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Nutritional Composition of Medicinal Plants Commonly Grown in the Kurukshetra District, Haryana, India

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ABSTRACT

Introduction: Medicinal plants, believed to possess hypoglycemic and hypolipidemic potential namely, *Gymnema sylvestre*, *Momorodica charantia*, *Murraya koenigii, Terminalia arjuna* and *Trigonella foenum graecum,* were analysed for nutritional composition. **Methods:** Proximate analysis was done following the methods of AOAC. Available carbohydrate, β-carotene and minerals were analysed using spectrophotometer and atomic absorption spectrophotometer, respectively. One-way variance analysis was used to statistically analyse the variations in nutrient contents among the plants. **Results:** Moisture, crude protein, crude fibre, crude fat, ash, carbohydrate and energy content ranged between 10.86 - 91.81 , 2.81-25.60, 6.22-13.63, 0.48-7.41, 3.27-19.40, 52.87- 68.20 g / 100 g and 292.78-400.17 Kcal / 100 g on dry weight basis, respectively. Total soluble, reducing, non-reducing sugar and starch varied from 3.02-7.74, 1.74-4.78, 0.65-5.49 and 1.99-19.38 g / 100 g, respectively. Neutral detergent fibre, acid detergent fibre, hemicellulose, cellulose and lignin ranged between 22.82-39.68, 1.98-20.69, 8.98-31.19, 1.21-8.93, 0.72-12.50 g / 100 g, respectively. *Gymnema sylvestre* had the highest concentration of β-carotene (7950 $\pm$ 0.45 mg / 100 g) and iron (37.21 $\pm$ 0.50 mg / 100 g), while *Murraya koenigii* had the highest copper (2.71 $\pm$ 0.09 mg / 100 g) and calcium concentration (42.76 $\pm$ 0.43 mg / 100 g). Chromium and zinc were highest in *Momorodica charantia* (2.93 $\pm$ 0.22 mg / 100 g) and *Trigonella foenum graecum* (3.61 $\pm$ 0.46 mg / 100 g), respectively. Significant difference was observed in the crude protein, crude fat, carbohydrate, energy, acid detergent fibre and lignin content of the medicinal plants. **Conclusion**: These medicinal plants can be considered as potential sources of protein, fat, dietary fibre, β-carotene and minerals for diabetic and dyslipidemic patients.

Key words: Diabetes mellitus, dyslipidemia, medicinal plants, nutritional composition

INTRODUCTION

Diabetes mellitus and dyslipidemia are major public health problems, both in the developed as well as in the developing countries. Diabetes mellitus is a group of metabolic disorders characterised by hyperglycemia. It is associated with abnormalities in carbohydrate, fat and protein metabolism; and results in chronic complications including macrovascular, microvascular and neuropathic disorders (Triplitt, Reasner & Isley, 2005). Dyslipidemia includes either a low high density lipoprotein (HDL) cholesterol value or elevations in atherogenic lipoprotein particles, including cholesterol, cholesterol esters and triglycerides (Doherty & Bottorff,

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2006). Dyslipidemia is an associated complication of diabetes mellitus and also is one of the major causes of atherosclerosis and atherosclerosis associated conditions such as coronary heart disease, cerebro-vascular disease and peripheral vascular disease (Pathak & Gurubacharya, 2003). In diabetic patients, dyslipidemia significantly contributes to cardiovascular morbidity and mortality.

Oral hypoglycemic agents and hypo-lipidemic synthetic drugs are the mainstay of treatment of diabetes and dyslipidemia, respectively and though these drugs are effective, they have prominent side-effects, with poor patient compliance and often expensive. Thus, plants and herbs believed to have medicinal value are gaining popularity because they are easily available at a relatively low cost and have better cultural acceptability (Kamboj, 2000).

Nature has been a source of medicinal treatment for thousands of years, and the plant-based system, mainly medicinal plants and herbs, continue to play an essential role in the primary health care of about 75-80% of the world's population, mainly in developing countries. But the last few years have seen a major increase in their use in the developed countries (Kamboj, 2000).

Some of the medicinal plants like *Gymnema sylvestre*, *Momorodica charantia*, *Murraya koenigii*, *Terminalia arjuna* and *Trigonella foenum graecum* have been found to possess therapeutic benefit for the treatment of diabetes mellitus as well as for dyslipidemia. Most studies on such medicinal plants pertain to their organic constituents such as glycosides, alkaloids and essential oils (Grover, Yadav & Vats, 2002; Mukherjee, 2003). The role of dietary fibre and some inorganic elements like zinc, calcium, copper, potassium, and traces of chromium in the management of diabetes mellitus and dyslipidemia has been increasingly recognised but little has been reported about the nutritional composition of such medicinal plants. Therefore, the present investigation was undertaken with the objective of determining the proximate composition, available carbohydrates, dietary fibre, β-carotene and mineral content of commonly used and easily available hypoglycemic and hypolipidemic medicinal plants of Kurukshetra district of Haryana state, North India.

METHODS

Plant materials

Five plants believed to possess hypoglycemic and hypolipidemic properties namely, *Gymnema sylvestre*, *Momorodica charantia*, *Murraya koenigii*, *Terminalia arjuna* and *Trigonella foenum graecum* were selected for the study. The selected medicinal plants are commonly grown and consumed in the district of Kurukshetra, Haryana, India. *Trigonella foenum graecum* seeds and fruits of *Momorodica charantia* were bought from the local market in Kurukshetra, Haryana, India, while the leaves of *Gymnema sylvestre* were obtained from a local farm. The bark of *Terminalia arjuna* and leaves of *Murraya koenigii* were procured from the premises of Kurukshetra University, Kurukshetra. Surface contaminants of the seeds were removed by wiping with tissue paper, while the other medicinal plants were washed under running tap water, followed by double-glass distilled water and were drained completely. Each plant sample was dried at 60 ± 5^0C for 24 h in an oven. The dried samples were ground and used for analysis. Fresh samples were used for the determination of moisture content.

Proximate analysis

Moisture, ash, crude protein, crude fat and crude fibre of the selected hypoglycemic and hypolipidemic medicinal plants (HGHLMP) were determined by the methods described in AOAC (1990). The carbohydrate content was estimated by using difference method while gross energy was obtained by calculation using Atwater's conversion factors (Passmore & Eastwood, 1986).

Total soluble sugar, reducing sugar and starch content were determined according to the anthrone method described by Hart & Fischer (1971). The content of non–reducing sugar was calculated from the difference between total soluble sugar and reducing sugar. Dietary fibre was determined by estimation of neutral detergent fibre, acid detergent fibre, hemicellulose, cellulose and lignin by the method described by Arora (1981). β-carotene content was estimated using the spectrophotometric method described by Carr & Price (1926). β-carotene of medicinal plants was extracted with petroleum ether followed by washing with potassium hydroxide solution and double-glass distilled water from unsaponified extract. The ether extract was dried and residue obtained was dissolved in chloroform and the absorbance of the solution was read spectrophotometerically at 450 nm using uv- vis spectrophotometer (Specord- 205, Analytic Jena, Germany). Minerals namely calcium, chromium, copper, iron and zinc were determined according to the method described by Lindsey & Norwell (1969). About 1.0 g each of the powdered sample was accurately weighed and digested with a diacid mixture (HNO_3: $HClO_4$:: 5:1, v / v). After a clear solution was obtained, the solution was filtered through Whatman No. 42 and finally made up to 50 ml with double-distilled water. Further quantitative analysis of the minerals in the digested samples was done on an atomic absorption spectrophotometer (ZEEnit - 700 P, Analytik Jena, Germany). All analyses were carried out in triplicates.

Statistical analysis

Experimental values are given as mean $\pm$ standard deviation (SD). Statistical significance was determined by one-way variance analysis (ANOVA). Differences at $p < 0.05$ were considered to be significant. A Tukey HSD multiple comparison test was used to compare multiple means by using the statistical package SPSS v 16.0 (SPSS, Chicago, Illinois, USA).

RESULTS AND DISCUSSION

Proximate composition

The moisture content of hypoglycemic and hypolipidemic medicinal plants (HGHLMP) ranged between 10.86 g / 100g for *Trigonella foenum graecum* to 91.81 g / 100g for *Momorodica charantia* (Table 1). Kandlakunta, Rajendran & Thingnganing (2008) have reported high moisture content in *Trigonella foenum graecum* and an almost similar value for *Momorodica charantia*, when compared with values obtained in the present study for the same medicinal plants. ANOVA revealed significant differences (P< 0.05) in the moisture content of the HGHLMP analysed except between *Trigonella foenum graecum* and *Terminalia arjuna*.

The ash content of the investigated medicinal plants varied from 3.27 g / 100g (*Trigonella foenum graecum*) to 19.40 g / 100g (*Terminalia arjuna*). Statistically significant differences were observed in the mineral matter of the medicinal plants analysed. However, subsequent analysis by Tukey HSD test revealed non-significant difference in the mineral matter content between *Trigonella foenum graecum* and *Murraya koenigii*.

Trigonella foenum graecum and *Momorodica charantia* had a high crude protein content of 25.60 g / 100g and 19.28 g / 100g, respectively. *Terminalia arjuna* was found to have a low protein content of 2.81 g / 100g. ANOVA showed significant differences in the crude protein content of the hypoglycemic and hypolipidemic medicinal plants (HGHLMP) analysed.

The maximum amount of ether extracted fat was observed in *Trigonella foenum graecum* (7.41 g / 100g) and minimum was noted in *Momorodica charantia* (0.48 g / 100g). Analysis of variance (ANOVA) showed a significant difference in fat content among the medicinal plants analyed. *Momorodica charantia* was found to be a good source of crude fibre (13.63 g / 100g), while *Trigonella foenum graecum* (6.22 g / 100g) contained the lowest amount of crude fibre. ANOVA revealed significant differences in the crude fibre content of the hypoglycemic and hypolipidemic medicinal plants (HGHLMP) except between *Murraya koenigii* and *Terminalia arjuna*. The carbohydrate content ranged from 52.87 g / 100g (*Gymnema sylvestre*) to 68.20 g / 100g (*Murraya koenigii*). The energy value of the analysed samples ranged between 292.78 Kcal / 100g in *Terminalia arjuna* to 400.17 Kcal / 100g in *Trigonella foenum graecum.* Statistically significant differences were found in the total carbohydrate and energy content among all the medicinal plants analysed (Table 1).

Available carbohydrate

The total soluble sugar content of HGHLMP ranged between 3.02 g / 100g for *Momorodica charantia* to 7.74 g / 100g for *Trigonella foenum graecum.* Statistically significant differences were found in the total soluble sugar content of the analysed medicinal plants except among *Gymnema sylvestre*, *Murraya koenigii* and *Terminalia arjuna*. Among the medicinal plants analysed, the amount of reducing sugar was lowest (1.74 g / 100g) in *Momorodica charantia* and highest (4.78g / 100g) in *Terminalia arjuna*. ANOVA showed significant difference in the amount of reducing sugar among the medicinal plants analysed. Further analysis of the data revealed non-significant difference among *Trigonella foenum graecum and Momorodica charantia, Murraya koenigii,* respectively and also between *Gymnema sylvestre* and *Murraya koenigii*. The non-reducing sugar content ranged from 0.65 g / 100g (*Terminalia arjuna*) to 5.49 g / 100 g (*Trigonella foenum graecum*). ANOVA revealed highly significant differences ($P < 0.05$) in the non-reducing sugar content of the hypoglycemic and hypolipidemic medicinal plants(HGHLMP). However, subsequent analysis by Tukey HSD test revealed a non-significant difference in the non-reducing sugar content between *Momorodica charantia* and *Terminalia arjuna,* and *Murraya koenigii* and *Gymnema sylvestre*. The starch content of the investigated medicinal plants varied considerably, ranging from 1.99 g / 100 g (*Terminalia arjuna*) to 19.38g / 100 g ((*Trigonella foenum graecum*). ANOVA revealed significant difference ($P < 0.05$) in starch content of the hypoglycemic and hypolipidemic medicinal plants (HGHLMP) analysed except for *Momorodica charantia* and *Murraya koenigii* (Table 2). Not much work has been reported on the available carbohydrate content of the medicinal plants.

Dietary fibre

Among the analysed samples (Table 3), the neutral detergent fibre (NDF) content was lowest (22.82 g / 100 g) in *Momorodica charantia* while it was highest (39.68 g / 100g) in *Gymnema sylvestre*. The dietary fibre contents of all the medicinal plants analysed in the present investigation were higher than their crude fibre content respectively. ANOVA showed non-significant difference in the NDF content for *Trigonella foenum graecum* and *Gymnema sylvestre,* and *Murraya koenigii* and *Terminalia arjuna* while significant differences were found among all other remaining medicinal plants. The acid detergent fibre (ADF) content in the samples varied between 1.98 g / 100 g in *Trigonella foenum graecum* to 20.69 g / 100g in *Terminalia arjuna.* ANOVA revealed significant difference ($P \leq 0.05$) in the ADF content of the hypoglycemic and hypolipidemic medicinal plants (HGHLMP) analysed. *Momorodica charantia* had the least hemicellulose content of 8.98 g / 100 g and *Trigonella foenum graecum* had the maximum content (31.19 g / 100g). The hypoglycemic and hypolipidemic medicinal plants (HGHLMP) were found to have varying amounts of cellulose, ranging from 1.21 to

Table 1. Proximate composition and energy content of hypoglycemic and hypolipidemic medicinal plants (per 100g dry weight)

Medicinal plants	*Moisture** *(g)*	*Ash (g)*	*Crude Protein (g)*	*Crude Fat (g)*	*Crude Fibre (g)*	*Carbohydrate (g)*	*Energy (Kcal)*
Gymnema sylvestre	12.57 ± 0.35^{a}	9.68 ± 0.38^{a}	10.76 ± 0.25^{a}	5.27 ± 0.13^{a}	11.72 ± 0.16^{a}	52.87 ± 0.52^{a}	302.45 ± 2.45^{a}
Momorodica charantia	91.81 ± 0.21^{b}	7.10 ± 0.52^{b}	19. 28 ± 0.18^{b}	0.48 ± 0.01^{b}	13.63 ± 0. 27^{b}	59.42 ± 0.73^{b}	319.19 ± 2.99^{b}
Murraya koenigii	74.26 ± 0.47^{c}	3.75 ± 0.04^{c}	14.78 ± 0.23^{c}	4.14 ± 0.21^{c}	9.11 ± 0.20^{c}	68.20 ± 0.17^{c}	369.21 ± 0.44^{c}
Terminalia arjuna	10.92 ± 0.37^{d}	19.40 ± 0.1^{d}	2.81 ± 0.37^{d}	1.91 ± 0.10^{d}	9.79 ± 0.37^{c}	66.07 ± 0.82^{d}	292.78 ± 1.25^{d}
Trigonella foenum graecum	10.86 ± 0.06^{d}	3.27 ± 0.26^{c}	25.60 ± 0.66^{e}	7.41 ± 0.10^{e}	6.22 ± 0.22^{d}	57.48 ± 0.58^{e}	400.17 ± 1.59^{e}

* Moisture is reported as g/ 100 g on fresh weight basis.
Each value is expressed as the mean ± SD of 3 replicate analysis.
Values with different superscript letters in the same column are significantly different at the 0.05 level ($P \leq 0.05$)

Table 2. Available carbohydrate content of hypoglycemic and hypolipidemic medicinal plants (g per 100g dry weight)

Medicinal plants	*Total soluble sugar*	*Reducing sugar*	*Non-reducing sugar*	*Starch*
Gymnema sylvestre	5.14 ± 0.20^{a}	2.90 ± 0.22^{a}	2.13 ± 0.24^{a}	4.77 ± 0.20^{a}
Momorodica charantia	3.02 ± 0.047^{b}	1.74 ± 0.02^{b}	1.22 ± 0.01^{b}	6.43 ± 0.25^{b}
Murraya koenigii	4.90 ± 0.14^{a}	2.47 ± 0.02^{ac}	2.58 ± 0.35^{a}	6.39 ± 0.11^{b}
Terminalia arjuna	5.44 ± 0.23^{a}	4.78 ±0.09^{d}	0.65 ±0.14^{b}	1.99 ±0.20^{c}
Trigonella foenum graecum	7.74 ± 0.11^{c}	2.25 ± 0.08^{bc}	5.49 ± 0.05^{c}	19.38 ± 0.43^{d}

Each value is expressed as the mean ± SD of 3 replicate analysis
Values with different superscript letters in the same column are significantly different at the 0.05 level ($P \leq 0.05$)

Table 3. Dietary fibre constituents of hypoglycemic and hypolipidemic medicinal plants (g per 100g dry weight)

Medicinal plants	*Neutral detergent fibre*	*Acid detergent fibre*	*Hemicellulose*	*Cellulose*	*Lignin*
Gymnema sylvestre	39.68 ± 0.18^{a}	10.62 ± 0.11^{a}	29.06 ± 0.64^{a}	8.72 ± 0.87^{a}	1.90 ± 0.24^{a}
Momorodica charantia	22.82 ±0.34^{b}	13.97 ± 0.31^{b}	8.98 ± 0.22^{b}	8.19 ± 0.22^{b}	5.78 ± 0.12^{b}
Murraya koenigii	31.69 ± 0.52^{c}	15.61 ± 0.51^{c}	16.08 ± 0.21^{c}	8.93 ± 0.13^{c}	6.68 ± 0.14^{c}
Terminalia arjuna	30.91 ± 0.26^{c}	20.69 ± 0.11^{d}	10.22 ± 0.29^{b}	8.19 ± 0.22^{b}	12.50 ± 0.17^{d}
Trigonella foenum graecum	34.47 ± 0.19^{a}	1.98 ± 0.11^{e}	31.19 ± 0.94^{d}	1.21 ± 0.07^{d}	0.72 ± 0.04^{e}

Each value is expressed as the mean ± SD of 3 replicate analysis
Values with different superscript letters in the same column are significantly different at the 0.05 level ($P \leq 0.05$)

Table 4. β-carotene and mineral content of hypoglycemic and hypolipidemic medicinal plants (mg per 100g dry weight)

Medicinal plants	*β-carotene*	*Calcium*	*Chromium*	*Copper*	*Iron*	*Zinc*
Gymnema sylvestre	7950 ± 0.45^{a}	42.44 ± 0.26^{a}	2.85 ± 0.18^{a}	0.73 ± 0.03^{a}	37.21 ± 0.50^{a}	2.55 ± 0.32^{a}
Momorodica charantia	1020 ± 0.15^{b}	21.27 ± 0.37^{b}	2.93 ± 0.22^{a}	0.74 ± 0.01^{a}	17.70 ± 0.45^{b}	2.47 ± 0.30^{a}
Murraya koenigii	7900 ± 0.45^{a}	42.76 ± 0.43^{a}	2.25 ± 0.29^{a}	2.71 ±0.09^{b}	9.45 ± 0.35^{c}	0.96 ± 0.01^{a}
Terminalia arjuna	610 ± 0.10^{bc}	42.73 ± 0.31^{a}	1.44 ± 0.33^{b}	1.29 ± 0.21^{c}	1.82 ± 0.36^{d}	1.20 ± 0.13^{b}
Trigonella foenum graecum	170 ± 0.02^{c}	15.26 ± 0.80^{c}	2.81 ± 0.31^{a}	1.19 ± 0.08^{c}	10.30 ± 0.49^{c}	3.61 ± 0.46^{c}

Each value is expressed as the mean ± SD of 3 replicate analysis
Values with different superscript letters in the same column are significantly different at the 0.05 level ($P \leq 0.05$)

8.93 g / 100 g. Statistically significant differences were observed in the cellulose and hemicellulose content of the HGHLMP analysed except for *Momorodica charantia* and *Terminalia arjuna. Trigonella foenum graecum* had a lignin content of 0.72 g / 100g while in the rest of the analysed samples, it varied from 1.90 to 12.50 g / 100 g. ANOVA revealed significant difference in the lignin content of the HGHLMP analysed. The positive effect of dietary fibre includes the reduction of blood cholesterol and the glycaemic index of carbohydrate sources (Liu *et al*., 2000).

β-carotene Content

β-carotene has an important function as a precursor of vitamin A, and has a direct impact on cholesterol synthesis (Burri, 2002). Furthermore, dietary supplementation with *β*-carotene can normalise low-density lipoprotein (LDL) oxidation and consequently may be of importance in delaying accelerated development of atherosclerosis in patients with diabetes mellitus (Levy *et al*., 2000). Among the analysed medicinal plants, *β*-carotene content was lowest (170 mg / 100g) in *Trigonella foenum graecum*, while it was highest (7950 mg / 100g) in *Gymnema sylvestre*. Kandlakunta *et al*. (2008) reported *β*-carotene in *Murraya koenigii*, *Momorodica charantia* and *Trigonella foenum graecum* as 8.84, 0.084 and 0.14 mg / 100g on fresh weight basis, respectively, different from the values obtained in the present study. ANOVA revealed highly significant difference in the *β*-carotene content of the analysed hypoglycemic and hypolipidemic medicinal plants (HGHLMP). Further analysis of the data revealed non-significant difference among *Terminalia arjuna* and *Trigonella foenum graecum, Momorodica charantia*, respectively and also between *Gymnema sylvestre* and *Murraya koenigii* (Table 4).

Mineral Content

Calcium is reported to play an important role in glucose tolerance factor (GTF), which decreases the blood glucose level by utilising insulin (Gurson & Saner, 1971). The calcium content in the analysed medicinal plants varied from 15.26 mg / 100 g in *Trigonella foenum graecum* to 42.76 mg / 100 g in *Murraya koenigii*. In the present study, calcium content of *Gymnema sylvestre* was lower than the value reported by Naga Raju *et al*. (2006). ANOVA revealed highly significant difference in the calcium content of the analysed hypoglycemic and hypolipidemic medicinal plants (HGHLMP). However, non-significant differences were found among *Gymnema sylvestre, Murraya koenigii, Terminalia arjuna* (Table 4).

Chromium is a critical cofactor in the action of insulin (Anderson, 1997) and an active component of the glucose tolerance factor (GTF). Deficiency of chromium has been implicated as one of the causes of diabetes mellitus and risk factor in atherosclerotic disease (Anderson, 1995). All the medicinal plants were good sources of chromium, ranging from 1.44 mg / 100 g (*Terminalia arjuna*) to 2.93 mg / 100 g (*Momorodica charantia*). The concentration of chromium in *Momorodica charantia* was higher than that found by Singh & Garg (1997). Singh & Garg (1997) reported a low chromium value (0.06 mg / 100g) for *Terminalia arjuna* bark. Chromium content in *Gymnema sylvestre* analysed in the present study was higher than the value reported by Ray *et al*. (2004) but lower than that reported by Naga Raju *et al*. (2006). Singh & Garg (1997) determined chromium content in *Trigonella foenum graecum* as 0.164 mg / 100g on a dry matter weight basis. Choudhury & Garg (2007) reported chromium content in *Murraya koenigii* as 0.082 mg / 100 g on a dry matter basis, that was lower than the value obtained in this study. Statistically significant differences were found in the chromium concentration between *Terminalia arjuna* and remaining medicinal plants. However, non-significant differences were found among *Momorodica charantia, Murraya koenigii, Gymnema sylvestre* and *Trigonella foenum graecum* (Table 4).

Copper possesses insulin-like activity and it has been found that its deficiency leads to glucose intolerance, decreased insulin response and increased glucose response (Mooradian & Morely, 1987). Copper deficiency can be also be atherogenic due to increased oxidative stress. The levels of copper in the samples ranged between 0.73 mg / 100 g in *Gymnema sylvestre* to 2.71 mg / 100 g in *Murraya koenigii.* Choudhury & Garg (2007) determined 3.01, 1.21, 0.687 and 1.61 mg / 100g copper content in *Murraya koenigii* leaves collected from eastern, western, northern and southern zones of India, respectively. ANOVA revealed significant difference (P< 0.05) in the copper content of the analysed medicinal plants. Further analysis of the data revealed non-significant difference among *Trigonella foenum graecum* and *Terminalia arjuna*, and *Gymnema sylvestre* and *Momorodica charantia* (Table 4).

Iron is a strong pro-oxidant that catalyses several cellular reactions that result in the production of reactive oxygen species (ROS), with a consequent increase in the level of oxidative stress (Puntarulo, 2005). This contributes to tissue damage that may potentially elevate the risk of type 2 diabetes. Serum ferritin levels (marker of body iron stores) positively correlate with levels of circulating insulin, glucose and also with dyslipidemia (Ramakrishnan, Kuklina & Stein, 2002; Tilbrook, 2004). The concentration of iron observed in the present study ranged from 1.82 to 37.21 mg / 100g in different plants analysed (Table 4). The concentration of iron in *Gymnema sylvestre* was higher than that found by Ray *et al*. (2004) and lower than the value reported by Naga Raju *et al*. (2006). Singh & Garg (1997; 2006) reported high iron content in *Trigonella foenum graecum* and *Terminalia arjuna* as 26.6 and 6.75 mg / 100 g dry matter weight, respectively. Statistically significant differences were observed in the concentration of iron among the hypoglycemic and hypolipidemic medicinal plants (HGHLMP) analysed except *for Trigonella foenum graecum* and *Murraya koenigii*.

Zinc plays an important role in production, storage, and regulation of insulin. Zinc levels tend to be low in diabetic patients (Garg *et al*., 2005). Further, coming to the relationship between zinc status and plasma lipids, there is some evidence that both zinc deficiency and an excess can cause dyslipidemia and impair hepatic cholesterol synthesis and enhance oxidative stress (Subramanyam & Vijaya, 1997). Leaves of *Murraya koenigii* contained the least concentration (0.96 mg / 100g) of zinc while the highest concentration (3.61 mg / 100g) was exhibited in the seeds of *Trigonella foenum graecum*. Singh & Garg (1997) have reported high zinc value for *Momorodica charantia* (8.11 mg / 100 g) and *Terminalia arjuna* (4.59 mg / 100 g). Naga Raju *et al*. (2006) have determined zinc content of *Gymnema sylvestre* as 2.89 mg / 100 g dry weight. The zinc value obtained for *Murraya koenigii* from this study in comparison to those available in the published literature showed much disagreement with those found by Singh & Garg (2006). ANOVA revealed significant differences in the concentration of zinc among the medicinal plants analysed (Table 4). Meanwhile, subsequent analysis by Tukey HSD test revealed non-significant difference in the zinc content among *Momorodica charantia, Gymnema sylvestre* and *Murraya koenigii.*

The variation in the nutrient content of same plants in different studies can be attributed to several factors like climatic or geographic conditions, nature of the soil, degree of maturity at harvest, cultivation and post harvest handling practices

CONCLUSION

In addition to their hypoglycemic and hypolipidemic action, bitter gourd, curry leaves, *gurmar* leaves, fenugreek seeds, and *Terminalia arjuna* bark can be considered as potential source for providing a reasonable amount of protein, fat, β-carotene and minerals. They are also a rich source of dietary fibre and available carbohydrates. Hence, it may be concluded that these hypoglycemic and hypolipidemic medicinal plants possessing no side effects provide various nutrients in the diet of diabetic as well as dyslipidemic patients as these nutrients are not provided by allopathic medicines. Diabetic and dyslipidemic patients should be encouraged to use these medicinal plants in their day-to-day food preparations to control blood sugar and blood lipid level.

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