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Nutrient Profile of Native Woody Species and Medicinal Plants in Northeastern Mexico: A Synthesis

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Abstract

Leaf nutrients have an important role in governing the trees growth and development of trees and are sources of nutrients for ruminants in forest. The present paper makes a synthesis of two earlier studies undertaken on macro and micronutrients of 1) 37 woody species and 2) 44 medicinal plants used traditionally of Northeastern Mexico. In the both the studies we estimated the contents of six nutrients in the leaves, three macronutrients (P, Mg, K, protein, C, N, C/N and three micronutrients (Cu, Fe, ZN) both for woody species and medicinal plants. A large variability exists in nutrient contents in woody species and medicinal plants. The species selected for the highest macronutrients and micronutrients may be utilized for confirming their physiological efficiency and probable better growth and productivity as well as good sources of macro and micronutrients for grazing wild animals. Similar to the results of woody trees, medicinal plants also exhibited a wider variability in macro and micronutrients. Based on the analysis of macro and micro nutrients the following species *Phalaris canariensis*, *Eruca sativa, Ocimum basilicum*, *Tragia ramosa*, *Mentha piperita, Mimosa malacophylla*, *Acalypha monostachya*, *Salvia hispánica*, *Tillandsia usenoides*, *Letsea glauscens*, *Tagetes lucida, Erygium heterophylla, Dyssodia setifolia, Nicotiana glauca, Ruta graveolens***,** *Olea europea, Equisetum hyemale, Rosamrinus officinalis* are selected containing a majority of each of these nutrients.

Keywords: Macro-Micronutrients; Native woody plants; Medicinal plants; Mexico; Variability; High nutritional values

Introduction

Woody plants and medicinal plants possesss various macro nutrients and micronutrients. These are essential to bring about the growth and development of the plants. These because of their medicinal values are used traditionally to cure various diseases. We made a short synthesis of researches undertaken on macro and micronutrients of woody species and medicinal plants.

Nutrients of woody plants

Woody plants of Tamaulipan Thornscrubs in the semiarid regions are of great economic importance for various uses such as timber for furniture, fences, firewood and serve as sources of forage for wild animal grazing [1]. Few studies are undertaken on nutrient contents of woody plants. The specific leaf area (SLA, leaf area per unit mass) appears to be correlated with leaf nitrogen per unit dry mass, photosyntheis and dark respiration sites [2].

A large variation exists among species in nutrient conservation. Species having nutrient conservation have long life span, high leaf mass per area, low nutrient concentrations and low photosynthetic capacity [3]. In a review a synthesis of crop responses to nutrient stress was made with special emphasis on nutritional values of nitrogen and phosphorus because these elements limit plant growth [4]. Leaf nutrient contents depend on the availability of macro and micronutrients that are present in the soil habitat. Nutrient-poor habitats are generally dominated by species that are nutrient conserving. The fertile habitats are generally dominated by species which have short term productivity per unit leaf mass [5]. Within a given habitat, the coexistence of the species is seen that exhibit variability in a large range of leaf traits [3].

With the age of leaves, nutrients are resorbed from older leaves prior to leaf abscission and reemployed in the developing tissues of leaves, fruits, and seeds. Resorption in general occurs throughout a leaf's life, more particularly when the leaves are shaded [6,7]. A major phase of resorption occurs shortly before leaf abscission [8] nutrient is recycled via resorption process [9]. It is reported that the presence of nutrient sinks that are active in particular have control over resorption [10]. Wright et al. [2] reported that most plants withdraw nutrients from leaves with advancement in age.

The nutrient availability and management were studied by [11] in the rhizophere showing genotypic differences. Understanding the role of plant-microbe-soil interaction governing the nutrient availability will enhance environmental sustainability. Green- leaf and senesced-leaf nitrogen and phosphorous contents quantified revealed that these in green and senesced leaves were positively correlated with leaf length in all species.

A study was conducted on chemical composition and potential value of subtropical tree species of Combreatum in southern Africa for ruminants. It was concluded that the foliage tested would not be a suitable resource of N to supplement protein deficiencies in low quality herbage [12].

Nutrients in medicinal plants

The role of traditional medicinal plants to alleviate various diseases in different countries since remote times is well known. In Mexico, many medicinal plants are commonly used traditionally to cure various

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diseases in rural and urban areas [13-15]. Although various studies on ethanobotany of medicinal plants have been undertaken [16], only few cases were documented and reported in the northeastern area of Mexico [17-22]. Besides, very little information about these species is available to examine the efficacy of each species based on of chemical analysis.

Several studies in medicinal plants have been undertaken on the use of the use of the medicinal plants to cure human and animal diseases such as in eye problem [23] and diabetes [24,25]. The micronutrients are essential for promoting good health of mankind, plants and animals. Their requirement is though in minor quantities the deficiency of these elements causes abnormalities that lead to infection of diseases [23].

Several medicinal plants possessing micronutrients are reported to be effective to control blood sugar such as Mulberry leaf, soybean, black bean, Persian shallot, *Zizyphus lotus*, etc. It is reported that Carbon, Nitrogen and C/N ratios contribute to the production of a number of secondary metabolites, antioxidants and flavonoids which are useful for the maintenance of health of human beings [26,27]. Antioxidants have the ability to reduce inflammations and promote normal cardiovascular functions [28] inhibits cancerous tumour [29] reduce the ageing process in the brain and nervous system [30] and delay or inhibit oxidation [31]. Several antioxidant compounds are present in some fruits, vegetables *viz.*, *Occimum sanctum*, *Terminalia belerica*, *Zingiber officinales* and several Chinese and Indian spices such as *Poper cababa*, *Allium sativa*. The flavones, isoflavones, flavonoids, anthocyanins, coumarins ligans, catechin and isocatechin and several secondary metabolites that are commonly found in plants exhibit the antioxidant activities [32,33]. High peroxidation of the secondary metabolites was reported in plants that have high C/N ratio and low nitrogen fertilization especially when exposed to elevated CO_2 levels. Under low nitrogen conditions, the growth and photosynthesis in plant increases the C/N ratio which leads to an increase in the production of secondary metabolites [30,34].

Very recently the consumption of nutraceuticals from plant has become popular to improve health and to prevent or treat various diseases. Some popular phyto-nutraceuticals are glucosamine from ginseng, Omega 3 fatty acids from linseed. Many of the nutraceuticals have high potentials for multiple therapeutic uses but research is lacking [35].

Methodology

These two studies were carried out at the experimental station of Facultad de Ciencias Forestales, Universidad Autonoma de Nuevo Leon, located in the municipality of Linares (24 47N 99 32 W), at elevation of 350 m. The climate is subtropical or semiarid with warm summer, monthly mean air temperature vary from 14.7°C in January to 23°C in August, although during summer the temperature goes up to 45°C. Average annual precipitation is around 805 mm with a bimodal distribution. The dominant type of vegetation is the Tamaulipan Thorn scrub or subtropical Thorn scrub wood land. The dominant soil is deep, dark grey, lime-grey, vertisol with montmorrillonite, which shrink and swell remarkably in response to change in moisture content.

Chemical analysis

The leaf samples were collected from each species and were placed to dry on a newspaper for a week. The leaves were separated from the rest of the plant and were passed twice through a mesh of 1 × 1 mm in diameter using a mill Thomas Wiley and subsequently dried for more than three days at 65°C in an oven (Precision model 16EG) to remove moisture from the sample and later these were placed in desiccators. A 2.0 mg of the sample was weighed in an AD6000 Perkin balance elmer in a vial of tin, bent perfectly. This was placed in Chons analyzer Perkin Elmer Model 2400 for determining carbon, and nitrogen. For estimating the mineral contents, the samples were incinerated in a muffle oven at 550°C for 5 hours. The ashed sample is then digested in a solution containing HCL and HNO_3, using the technique of wet digestion [36]. The estimations of Carbon and nitrogen foliar contents (% dry mass basis) were carried out in 0.020 g of milled dried leaf tissue by using a CHN analyser (PerkinElemer, model 2400). Protein is calculated following N x 6.25.

Mature leaf samples (1.0 g dry weight) obtained from each plant and shrub species was used for determining the contents of minerals (Cu, Fe, Zn, Mg, K and P). Mineral content was estimated by incinerating samples in a muffle oven at 550°C during 5 hours. Ashes were digested in a solution containing HCl and HNO_3, using the wet digestion technique [36]. Cu, Fe, Zn, K and Mg (air/acetylene flame) were determined by atomic absorption spectrophotometry (Varian, model SpectrAA-200), whereas P was quantified spectrophotometrically using a PerkinElmer spectrophotometer (Model Lamda 1A) at 880 nm [37].

Results

In the present paper we presented the brief results of two studies, 1) leaf macro and micronutrients of 37 woody species and 2) of 44 medicinal plant species that were used traditionally in Northeastern Mexico during summer 2015.

Study 1: Macro and micronutrients of 37 woody species

Results: The data regarding the macro- and microminera; contents of 37 native shrubs and trees are presented in Table 1. It is observed that there exists a large variability in the contents of macro (P, Mg, K, protein, C, N (μg g^{-1} dw), C/N ratio) and micronutrients (Cu, Fe, Zn (μg g^{-1} dw), thereby giving large opportunity for the selection of the species with high nutrient contents. In the following we selected species with high macro and micronutrients which could serve as good source of nutrients.

Macronutrients (mg g^{-1} dw):

P: The species containing high P are *Croton suaveleons* (2.43), *Eysenhardtia polystachya* (1.84), *Prosopis laevigata* (1.65), *Parkinsonia aculeate* (1.56), *Acacia farnesiana* (1.54), *Salix lasiolepis* (1.15).

Mg (mg g^{-1} dw): The species containing high Mg are *Ehretia anacua* (9.45), *Condalia hookeri* (6.50), *Parkinsonia aculeata* (5.29), *Helietta parviflora* (3.17), *Guiacum angustifolia* (4.1).

K (mg g^{-1} dw): The species containing high K are *Croton suaveolens* (75.62), *Cordia boissieri* (45.58), *Celtis pallida* (42.6), *Acacia rigidula* (38.75), *Diospyros texana* (36.55), *Acacia farnesiana* (34.72), *Prosopis laevigata* (34.04), *Bumelia celastrina* (33.02).

C%: The species containing high C are *Leucophyllum frutescens* (49.97), *Foresteria angustifolia* (49.47), *Bumelia celastrina* (49.25), *Acacia berlandieri 49.18, Acacia rigidula* (48.23), *Gymnosperma glutinosum* (46.19), *Acacia farnesiana* (46.17), *Croton suaveolens* (45.17), *Sargentia gregii* (44.07).

N%: The species containing high N% are *Gymnosperma glutinosum* (5.89), *Lantana macropoda* (4.43), *Acacia shaffneri* (4.32), *Bernardia myricifolia* (2.21), *Celtis pallida* (4.12), *Eysenhardtia polystachya* (4.06), *Cercidium macrum* (4.01).

Species	Leaf macro-nutrient contents						Leaf micronutrient contents		
	(mg g^{-1} dw)			(%)			(µg g^{-1} dw)		
	K	Mg	P	C	N	C:N	Cu	Fe	Zn
Acacia berlandieri	0.78 ± 0.08	2.69 ± 0.41	6.80 ± 2.10	23.88	49.18 ± 1.25	3.82 ± 0.14	3.52 ± 0.62	73.46 ± 8.01	15.08 ± 3.61
Acacia farnesiana	1.54 ± 0.11	0.22 ± 0.17	34.72 ± 2.20	21.31	46.17 ± 2.63	3.41 ± 0.18	24.62 ± 1.11	259.76 ± 2.66	15.47 ± 0.83
Acacia rigidula	1.25 ± 0.14	0.43 ± 0.09	38.75 ± 0.55	16.25	48.23 ± 1.56	2.60 ± 0.22	7.09 ± 0.36	252.33 ± 3.04	10.23 ± 1.16
Acacia schaffneri	1.44 ± 0.22	1.72 ± 1.17	19.86 ± 1.77	27	39.52 ± 0.99	4.32 ± 0.16	3.18 ± 0.94	138.93 ± 32.25	44.6 ± 5.71
Acacia wrightii	1.22 ± 0.19	3.03 ± 1.23	20.5 ± 3.41	24.75	36.59 ± 1.11	3.96 ± 0.18	8.11 ± 2.97	99.04 ± 23.21	28.14 ± 2.29
Amyris texana	1.09 ± 0.08	2.67 ± 0.36	19.56 ± 4.79	23.25	38.06 ± 1.89	3.72 ± 0.33	9.18 ± 1.17	99.88 ± 31.75	17.40 ± 1.24
Berberis chococo	0.90 ± 0.05	2.35 ± 0.86	12.42 ± 2.06	15.19	36.91 ± 1.25	2.43 ± 0.19	5.12 ± 0.38	58.79 ± 13.95	50.68 ± 9.41
Bernardia myricifolia	1.09 ± 0.10	3.61 ± 0.38	11.54 ± 1.18	26.31	42.69 ± 1.13	4.21 ± 0.49	8.03 ± 0.85	139.73 ± 24.69	16.17 ± 0.93
Bumelia celastrina	0.09 ± 0.78	0.68 ± 0.13	33.02 ± 1.30	15.13	49.25 ± 1.56	2.42 ± 0.36	25.24 ± 1.50	249.00 ± 15.03	14.10 ± 7.38
Caesalpinia mexicana	1.29 ± 0.23	1.20 ± 0.12	13.32 ± 1.88	18.19	41.12 ± 1.96	2.91 ± 0.38	4.55 ± 0.96	48.47 ± 19.26	17.36 ± 5.74
Celtis laevigata	1.57 ± 0.23	2.19 ± 0.27	20.67 ± 3.28	18.81	39.45 ± 0.51	3.01 ± 0.18	8.88 ± 2.09	254.09 ± 40.44	42.28 ± 5.49
Celtis pallida	1.24 ± 0.18	3.20 ± 0.25	42.60 ± 0.90	25.75	38.66 ± 0.88	4.12 ± 0.67	25.98 ± 1.04	276.89 ± 5.70	12.42 ± 0.29
Cercidium macrum	1.10 ± 0.11	2.95 ± 0.87	14.5 ± 6.07	25.06	43.41 ± 3.44	4.01 ± 0.30	5.97 ± 1.50	96.08 ± 24.65	25.29 ± 5.86
Condalia hoockeri	0.89 ± 0.06	6.50 ± 0.84	25.76 ± 3.33	19.13	30.07 ± 2.81	3.06 ± 0.41	5.02 ± 0.39	73.79 ± 18.44	11.54 ± 3.41
Cordia boissieri	1.42 ± 0.12	2.72 ± 0.31	45.58 ± 1.65	20.5	43.43 ± 1.20	3.28 ± 0.09	30.71 ± 0.55	280.55 ± 8.46	51.87 ± 1.80
Croton suaveolens	2.43 ± 0.14	0.22 ± 0.09	75.62 ± 3.67	14.5625	45.17 ± 0.35	2.33 ± 0.53	26.87 ± 1.66	229.13 ± 24.25	34.55 ± 4.11
Diospyros palmeri	0.96 ± 0.06	2.84 ± 0.92	18.13 ± 1.60	13.56	37.59 ± 1.72	2.17 ± 0.12	5.36 ± 1.13	92.96 ± 14.59	18.58 ± 5.90
Diospyros texana	0.98 ± 0.08	2.59 ± 0.55	36.55 ± 2.26	11.81	40.79 ± 1.46	1.89 ± 0.06	2.80 ± 0.16	72.47 ± 22.66	41.45 ± 4.03
Ebenopsis ebano	0.90 ± 0.03	2.88 ± 0.25	14.06 ± 1.27	24.13	37.57 ± 1.21	3.86 ± 0.20	8.85 ± 2.14	130.60 ± 94.49	17.21 ± 3.81
Ehretia anacua	1.12 ± 0.06	9.45 ± 0.37	16.72 ± 1.18	15.25	34.09 ± 2.51	2.44 ± 0.10	12.62 ± 0.79	68.90 ± 5.82	40.07 ± 5.31
Eysenhardtia polystachya	1.84 ± 0.22	2.22 ± 0.24	16.43 ± 2.54	25.375	36.26 ± 0.58	4.06 ± 0.27	16.16 ± 2.92	82.86 ± 10.47	51.39 ± 10.66
Forestiera angustifolia	0.89 ± 0.06	1.27 ± 0.35	28.32 ± 3.61	18.75	49.47 ± 0.43	3.00 ± 0.41	4.03 ± 0.39	70.10 ± 11.86	48.56 ± 6.13
Fraxinus greggii	0.88 ± 0.05	1.55 ± 0.54	23.07 ± 1.63	13.44	38.06 ± 1.89	2.15 ± 0.14	8.16 ± 1.21	125.13 ± 43.75	30.94 ± 3.97
Guaiacum angustifolium	0.80 ± 0.18	4.10 ± 0.87	12.69 ± 1.32	18.13	41.89 ± 3.56	2.90 ± 0.42	3.99 ± 2.07	83.30 ± 6.70	20.59 ± 4.08
Gymnosperma glutinosum	1.40 ± 0.04	1.90 ± 0.13	21.49 ± 3.31	36.8125	46.19 ± 1.04	5.89 ± 0.29	8.93 ± 2.40	167.40 ± 13.81	12.16 ± 1.64
Harvadia pallens	1.11 ± 0.11	3.15 ± 0.68	22.86 ± 2.52	18.5625	43.49 ± 1.24	2.97 ± 0.15	3.51 ± 0.46	109.87 ± 10.53	29.57 ± 6.38
Helietta parvifolia	1.01 ± 0.12	5.17 ± 0.45	21.48 ± 1.83	15.19	31.13 ± 1.03	2.43 ± 0.25	9.11 ± 2.21	72.94 ± 4.97	37.55 ± 9.07
Karwinskia humboldtiana	1.05 ± 0.12	1.31 ± 0.37	16.41 ± 2.28	17.75	31.35 ± 0.70	2.84 ± 0.10	5.86 ± 0.75	70.41 ± 12.17	13.19 ± 1.61
Lantana macropoda	1.37 ± 0.06	3.71 ± 0.31	26.04 ± 2.04	27.69	42.91 ± 3.74	4.43 ± 0.39	13.00 ± 0.22	145.81 ± 48.14	28.29 ± 4.72
Leucaena leucocephala	0.98 ± 0.05	2.60 ± 0.38	14.21 ± 2.03	23.63	43.16 ± 1.98	3.78 ± 0.50	6.03 ± 0.41	77.59 ± 2.20	11.06 ± 1.12
Leucophyllum frutescens	0.8 ± 0.10	2.69 ± 0.28	13.69 ± 3.10	14.06	49.97 ± 0.94	2.25 ± 0.27	6.45 ± 0.79	118.12 ± 15.44	27.23 ± 3.79
Parkinsonia aculeata	1.56 ± 0.35	5.29 ± 1.82	24.93 ± 2.81	19	36.63 ± 3.25	3.04 ± 0.41	7.44 ± 2.20	165.63 ± 69.17	51.66 ± 8.09
Prosopis laevigata	1.65 ± 0.29	2.88 ± 1.12	34.04 ± 2.03	24.06	41.64 ± 0.71	3.85 ± 0.21	5.17 ± 1.53	128.92 ± 41.18	48.47 ± 11.71
Quercus virginiana	0.91 ± 0.07	2.60 ± 1.34	15.04 ± 1.37	12.25	43.02 ± 2.38	1.96 ± 0.18	3.63 ± 0.50	66.32 ± 13.19	39.25 ± 3.88
Salix lasiolepis	1.51 ± 0.09	2.34 ± 1.18	23.57 ± 1.54	12.875	33.37 ± 4.58	2.06 ± 0.50	8.49 ± 0.52	95.49 ± 13.15	144.86 ± 12.77
Sargentia gregii	0.78 ± 0.04	2.45 ± 0.19	13.19 ± 3.84	11.94	44.07 ± 1.22	1.91 ± 0.45	4.79 ± 0.47	87.80 ± 18.23	14.48 ± 0.94
Zanthoxylum fagara	0.99 ± 0.13	2.80 ± 0.46	14.77 ± 2.51	18.63	40.35 ± 3.15	2.98 ± 0.90	15.66 ± 3.17	112.80 ± 22.32	18.92 ± 2.80

Data are means and standard deviation (n=5).

Table 1: Leaf nutrient content in different plant species.

C/N ratio: The species containing high C/N are *Sargentia gregii* (23.13), *Leucophyllum frutescens (*22.17), *Quercus virginiana* (21.95), *Diospyros texana* (21.58), *Bumelia celastrina* (20.35), *Croton suaveolens* (20.16).

Micronutrients: Cu (μg g^{-1} dw): The species containing high Cu are *Cordia boissieri* (30.71), *Croton suaveolenss* (26.87), *Celtis pallida* (25.98), *Bumelia celastrina* (23.24), *Acacia farnesiana* (24.62), *Eysenhardtia polystachya* (16.16), *Zanthoxylum fragara* (15.66), *Lantana macropoda* (13.0), *Ehretia anacua* (12.62).

Fe (μg g^{-1} dw): The species containg high Fe are *Cordia boissieri* (280.55), *Celtis pallida* (276.89), *Acacia farnesiana* (259.76), *Celtis laevigata* (234.09), *Acacia rigidula* (252.33), *Bumelia celastrina* (249), *Croton suaveolens* (229.19), *Gymnosperma glutinosum* (167.4), *Parkinsonia aculeate* (165.63), *Lantana macropoda* (145.81), *Bernardia myricifolia* (139.73), *Acacia shaffneri* (138.93).

Zn (μg g^{-1} dw): The species containing high Zn are *Salix lasiolepis* (144.86), *Cordia boissieri* (51.87), *Parkinsonia aculeata* (51.66), *Eysenhardtia polystachya* (51.39), *Foresteria angustifolia* (48.56), *Prosopis laevigata* (48.47), *Acacia shaffneri* (44.60), *Celtis laevigata* (42.28), *Diospyros texana* (41.45), *Ehretia anacua* (40.07).

In the context of the above results it may be stated that the species show large variation in the contents of six macro (P, Mg, K, C, N, C/N, % protein) and three micronutrients Cu, Fe and Zn), thereby offering an opportunity to select species for high macro and micronutrients. The roles of nutrients are emphasized in various studies [4-6] and others.

Discussion: Studies on variability in leaf nutrient contents among woody species are rare but various studies have been demonstrated on nutrient contents of plants with respect to nutrient conservation, photosynthetic capacity (3), availability of leaf nutrients in soil habitat (5), resorption of nutrients from older leaves with age of leaves (6,7); leaf abscission (8); nutrient management in rhizosphere (11); protein deficiencies in low quality herbage (2). In the context of the above results and discussion, there is a research need to study the nutritional values of the selected species for animal nutrition and the productivity of trees and establish a germplasm bank with high nutrient profile for future research.

Study 2: Nutrient profile (Macro and micronutrients) of 44 medicinal plants used traditionally in Northeastern Mexico

Results: We determined macronutrients (K, Mg, P, C, C/N), protein content, and micronutrients (Cu, Fe, Zn) from the 44 medicinal plants (Table 2). The information helps to select plants with high quantity of each nutrient. This will inturn confirm the efficacy of the medicinal activity of the plant.

It is observed from the Table 3 that there exists a large variability in the contents of macro nutrients (K, Mg, P, N, C/N (mg g^{-1} dwt) and micronutrients Fe, Cu, Zn (μg g^{-1} dwt). Therefore, a large variation in the contents of nutrients and protein%, offers an opportunity to scientists working on medicinal plants to select plants with nutritional values. In the following the medicinal plants were grouped based on the maximum content of macro and micro nutrients.

Macronutrients:

- **Species containing high Potassium (K) content (mg g^{-1} dwt)**

Phalaris canariensis (163.3), *Eruca sativa* (144.2), *Opuntia ficus-indica* (101.5), *Phoradendron villosum* (100.6), *Melia azadirachta* (100), *Moringa oleífer* (96.0), *Marrubium vulgare* (91.3).

- **Species containing high Magnesium (Mg) content (mg g^{-1} dwt)**

Mimosa malacophylla (8.6), *Acalypha monostachya* (8.1), *Opuntia ficus-indica* (6.4), *Salvia hispanica* (3.5).

- **Species containing high Phosphorus (P) content (mg g^{-1} dwt)**

Celtis laevigata (4.03), *Carya illinoiensis* (2.89), *Croton suaveolens* (2.40), *Litsea glauscens* (2.40), *Eryngium heterophyllum* (2.27), *Lepidium virginicumm* (2.27), *Cnidoscolus aconitifolius* (2.05), *Mentha piperita* (2.0).

- **Species containing with high Carbon (C) (Per cent) capacity of Carbon dioxide fixation**

Eugenia caryophyllata (51.66), *Rhus virens* (50.38), *Cinnamomum verum* (49.34), *Arbutus xalapensis* (49.1), *Tecoma stans* (48.79), *Eryobotria japonica* (47.98), *Rosamrinus officinalis* (47.77), *Hedeoma palmeri* (46.38), *Moringa oleífer* (45.96), *Buddleja cordata* (45.70), *Croton suaveolens* (45.17), *Mimosa malacophylla* (45.15), *Chrysactinia mexicana* (45.04), *Melia azadirachta* (45.12).

- **Species containing high Nitrogen (N) (per cent)**

Mimosa malacophylla (8.46), *Moringa oleífer* (6.25), *Tagetes lucida* (5.98), *Tagetes lucida* (5.89), *Marrubium vulgare* (5.58), *Eruca sativa* (5.48), *Salvia hispanica* (5.24).

- **Species containing high C/N ratio**

Agave macroculmis Todaro (31.04), *Arbutus xalapensis* (26.94), *Eryngium heterophyllum* (24.23), *Rhus virens* (22.92), *Olea europea* (22.08), *Croton suaveolens* (20.16).

- **Protein%**

Mimosa malacophylla (52.87), *Moringa oleífer* (39.04), *Tagetes lucida* (36.81), *Poliomintha longiflora* (36.54), *Eruca sativa* (34.23), *Lepidium virginicumm* (33.73), *Melia azadirachta* (36.55), *Nicotiana glauca* (29.1), *Phoradendron villosum* (30.76).

Micronutrients:

- **Species with high Copper (Cu) content (μg g^{-1}dwt)**

Celtis laevigata (33.88), *Phalaris canariensis* (33.78), *Tillandsia usenoides* L. (33.70), *Arbutus xalapensis* (33.40), *Lepidium virginicumm* (33.06), *Phalaris canariensis* (33.04), *Lepidium virginicumm* (31.06), *Buddleja cordata* (29.90), *Cnidoscolus aconitifolius* (29.67).

- **Species with high Iron (Fe) content (μg g^{-1}dwt)**

Gnaphalium canecens (3973.55), *Tragia ramosa* (1450.25), *Tillandsia usenoides* (936.75), *Nicotiana glauca* (771.51), *Salvia hispanica* (479.51), *Salix lasiolepis* (444.872*), Ruta graveolens* (458.62), *Olea europea* (406.30), *Ocimum basilicum* (405.13).

- **Species with high Zinc (Zn) content (μg g^{-1}dwt)**

Salix lasiolepis (216.31), *Ocimum basilicum* (118.77), *Rosamrinus officinalis* (86.07), *Salvia hispanica* (62.22), *Phalaris canariensis* (63.97), *Tragia ramosa* (57.87), *Carya illinoiensis* (57.69), *Agave macroculmis Todaro* (55.20), *Gnahalium canescens* (53.73), *Hedeoma palmeri* (53.54*)*, *Melia azadirachta* (52.57), *Ruta graveolens* (50.72), *Opuntia ficus-indica* (50.05), *Phoradendron villosum* (52.02).

Discussion: The medicinal plants used traditionally by Mexicans for various diseases such as for diabetes, few for stomach ache and others in various diseases such as cancer, bronchitis, infertility, inflammation, blood circulation, digestion, fever, kidney problem,

Particular diseases	Common name	Scientific name	Family	Type
Diabetes	Maguey Tódaro	*Agave macroculmis Todaro*	Agavaceae	Rosetofilus
Diabetes	Madroño	*Arbutus xalapensis*	Ericaceae	Bush
Diabetes	Pata de vaca	*Bauhinia forficata*	Fabaceae	Tree
Diabetes	Tepozan	*Buddleja cordata*	Buddlejaceae	Tree
Diabetes	Nogal	*Carya illinoiensis*	Juglandaceae	Tree
Diabetes	Palo blanco	*Celtis laevigata*	Ulmaceae	Tree
Diabetes	*Canela*	*Cinnamomum verum*	Lauraceae	Tree
Diabetes	Salvia	*Croton suaveolens*	Euphorbiaceae	Bush
Diabetes	Níspero	*Eryobotria japonica*	Rosaceae	Bush
Diabetes	Betónica o poleo de hoja ancha	*Hedeoma palmeri*	Lamiaceae	Bush
Diabetes	Manrrubio	*Marrubium vulgare*	Lamiaceae	Herb
Diabetes	Neem	*Melia azadirachta*	Meliaceae	Tree
Diabetes	*Moringa*	*Moringa oleífer*	Moriginaceae	Tree
Diabetes	Nopal de t. año	*Opuntia ficus-indica*	Cactaceae	Bush
Diabetes	Injerto	*Phoradendron villosum*	Viscaceae	Bush
Diabetes	Lantrisco	*Rhus virens*	Anacardiaceae	Bush
Diabetes	Sauce	*Salix lasiolepis*	Salicaceae	Tree
Diabetes	Tronadora	*Tecoma stans*	Bignoniaceae	Bush
Diabetes	Maguey Tódaro	*Agave macroculmis Todaro*	Agavaceae	Rosetofilus
Ulcer, tumour, respiratory problems	Uña de gato	*Acacia wrightii*	Mimosaceae	Tree
Cancer	Hierba del cáncer	*Acalypha monostachya*	Euphorbiaceae	Herb
Bronchitis, infertility, inflamation	Hierba de San Nicolás	*Chrysactinia mexicana*	Asteraceae	Bush
Circulation, digestion	Chaya	*Cnidoscolus aconitifolius*	Euphporbiaceae	Tree
Fever	Parraleña	*Dyssodia setifolia*	Asteraceae	Herb
Kidney, cancer	Cola de caballo	*Equisetum hyemale*	Equisetaceae	Stem erect
Stomach ache	Colesia	*Eruca sativa*	Brasscaceae	Herb
Cholesterol	Hierba del sapo	*Eryngium heterophyllum*	Apiaceae	Herb
Tonic, stimulant	Clavo de olor	*Eugenia caryophyllata*	Myrtaceae	Tree
Expectorant	Gordolobo	*Gnahalium canescens*	Asteraceae	Herb
Stomachache	Ocotillo	*Gochnatia hypoleuca*	Asteraceae	Bush
Stomachache	Hierba del pajarito	*Lepidium virginicumm*	Brasscaceae	Herb
Stomachache	Laurel	*Litsea glauscesens*	Lauraceae	Bush
Stomachache	Yerbabuena	*Mentha piperita*	Lamiaceae	Herb
Kidney	Charrasquilla	*Mimosa malacophylla*	Leguminosae	sub Bush
Headache, gum pain, joint pain	Gigante	*Nicotiana glauca*	Solanaceae	Bush
Earache, taquicardia	Albahaca	*Ocimum basilicum*	Lamiaceae	herb
Cholesterol	Olivo	*Olea europea*	Oleaceae	Tree
Circulation, blood pressure	Alpistle	*Phalaris canariensis*	Poaceae	Bush
Cough, expectorante	Orégano	*Poliomintha longiflora*	Lamiaceae	Bush
Circulation, hairfall	Romero	*Rosamrinus officinalis*	Lamiaceae	Bush
Earache, blood pressure	Ruda	*Ruta graveolens*	Rutaceae	Herb
Cancer, coagulation, antitumour, elimination of fat	Chia	*Salvia hispanica*	Lamiaceae	Herb
Somachache, antifungal	Tatalencho	*Tagetes lucida*	Asteraceae	sub Bush
Burning	Paistle	*Tillandsia usenoides* L.	Bromeliaceae	Caulescent
Bronchitis blood purification	Ortiguilla	*Tragia ramosa*	Euphorbiaceae	Herb

Table 2: List of medicinal plants used to determine the leaf nutrient content.

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	Leaf Macro-nutrient Content							Leaf Micro-nutrient Content		
	(mg g^{-1} dw)			(%)				(µg g^{-1} dw)		
Plant Species	**K**	**Mg**	**P**	**C**	**N**	**C:N**	**% Proteín**	**Cu**	**Fe**	**Zn**
Agave macroculmis Todaro	**78.45** ± 1.07	1.38 ± 0.29	0.73 ± 0.02	41.32 ± 0.74	1.36 ± 0.21	**31.05** ± 5.11	8.49	18.76 ± 2.87	**210.53** ± 17.37	**55.20** ± 3.39
Arbutus xalapensis	30.65 ± 13.9	0.54 ± 0.60	1.78 ± 0.40	**49.1** ± 0.42	1.86 ± 0.30	**26.94** ± 3.72	11.6	**33.40** ± 20.18	**347.58** ± 104.2	25.07 ± 2.65
Bauhinia forficata	8.29 ± 1.27	1.45 ± 0.31	1.37 ± 0.11	34.02 ± 2.32	2.33 ± 0.6	14.60 ± 3.86	14.56	12.86 ± 0.73	161.65 ± 5.30	10.73 ± 0.28
Buddleja cordata	39.30 ± 1.82	0.17 ± 0.09	0.56 ± 0.10	**45.70** ± 0.56	3.26 ± 0.40	14.16 ± 1.44	**20.38**	**29.90** ± 1.85	148.00 ± 26.25	40.26 ± 3.39
Carya illinoiensis	31.16 ± 1.89	0.85 ± 0.34	**2.89 ± 0.06**	**44.27** ± 1.00	3.76 ± 0.71	12.04 ± 1.81	**23.5**	**25.74 ± 1.70**	166.49 ± 20.45	**57.69** ± 7.74
Celtis laevigata	16.10 ± 4.59	1.51 ± 0.67	**4.03 ± 0.29**	39.45 ± 0.51	3.01 ± 0.18	13.13 ± 0.70	18.83	**33.88** ± 12.60	**213.15** ± 49.80	23.53 ± 1.91
Cinnamomum verum	16.14 ± 1.35	0.27 ± 0.03	0.53 ± 0.05	**49.34** ± 0.48	2.49 ± 0.20	19.89 ± 1.70	15.59	24.53 ± 2.77	**217.14** ± 9.90	9.49 ± 1.47
Croton suaveolens	**75.62** ± 3.67	0.22 ± 0.09	**2.43** ± 0.14	**45.17** ± 0.35	2.33 ± 0.53	**20.16** ± 4.52	14.58	**26.87** ± 1.66	**229.13** ± 24.25	34.55 ± 4.11
Eryobotria japonica	18.77 ± 1.68	1.78 ± 0.36	**2.20** ± 0.20	**47.98** ± 1.18	3.03 ± 0.35	15.98 ± 1.58	18.94	22.04 ± 3.44	177.91 ± 13.45	17.13 ± 1.56
Hedeoma palmeri	**76.50** ± 1.42	0.18 ± 0.14	1.40 ± 0.03	**46.38** ± 1.66	2.83 ± 0.78	17.14 ± 3.33	17.69	23.98 ± 1.20	**334.23** ± 9.96	**53.54** ± 2.88
Marrubium vulgare	**91.27 ±** 3.70	0.64 ± 0.42	1.85 ± 0.05	40.48 ± 0.32	**4.56** ± 0.58	8.99 ± 1.03	**28.48**	**25.14** ± 1.07	**374.78** ± 13.18	46.79 ± 3.07
Melia azadirachta	**90.99** ± 7.21	**3.41** ± 0.80	1.98 ± 0.35	**45.12** ± 0.87	**5.85** ± 0.32	7.73 ± 0.32	**36.55**	24.20 ± 5.26	**265.59** ± 21.75	**52.57** ± 11.28
Moringa oleífer	**95.59** ± 7.56	0.81 ± 0.89	1.91 ± 0.15	**45.96** ± 0.23	**6.25** ± 0.25	7.37 ± 0.31	**39.05**	10.59 ± 2.22	**773.04 ± 198.33**	26.74 ± 4.75
Opuntia ficus-indica	**101.47** ± 9.1	**6.39** ± 0.90	0.84 ± 0.07	25.54 ± 0.99	2.36 ± 0.43	11.1 ± 1.94	14.74	22.76 ± 1.66	135.18 ± 10.44	**50.05** ± 4.80
Phoradendron villosum	**100.58** ± 7.6	**2.29** ± 0.68	**2.40** ± 0.04	40.4 ± 0.63	**4.92** ± 0.20	8.22 ± 0.44	**30.76**	**25.30** ± 1.28	151.30 ± 10.06	**52.02** ± 6.85
Rhus virens	14.77 ± 2.64	0.33 ± 0.15	1.41 ± 0.26	**50.34** ± 0.59	2.27 ± 0.45	**22.92** ± 4.67	14.19	22.98 ± 6.24	98.28 ± 23.19	12.75 ± 1.54
Salix lasiolepis	15.66 ± 3.34	1.24 ± 0.17	1.19 ± 0.07	33.37 ± 4.58	2.06 ± 0.50	16.24 ± 9.16	12.88	8.73 ± 3.27	**444.82** ± 24.76	**216.31** ± 10.83
Tecoma stans	**57.22** ± 8.90	0.31 ± 0.11	1.36 ± 0.02	**48.79** ± 1.21	3.28 ± 0.47	15.17 ± 2.34	**20.47**	**25.67** ± 3.33	**263.66** ± 32.88	**29.49** ± 1.27
Acacia wrightii	12.23 ± 2.97	0.49 ± 0.28	0.99 ± 0.21	36.59 ± 1.11	3.96 ± 0.18	9.25 ± 6.22	**24.75**	11.51 ± 12.73	196.38 ± 15.07	11.53 ± 6.33
Acalypha monostachya	25.70 ± 1.86	**8.11** ± 0.88	1.58 ± 0.04	29.71 ± 3.28	1.86 ± 0.26	15.95 ± 12.53	11.64	9.80 ± 1.50	**275.96** ± 36.79	64.74 ± 3.01
Chrysactinia Mexicana	5.47 ± 0.81	0.57 ± 0.36	0.86 ± 0.05	**45.04** ± 0.48	3.39 ± 0.49	13.56 ± 2.46	**21.2**	12.53 ± 1.69	**231.53** ± 21.08	30.30 ± 3.09
Cnidoscolus aconitifolius	39.96 ± 0.98	2.28 ± 0.36	**2.05** ± 0.06	39.11 ± 2.20	**4.34** ± 0.08	9.02 ± 2.75	**27.09**	**29.67** ± 1.04	**354.7**2 ± 20.59	**52.01** ± 4.65
Dyssodia setifolia	11.12 ± 2.24	0.58 ± 0.44	1.06 ± 0.29	39.68 ± 1.35	2.35 ± 0.67	18.59 ± 7.38	14.67	**25.25** ± 1.45	3540.19 ± 557.14 ??	27.97 ± 1.25
Equisetum hyemale	12.86 ± 0.86	2.28 ± 0.38	1.51 ± 0.61	26.95 ± 1.09	1.81 ± 0.08	14.89 ± 12.82	11.31	9.97 ± 1.63	229.29 ± 8.67	107.44 ± 17.64
Eruca sativa	**144.23** ± 2.3	2.22 ± 0.24	**2.22** ± 0.26	41.13 ± 0.72	**5.48** ± 0.64	7.59 ± 0.90	**34.23**	22.54 ± 8.27	**312.46** ± 60.02	45.51 ± 1.96
Eryngium heterophyllum	**43.07** ± 8.87	0.38 ± 0.29	**2.27** ± 0.11	40.9 ± 0.65	1.75 ± 0.40	**24.23** ± 4.89	10.94	**33.30** ± 12.18	144.26 ± 57.95	15.45 ± 3.49
Eugenia caryophyllata	37.73 ± 1.40	0.97 ± 0.34	0.89 ± 0.08	**51.66** ± 1.85	2.9 ± 0.35	18.01 ± 2.30	18.14	**27.33** ± 1.25	**221.34** ± 156.74	12.27 ± 0.56
Gnahalium canescens	16.69 ± 0.53	1.40 ± 0.18	1.08 ± 0.26	37.73 ± 1.26	2.56 ± 0.32	14.89 **± 1.37**	15.99	**25.13** ± 1.70	3973.55 ± 1342.28	**53.73** ± 0.79
Gochnatia hypoleuca	22.54 ± 2.48	0.48 ± 0.25	0.82 ± 0.04	**49.86** ± 0.87	3.59 ± 0.50	14.11 ± 1.89	**22.41**	11.37 ± 0.89	**292.92** ± 23.68	24.43 ± 0.77
Lepidium virginicumm	11.67 ± 0.59	1.89 ± 0.52	**2.27** ± 0.05	43.8 ± 1.22	**4.46** ± 0.59	9.95 ± 1.11	**27.85**	5.36 ± 1.80	188.69 ± 7.64	28.26 ± 1.49
Litsea glauscesens	10.94 ± 2.47	0.33 ± 0.28	**2.40** ± 0.13	**51.34** ± 0.28	3.36 ± 0.45	15.5 ± 2.03	**21**	22.84 ± 7.79	177.31 ± 27.21	33.09 ± 2.68
Lepidium virginicumm	**58.22** ± 4.35	1.15 ± 0.24	**2.20** ± 0.03	**44.14** ± 2.71	**5.4** ± 0.15	8.18 ± 0.41	**33.73**	**31.06** ± 0.74	**373.38** ± 9.40	49.17 ± 5.46
Mimosa malacophylla	16.39 ± 0.45	**8.64** ± 0.99	0.84 ± 0.04	**45.15** ± 0.53	**8.46** ± 0.18	5.34 ± 0.17	**52.87**	4.17 ± 1.25	222.28 ± 3.85	35.28 ± 1.14
Nicotiana glauca	18.19 ± 1.32	1.31 ± 0.15	1.30 ± 0.12	37.94 ± 0.56	**4.79** ± 0.54	8.00 ± 0.87	**29.91**	**33.06** ± 2.95	**721.51** ± 234.69	43.64 ± 3.96
Ocimum basilicum	**72.09** ± 2.43	2.42 ± 0.09	2.18 ± 0.03	38.31 ± 0.34	**4.66** ± 0.45	8.29 ± 0.84	**29.1**	14.56 ± 0.79	**405.13** ± 34.32	**118.77** ± 5.93
Olea europea	**48.16** ± 1.21	0.80 ± 0.20	1.23 ± 0.11	41.13 ± 2.59	1.86 ± 0.8	**22.08** ± 3.23	11.64	7.91 ± 1.13	**406.30** ± 31.86	21.93 ± 0.82
Phalaris canariensis	**163.35** ± 6.8	2.74 ± 0.30	1.48 ± 0.17	40.73 ± 0.53	2.84 ± 0.52	14.78 ± 2.87	17.73	**33.78** ± 8.95	**254.84** ± 70.34	**63.97** ± 7.56
Poliomintha longiflora	31.63 ± 5.50	1.80 ± 0.81	1.45 ± 0.75	42.9 ± 0.24	**4.89** ± 0.21	8.79 ± 0.36	**30.54**	**29.04** ± 2.79	**316.63** ± 130.27	32.99 ± 7.99
Rosamrinus officinalis	26.59 ± 5.54	1.18 ± 0.28	1.24 ± 0.38	**47.77** ± 5.43	**4.54 ±** 0.24	10.57 **± 1.65**	**28.41**	11.36 ± 7.39	**336.95** ± 122.63	**86.07** ± 21.27
Ruta graveolens	28.04 ± 2.59	0.88 ± 0.20	1.24 ± 0.20	38.86 ± 1.4	2.79 ± 0.25	**13.23 ± 5.7**	17.41	20.87 ± 9.55	**458.62** ± 71.30	**50.72** ± 11.64
Salvia hispanica	46.48 ± 6.70	**3.52** ± 0.71	**5.79** ± 0.75	**44.68** ± 2.18	**5.24** ± 0.62	**8.59 ± 0.81**	32.77	28.11 ± 4.75	**479.51** ± 64.24	**62.22** ± 3.93
Tagetes lucida	21.49 ± 3.31	1.90 ± 0.13	1.40 ± 0.04	**46.19** ± 1.04	**5.89** ± 0.29	7.85 ± 0.33	**36.81**	8.93 ± 2.40	167.40 ± 13.81	12.16 ± 1.64
Tillandsia usenoides L.	40.56 ± 4.67	1.20 ± 0.14	**4.45** ± 0.17	**44.10** ± 1.61	1.56 ± 0.71	31.32 ± 8.20	**9.75**	**31.70 ± 24.04**	**936.75** ± 543.65	34.06 ± 9.45
Tragia ramosa	60.57 ± 10.1	0.46 ± 0.42	1.45 ± 0.10	42.68 ± 1.16	3.89 ± 0.63	11.22 ± 2.01	**24.31**	**24.96** ± 2.87	**1450.25** ± 273.89	**57.87** ± 5.81

Data are means and standard deviation (n=5).

Table 3: Leaf nutrient content of the 44 species used to cure particular diseases.

earache, cholesterol, cough, respiratory headache, circulation, burning [18-20,22]. The supply of macro-and micronutrients has been found to useful in alleviating various diseases. Several medicinal plants used to reduce blood sugar such as Mulberry leaf, soybean, black bean, Persian shallot, *Zizyphus lotus*, etc, such as in alleviate-ing eye problem [23] and diabetes [24,25].

It may be stated here that the efficacy of the species used for different diseases is not confirmed scientifically, though few studies have been directed on the chemistry of few species. Some Mexican medicinal plants containing β-glycosides and other compounds are effective in lowering blood sugar and body weight in diabetic patients. The results reveal great variability in nutrient profile among the medicinal species. The species with high nutrients could be verified for their efficacy. In other words, these variation studies in macro and micronutrient contents of 44 medicinal plant species were studied in medicinal plants that are traditionally utilized to control diabetes and other diseases in Nuevo Leon, Mexico. It is observed that most of the species used traditionally to combat various diseases contain very high amount of macro and micronutrients and protein confirming the efficacy of these species. In this respect we have no scope to compare the contents of nutrient profile with individual disease species wise. In addition to micronutrients some major elements are necessary in higher amounts for good health. In this respect phosphorus is required for many biochemical reactions in the body, such as conversion of foods to energy, muscle contractions, nerve conductions, normal kidney functions and helps to build strong bones [38].

It is reported that most of American diets are adequate in magnesium (Mg). Magnesium is an activator of numerous enzyme systems to control carbohydrate, fat and electrolyte metabolism, nucleic acid, protein synthesis, membrane integrity and transport [39].

In the case of diabetes we want to mention the nutraceutical values of few species commonly used in combating diabetes. In this context research on nutraceutical plants is a modern trend. The nutraceutical values of various plants are well documented in the literature. It is evident from this study that the species which are commonly used to combat diabetes contain very high amount of nutrients, therby confirming their efficacy, but the efficacy of these species should be confirmed by analyzing the tolerance level in a pharmacology laboratory. On the other hand may be cited the use of *Tragia ramose* commonly used traditionally in blood purification contain very high amount of Fe (1250.25) confirming the role of iron as blood purifier and heamoglobin function. In the present study few medicinal plants were selected viz. *Gnaphalium canecens* (3973.55), *Tragia ramosa* (1450.25), *Tillandsia usenoides* (936.75), *Nicotiana glauca* (771.51), *Salvia hispanica* (479.51), for having very high amount of Fe which may be tested for blood prurification. On the other hand, the exceptional high amount of iron in the case of *Dyssodia setifolia*, containing 3540.19 could be confirmed for its possible efficacy in blood purification, hemoglobin function, blood circulation through pharmacological study.

Research on medicinal plants could follow the following steps

- Several medicinal plants are used to alleviate a disease. There is a necessity to select species of maximum use.
- Chemical analysis of the species and selection of species with high nutrient profile.
- Analysis of chemical composition (ingredients) of the selected species.
- Final selection and confirmation of the species for its efficacy.
- Analysis of the tolerance level of the selected species at the laboratory.
- Establish a germplasm bank with high nutritional values.

Conclusion

It is assessed from the present study that most of the species used traditionally to combat various diseases contain high amount of nutrients of high nutraceutical values, thereby confirming the efficacy of these medicinal species, justifying the importance of these in ethnomedicine. Based on the analysis of macro and micro nutrients the following species *Phalaris canariensis*, *Eruca sativa, Ocimum basilicum*, *Tragia ramosa*, *Mentha piperita, Mimosa malacophylla*, *Acalypha monostachya*, *Salvia hispánica*, *Tillandsia usenoides*, *Litsea glauscens*, *Tagetes lucida, Erygium heterophylla, Dyssodia setifolia, Nicotiana glauca, Ruta graveolens*, *Olea europea, Equisetum hyemale, Rosamrinus officinalis* are selected containing a majority of each of these nutrients. In our study we obtained few species with high C/N ratio having high potentialities of the production of secondary metabolites and antioxidants exhibiting as the potential lines of research in future. It is suggested that the efficacy of the species with high nutritional values in alleviating various diseases need to be confirmed in the pharmacology laboratory *via* tolerance level. It may be stated here that the high amount of nutrients reported in this study in the studied medicinal plants are rarely available in food grains and vegetables. Therefore the high nutritional values of these medicinal species could serve as enriched sources of various macro- and micronutrients for our health improvement. There is a great necessity of inter-multidisciplinary research to harness high neutraceuticals reported in the present study to improve health as well as to alleviate various diseases.

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