)	RSD (%)	Quantity found (mg g ⁻¹ ±SD)	RSD (%)
GS	0.1070±0.003	0.7	0.0092±0.008	1.7
MC	0.0723±0.007	2.4	0.0149±0.015	2
SJ	0.0278±0.90	0.9	0.0035±0.001	0.6
ACV	0.0620±0.004	1.6	0.0049±0.006	2.4
AS	0.0573±0.002	0.9	0.0135±0.002	0.3
FG	0.1108±0.013	2.9	0.0024±0.001	0.1

Table 8: Range of Concentration of metals in Selected Herbs (recommended dose in mg day⁻¹)

Sample ID	Cr	Fe	Mg	Mn	Zn
Gymnema Sylvestre(WE)	0.0005–0.001	0.004–0.006	0.88–1.10	0.02–0.03	0.003–0.005
Momardica Charantia(AE)	0.02–0.115	0.51–2.60	12.0–59.9	0.10–0.55	0.081–0.41
Syzygium Jambolanm(AE)	0.01–0.03	0.45–1.18	0.74–1.87	0.019–0.05	0.05–0.14
Adiantm Cappillus(WE)	0.96–0.20	0.007–0.02	0.70–1.42	0.03–0.08	0.02–0.05
Allium Sativum(AE)	0.02–0.03	1.05–1.32	10.50–13.15	0.14–0.18	0.45–0.58
Fenugreek(AD)					
(W.E)	0.34–0.50	10.5–15.0	35.0–55.0	0.40–0.65	1.66–2.0
	0.15–2.50	0.05–0.90	6.0–63.0	0.90–1.0	0.10–1.5
Daily Intake (mg/70 Kg body weight)	0.09–0.13	8–18	240–280	2–3	10–15

Magnesium which is a major metal required by the body was found highest in GS (9.06 mg g⁻¹) and lowest in SJ (0.37 mg g⁻¹). Whereas ACV has 2.30 mg g⁻¹ and FG has 2.53 mg g⁻¹. MC has 3.98 mg and AS showed 1.31 mg magnesium g⁻¹ of herb. Water extract of these herbs showed lowest value for SJ (0.03 mg g⁻¹) and highest for GS (2.19 mg g⁻¹) (Table 5).

Similar to Mg, the highest concentration of Manganese was found in GS in acid digested (0.61 mg g⁻¹) as well as in water extract (0.05 mg g⁻¹). The least value was found in SJ in acid digested samples, whereas in water extracts FG is lowest (0.001 mg g⁻¹), SJ has also nearly same value (0.002 mg g⁻¹) (Table 6).

In case of Zinc, in acid digested samples, FG showed highest value (0.12 mg g⁻¹), GS has also nearly same (0.11 mg g⁻¹), whereas least value was found in Syzygium (0.03 mg g⁻¹). In water extracts least value found for FG

(0.002 mg g⁻¹) and highest for MC (0.01 mg g⁻¹). Allium sativum and Gymnema sylvester also showed high values (0.01 and 0.009 mg g⁻¹) (Table 7).

DISCUSSION

Most of the herbs are used after soaking in water and thus only this water extract is taken for the cure of disease, but some are taken as a whole in the form of powder or cooked or eaten as a fruit. The metals from these may be extracted in stomach after the action of acid. Therefore these acid extracts may provide information related to metals available from these herbs for biological research. With respect to dosage recommended it is obvious that FG (Methi) is the best in supply of Cr among other samples if taken solid as its acid digested sample gives 0.34-0.50 g dose⁻¹ of Cr (Table 8). Its acid extract

also provide required amount of Zn and Mn found to be affective in diabetes^[23].

A very minor negative point with FG is that it also provides a large amount of iron (but within limit) which may cause indigestion. This effect may be minimized by using either a 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, Magnesium and Zinc were in reasonable amount and a slight excess of chromium was also shown.

ACV showed an average concentration of all these metals. While AS and FG both has Chromium and Zinc in considerable amounts. Iron found in significant amount, only in GS. Fenugreek which is a very commonly used seeds in Pakistan and India, known as Methi, are not used as antidiabetic. However seeds as well as 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 same metallic combination as found in *Gymnema Sylvester* (Gumar) which is known to be best herb for the cure of diabetes. Fenugreek is even better as it does not have excessive amount of iron which is present in GS. Its water extract even have 11.0 ppm iron, while Fenugreek has 1.8 ppm. It is already known that presence of iron may not help in anti-diabetic activity.

It is found that the species very effective in the cure of diabetes may have a combination of Zinc, Chromium and Manganese. Water extract of *Gymnema* can provide chromium, magnesium, zinc and manganese all. *Momordica* and *Allium* can also provide zinc. Excessive amount of iron is reported to be harmful for diabetics^[23], thus if taken solid, iron may be intaken otherwise water extracts of all these herbs 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 prolong use of this herb may produce cancer, which is observed in some cases.

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