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Analysis of nutrient and antinutrient content of underutilized green leafy vegetables

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Abstract

Analysis of chemical composition of 13 locally available underutilized green leafy vegetables (GLV) was the objective of this study. Moisture, ash and ether extract of the greens were in the range of 73–95 g/100 g, 0.77–3.54 g/100 g and 0.2–0.9 g/100 g, respectively. Four GLV had high iron content (13.15–17.72 mg/100 g) while the rest had lower levels (2.62–9.86 mg/100 g). Calcium content varied largely between the greens ranging from 41 mg/100 g in *Polygala erioptera* to 506 mg/100 g in *Digera arvensis*, whereas phosphorous ranged from 16 to 63 mg/100 g. Ascorbic acid was higher in *Delonix elata* (295 mg/100 g) and *Polygala erioptera* (85 mg/100 g) and lower in others (3–46 mg/100 g). Thiamine was found to be less than 0.1 mg/100 g in six greens and 0.1–0.33 mg/100 g in others. Total carotene content ranged between 10 and 35 mg/100 g in all with exceptionally high amount in *Cocculus hirsutus* (67 mg/100 g) and *Delonix elata* (60 mg/100 g). β-carotene was 13–25% of total carotene in all greens. Oxalate content was below 100 mg/100 g in five greens and less than 1400 mg/100 g in the remaining GLV. Tannin content ranged between 61 and 205 mg/100 g in all GLV with the exception of *Coleus aromaticus* (15 mg/100 g) and *Delonix elata* (1330 mg/100 g).

Keywords: Micronutrient; Macronutrient; Dietary fiber; Tannins; Oxalates; Phytic acid

1. Introduction

The search for lesser-known crops, many of which are potentially valuable as human and animal food has been identified to maintain a balance between population growth and agricultural productivity, particularly in the tropical and subtropical areas of the world. In these regions, indigenous vegetables are abundant immediately after the rainy season and very scarce during the dry season. India, being blessed with a variety of natural surroundings and varying climates and seasons, has a number of edible green leafy vegetables (GLV) some of which are locally grown and utilized. GLV are rich sources of vitamins such as β-carotene, ascorbic acid, riboflavin and folic acid as well as minerals such as iron, calcium and phosphorous. GLV are also recognized for their characteristic color, flavor and therapeutic value. Some of the commonly consumed leafy vegetables are amaranth, spinach, fenugreek, coriander, etc., the nutritive value of which has been reported in the Food Composition tables (Gopalan et al., 1996). Apart from these there are various types of underutilized leafy vegetables, which are available seasonally, and practically no information is available on the nutrient content and antinutritional factors of such vegetables. Consumption of such food materials is confined to the people living in the areas where they grow. Recognizing the need for identification of such GLV, which are believed to be nutritious, may help in achieving nutritional (micronutrient) security. Gupta, Barat, Wagle, and Chawla (1989) analysed the nutrient content of few of the GLV grown in north India and found them

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to be rich sources of macro and micronutrients. Bhaskarachary, Rao, Deosthale, and Reddy (1995) have reported that some of the less familiar GLV are rich sources of β-carotene. Analysis of proximate composition of the unconventional leafy vegetables found in the forest and wetlands of Konkan region of Maharastra, India, revealed that some of the greens contained comparatively higher amounts of crude protein. In general, they contained less oxalates compared to cultivated vegetables (Shingade, Chavan, & Gupta, 1995). However, antinutritional factors viz. oxalates, tannins, dietary fiber and saponins were found in the underutilized GLV (Gupta & Wagle, 1978). A significant variation was observed in the antinutritional factors among the vegetables (Gupta et al., 1989). Bawa and Yadav (1986) reported the phytic acid content of GLV consumed by a certain section of population in Nigeria to be between 12.5 and 18.75 mg/100 g.

Looking into the prevalence of high level of micronutrient malnutrition among the vulnerable sections in the developing countries and the increasing prevalence of chronic degenerative diseases globally, the need for exploration of underutilized foods is significant to overcome the nutritional disorders. The diet and food based approach in combating micronutrient malnutrition is essential for its role in increasing the availability and consumption of micronutrient rich foods (FAO, 1997). Increasing the utilization of GLV in our diet, known to be rich sources of micronutrients as well as dietary fiber can be a food-based approach for ensuring the intake of these nutrients. It is essential that the locally available GLV, which are inexpensive and easy to cook, be used in the diets to eradicate micronutrient malnutrition and also to prevent the degenerative diseases.

Therefore, the present investigation was undertaken with the objective of exploring the lesser-known underutilized GLV grown in and around Mysore district of Karnataka state, South India (nutrient composition of which has not been reported in literature) and to analyse the chemical composition of the same.

2. Materials and methods

Thirteen GLV were selected for the study. They were identified by a taxonomist and are as follows—Adachitkana (*Trianthema portulacastrum,* Linn.), Annae (*Celosia argentea,* Linn.), Bagargunchi (*Boerhaavia diffusa*, Linn.), Balae (*Polygala erioptera*, DC.), Brahmi leaves (*Centella asiatica*, Urb.), Doddipatre (*Coleus aromaticus*, Benth.), Gurchi (*Digera arvensis*, Forsk.), Javanada (*Cocculus hirsutus*, Diels.), Kanne (*Commelina benghalensis*, Linn.), Kilkeerae (*Amaranthus tricolor*, Willd.), Naribalae (*Gynandropsis pentaphylla*, DC.), Pumpkin leaves (*Cucurbita maxima*, Duch.) and Vayunarayani (*Delonix elata*, Gamb.).

The fresh leaves were procured from the local markets or field locations. The leaves were separated from roots, washed under running water, followed by double glass-distilled water. They were drained completely and used for analysis. Double glass-distilled water was used for preparation of reagents used in the entire analysis. All chemicals used for the study were of analytical grade. Moisture was estimated by standard method. Ascorbic acid was estimated by visual titration method of reduction of 2,6-dicholorophenol-indophenol dye. Total carotene was extracted in acetone; β-carotene was separated by column chromatography and estimated colorimetrically (Ranganna, 1986). Thiamine was analysed by oxidation to thiochrome, which fluoresces in UV light (Raghuramulu, Nair, & Kalyansundaram, 1983). Total oxalate was analysed by extraction with hydrochloric acid and soluble oxalate with water followed by precipitation with calcium oxalate from deproteinized extract and subsequent titration with potassium permanganate (Baker, 1952).

The samples were dried in a hot air oven at $50 \pm 5\,°C$ for 10–12 h, finely powdered and stored in airtight containers for further analysis. The nitrogen content was estimated by Kjeldhal method, based on the assumption that plant proteins contain 16% nitrogen, protein content of the GLV was calculated using the formula, protein = nitrogen × 6.25. Ether extractives and ash (minerals) were estimated by standard methods (Ranganna, 1986). Insoluble and soluble dietary fiber was analysed by separation of non-starch polysaccharides by enzymatic gravimetric method (Asp, Johansson, Hallmer, & Siljestrom, 1983). Tannins were extracted in methanol and read colorimetrically by using vanillin-hydrochloride method (Burns, 1971). Phytic acid was extracted and determined according to the precipitate analysis method of Thompson and Erdman (1982). The conversion factor 3.55 for phosphorus to phytic acid was used.

The samples were ashed in a muffle furnace and ash solution was prepared by dry ashing. Total iron and phosphorous were estimated colorimetrically by α-α-dipyridyl method (AOAC, 1965) and Taussky and Shorr (1953), respectively. Calcium was analysed by precipitation as calcium oxalate and subsequent titration by potassium permanganate (Oser, 1965). Samples for determination of mineral contents were digested using nitric/sulphuric acid mixtures and diluted to a known volume (Ranganna, 1986). The samples were analysed for sodium, potassium, magnesium, zinc, copper, chromium and manganese using flame atomic absorption spectrophotometer. Instrument parameters such as resonant wavelength, slit width and air–acetylene flow rate that are appropriate for each element was selected. The instrument was calibrated against a range of working standards of each element. Test solution was aspirated and the concentration of the element determined. The entire analysis was carried out in four replicates and the average values are reported on as-is basis.

Statistical analysis: The data was analysed statistically using analysis of variance with 5% level of significance using the statistical software Minitab 11.32.

3. Results and discussion

The edible portion, moisture, protein and ether extract of the GLV studied are reported in Table 1. The edible portion of the GLV was in the range of 37–81 g/100 g fresh vegetable. Moisture content of the analysed samples ranged between 73.0 and 95.3 g/100 g, with the highest being in *Coleus aromaticus* (95.3 g/100 g). *Delonix elata* had the lowest moisture content of 73 g/100 g while the rest of the greens had moisture content of about 85 g/100 g. *Delonix elata* and *Digera arvensis* had a high protein content of 7.1 and 4.3 g/100 g respectively. Similar values have been reported for the protein content of some tropical leafy vegetables of Nigeria (Aletor & Adeogun, 1995). *Trianthema portulacastrum*, *Polygala erioptera*, *Commelina benghalensis*, *Boerhaavia diffusa* and *Centella asiatica* had a protein content in the range of 2–3 g/100 g while *Celosia argentea*, *Cocculus hirsutus*, *Amaranthus tricolor*, *Gynandropsis pentaphylla* and *Cucurbita maxima* were in the range of 3–4 g/100 g. Gopalan et al. (1996) have reported similar values for the protein content of conventional GLV. *Coleus aromaticus* was found to have a low protein content of 0.6 g/100 g. All the leafy vegetables were found to be poor sources of fat, which ranged between 0.2 and 0.9 g/100 g. The maximum amount of ether-extracted fat was observed in *Delonix elata* while the rest of the GLV contained less than 0.75 g/100 g fat. The variations in the moisture, protein and fat content of the greens were found to be statistically significant ($P \leqslant 0.001$). Variations in the chemical constituents may be due to species differences and different agro-climatic conditions. The variation may also be due to different age and stage of the plants.

The ash content of all GLV was high except for *Polygala erioptera* (0.77 g/100 g). The rest of the under-utilized greens contained appreciable amounts of ash in comparison with the cultivated species like spinach, shepu and amaranth, etc. (Gopalan et al., 1996). In general the mineral matter ranged from 0.77 to 3.54 g/100 g (Table 2). Variations in the mineral matter among the GLV were statistically significant ($P \leqslant 0.001$). The analysed GLV were found to be rich sources of calcium. *Digera arvensis*, *Boerhaavia diffusa*, *Cucurbita maxima*, and *Amaranthus tricolor* had a high calcium content of 506, 330, 302 and 239 mg/100 g respectively. *Trianthema portulacastrum* and *Polygala erioptera* were observed to have 52 and 41 mg/100 g, respectively, while the rest of the greens had calcium content in the range of 112–188 mg/100 g. The phosphorous content was found to be in the range of 16–63 mg/100 g for all the greens and these values were similar to those reported by Gopalan et al. (1996) for the common GLV. The calcium and phosphorous content varied significantly among the greens ($P \leqslant 0.001$). Of the 13 GLV analysed, *Digera arvensis* contained the greatest amount of potassium (604 mg/100 g) and *Polygala erioptera* the least amount (125 mg/100 g). *Coleus aromaticus* also contained low amounts of potassium (138 mg/100 g). The rest had potassium contents in the range of 317–476 mg/100 g. These values are similar to those reported by Gopalan et al. (1996) in common GLV and Herzog, Farah, and Amadao (1993) in wild leafy vegetables. No significant differences were found in

Table 1
Edible portion, moisture, protein and ether extract of green leafy vegetables—g/100 g fresh vegetable[a]

Green leafy vegetable	Edible portion	Moisture	Protein	Ether extract
Trianthema portulacastrum	49	90.0	2.5	0.33
Celosia argentea	55	87.6	3.2	0.34
Polygala erioptera	64	83.6	2.2	0.75
Boerhaavia diffusa	62	82.1	3.0	0.46
Centella asiatica	45	84.6	2.4	0.45
Coleus aromaticus	81	95.3	0.6	0.16
Digera arvensis	56	83.8	4.3	0.30
Cocculus hirsutus	37	76.5	3.9	0.63
Commelina benghalensis	60	89.1	2.4	0.35
Amaranthus tricolor	46	86.0	3.4	0.45
Gynandropsis pentaphylla	46	88.8	3.6	0.45
Cucurbita maxima	74	85.0	4.1	0.53
Delonix elata	56	73.0	7.1	0.90
F ratio		14.78***	39.54***	210.44***

***Significant at $P \leqslant 0.001$.
[a]Values expressed are means of 4 replicates.

Table 2
Mineral content of green leafy vegetables per 100 g fresh vegetable[a]

Green leafy vegetable	Ash (g)	Ca (mg)	P (mg)	K (mg)	Na (mg)	Mg (mg)
Trianthema portulacastrum	2.29	52	22	317	16.0	153
Celosia argentea	2.65	188	35	476	240.6	233
Polygala erioptera	0.77	41	43	125	9.8	57
Boerhaavia diffusa	2.91	330	27	381	—	167
Centella asiatica	2.06	174	17	345	107.8	87
Coleus aromaticus	1.06	158	16	138	4.7	88
Digera arvensis	3.54	506	63	604	—	232
Cocculus hirsutus	1.44	126	18	343	9.4	35
Commelina benghalensis	1.85	113	19	473	20.7	77
Amaranthus tricolor	2.51	239	33	433	84.0	253
Gynandropsis pentaphylla	1.80	151	38	360	15.7	77
Cucurbita maxima	3.04	302	34	368	12.0	150
Delonix elata	1.36	112	29	365	10.8	59
F ratio	265.56[***]	162.07[***]	47.52[***]	0.70[ns]	251.22[***]	52.45[***]

[***]Significant at $P \leqslant 0.001$; ns, not significant.
[a]Values expressed are means of 4 replicates.

potassium content of the analysed GLV ($P \geqslant 0.05$). Among the GLV, eight of them has sodium content in the range of 4.7–20.7 mg/100 g. *Celosia argentea* had a maximum amount of sodium (240.6 mg/100 g) and *Centella asiatica* had 107.8 mg/100 g on fresh weight basis. Achinewhu, Ogbonna, and Hart (1995) have reported similar values for sodium in the indigenous herbs and leaves of Nigeria. The levels of magnesium in the samples ranged between 35 mg/100 g in *Cocculus hirsutus* to 253 mg/100 g in *Amaranthus tricolor*. These levels are comparable to those present in common GLV consumed in India (Gopalan et al., 1996). Statistically significant differences were found in the sodium and magnesium content of the analysed GLV ($P \leqslant 0.001$).

A large number of elements are required in trace amounts for a wide range of functions in the body. The essentiality of some of the trace elements for humans are well established, viz. iron, zinc, copper, chromium, manganese, etc. The iron content of the GLV analysed varied considerably ($P \leqslant 0.01$). *Coleus aromaticus* had a low iron content of 2.62 mg/100 g. Four greens, *Celosia argentea*, *Centella asiatica*, *Amaranthus tricolor* and *Digera arvensis*, were found to have exceptionally high iron content of 13.15, 14.86, 15.01 and 17.72 mg/100 g respectively (Table 3). The rest varied from 4.16 to 9.86 mg/100 g. By including these iron rich GLV in the diet, 40–50% of the daily requirements of iron from one serving can be easily fulfilled. At 0.97 mg/100 g, *Centella asiatica* had the highest zinc content, followed by *Delonix elata* at 0.76 mg/100 g. The remaining GLV contained zinc levels in the 0.33–0.68 mg/100 g range. Regular consumption of these vegetables may assist in preventing the adverse effects of zinc deficiency such as growth retardation.

Delonix elata, *Centella asiatica*, *Boerhaavia diffusa* and *Cocculus hirsutus* had high amounts of copper, 0.27, 0.24, 0.22 and 0.22 mg/100 g, respectively. *Commelina benghalensis* and *Amaranthus tricolor* had the least copper content of 0.09 mg/100 g. The rest of the greens contained copper in the range of 0.12–0.19 mg/100 g. *Digera arvensis* and *Trianthema posrtulacastrum* contained the maximum amounts of chromium (0.243 and 0.200 mg/100 g respectively) followed by *Celosia argentea* (0.153 mg/100 g), *Amaranthus tricolor* (0.140 mg/100 g) and *Commelina benghalensis* (0.115 mg/100 g). The remainder of the plants contained chromium levels in the 0.022–0.078 mg/100 g range. These GLV would provide good amounts of chromium to the diets. Manganese content was below the detection limit in eight of the thirteen GLV analysed. *Commelina benghalensis* had the least manganese content of 0.08 mg/100 g and *Trianthema portulacastrum* had the maximum content (0.43 mg/100 g). The manganese content of the analysed greens was similar to that of common GLV reported in literature (Gopalan et al., 1996), whereas it was higher in some of the non-conventional GLV consumed by the rural populace of Nigeria (Barminas, Charles, & Emmanuel, 1998). Statistically significant differences were found in the zinc, copper, chromium and manganese content of the greens ($P \leqslant 0.001$). The variation in the mineral constituents of plants can be attributed to the stage of maturity of the plant, conditions of growth, fertilization and the nature of the soil.

Large variations were found in the ascorbic acid content of the underutilized GLV ($P < 0.001$). *Polygala erioptera* and *Delonix elata* were found to be rich sources of ascorbic acid, having 85 and 295 mg/100 g, respectively (Table 4). The remaining had ascorbic acid in the range of 11–49 mg/100 g with the exception of *Coleus aromaticus*, which was found to have 3 mg/100 g. *Delonix elata* was found to contain maximum amount of

Table 3
Trace mineral content of green leafy vegetables—mg/100 g fresh vegetable[a]

Green leafy vegetable	Iron	Zinc	Copper	Chromium	Manganese
Trianthema portulacastrum	4.16	0.46	0.12	0.200	0.43
Celosia argentea	13.15	0.49	0.15	0.153	0.27
Polygala erioptera	4.76	0.68	0.15	0.029	0.18
Boerhaavia diffusa	7.83	0.44	0.22	0.040	—
Centella asiatica	14.86	0.97	0.24	0.046	—
Coleus aromaticus	2.62	0.33	0.12	0.022	—
Digera arvensis	17.72	0.57	0.16	0.243	0.23
Cocculus hirsutus	9.86	0.55	0.22	0.059	—
Commelina benghalensis	7.11	0.63	0.09	0.115	0.08
Amaranthus tricolor	15.01	0.60	0.09	0.140	—
Gynandropsis pentaphylla	4.84	0.57	0.13	0.078	—
Cucurbita maxima	4.38	0.62	0.19	0.049	—
Delonix elata	6.20	0.76	0.27	0.068	—
F ratio	5.36**	45.99***	116.71***	94.17***	83.25***

**Significant at $P \leqslant 0.01$; ***Significant at $P \leqslant 0.001$.
[a]Values expressed are means of 4 replicates.

Table 4
Vitamin content of green leafy vegetables—mg/100 g fresh vegetable[a]

Green leafy vegetable	Ascorbic acid	Thiamine	Total carotene	β-carotene
Trianthema portulacastrum	22	0.10	21.37	4.00
Celosia argentea	26	0.09	25.05	4.42
Polygala erioptera	85	0.14	21.61	3.83
Boerhaavia diffusa	16	0.09	32.02	6.73
Centella asiatica	11	0.04	25.93	3.90
Coleus aromaticus	3	0.08	10.38	1.50
Digera arvensis	49	0.10	17.93	3.36
Cocculus hirsutus	28	0.19	66.67	9.20
Commelina benghalensis	46	0.04	25.56	3.81
Amaranthus tricolor	39	0.07	35.17	5.41
Gynandropsis pentaphylla	42	0.16	21.86	5.38
Cucurbita maxima	37	0.20	22.37	2.27
Delonix elata	295	0.33	59.92	10.51
F ratio	11.83***	8.76***	12.6***	5.16**

**Significant at $P \leqslant 0.01$; ***Significant at $P \leqslant 0.001$.
[a]Values expressed are means of 4 replicates.

thiamine (0.33 mg/100 g). *Celosia argentea*, *Commelina benghalensis*, *Boerhaavia diffusa*, *Centella asiatica*, *Coleus aromaticus* and *Amaranthus tricolor* had less than 0.1 mg/100 g of thiamine whereas in rest of the greens the thiamine content varied from 0.1 to 0.2 mg/100 g on fresh weight basis. Raghuvanshi, Singh, and Singh (2001) have reported similar values for thiamine content in uncommon foods. Statistically significant differences were found in the thiamine content among the analysed greens ($P \leqslant 0.001$).

GLV are good sources of total carotene and β-carotene. β-carotene is a precursor for vitamin A. Large variations were found in the total carotene content of the analysed GLV. *Coleus aromaticus* and *Digera arvensis* were found to have a total carotene content of 10.38 and 17.93 mg/100 g, respectively. *Delonix elata* and *Cocculus hirsutus* had a higher total carotene content of 59.92 and 66.67 mg/100 g, respectively. Nambiar and Seshadri (1998) have reported total carotene content of 16 common leafy vegetables to be less than 20 mg/100 g. The total carotene content of the greens analysed in the present study was found to be in the range of 21.37–35.16 mg/100 g indicating that the underutilized GLV are rich sources of total carotene. The β-carotene content varied from 1.50 to 10.51 mg/100 g among the GLV. β-carotene as percent of total carotene ranged between 13% and 25% with *Cucurbita maxima* having the least percentage and *Gynandropsis pentaphylla* having the highest. Among the greens that were analysed, β-carotene content of seven of them

Table 5
Oxalate, tannin, dietary fiber and phytic acid content of green leafy vegetables—per 100 g fresh vegetable[a]

Green leafy vegetable	Total oxalates (mg)	Soluble oxalates (mg)	Tannins (mg)	Insoluble dietary fiber (g)	Soluble dietary fiber (g)	Phytic acid (mg)
Trianthema portulacastrum	1080	610	61	2.57	0.42	2.02
Celosia argentea	920	580	113	3.71	1.39	2.95
Polygala erioptera	60	10	98	5.39	1.18	3.38
Boerhaavia diffusa	1250	420	94	6.23	1.04	4.08
Centella asiatica	60	20	132	5.43	0.49	2.13
Coleus aromaticus	50	20	15	1.56	0.31	0.92
Digera arvensis	1410	570	79	3.75	0.65	2.49
Cocculus hirsutus	230	40	205	10.45	0.63	4.40
Commelina benghalensis	390	140	105	5.10	0.29	2.38
Amaranthus tricolor	1270	690	106	3.47	1.33	1.95
Gynandropsis pentaphylla	20	10	136	3.26	0.07	13.06
Cucurbita maxima	200	70	157	5.29	0.55	9.23
Delonix elata	90	30	1330	8.16	0.64	5.11
F ratio	33.9***	15.0***	64.55***	313.42***	9.01***	28.281***

***Significant at $P \leqslant 0.001$.
[a]Values expressed are means of 4 replicates.

consumed by the tribals of Andhra Pradesh, India reported by Rajyalakshmi et al. (2001) were found to be similar. Statistically significant differences were found in the total carotene ($P \leqslant 0.001$) and β-carotene ($P \leqslant 0.01$) content of the analysed GLV.

Oxalic acid is one of the antinutritional factors, which are widely distributed in plant foods. Oxalic acid is known to interfere with calcium absorption by forming insoluble salts of calcium. *Digera arvensis*, *Amaranthus tricolor*, *Boerhaavia diffusa*, *Trianthema portulacastrum* and *Celosia argentea* were found to have high total oxalate values of 1410, 1270, 1250, 1080 and 920 mg/100 g, respectively (Table 5). The rest of the greens had lower total oxalate content, which was found to be in the range of 20–390 mg/100 g. Oxalic acid values of some of the unconventional leafy vegetables from the Konkan area of Maharashtra, India were also found to be in the same range (Shingade et al., 1995). Soluble oxalates varied from 10 to 690 mg/100 g in the analysed GLV. Statistically significant differences were found in the total and soluble oxalate content among the GLV ($P \leqslant 0.001$). The tannin content of the GLV varied largely ($P \leqslant 0.001$). The tannin values ranged between 61 and 205 mg/100 g with the exception of *Coleus aromaticus* (15 mg/100 g) and *Delonix elata* (1330 mg/100 g). Not much work has been reported on the tannin content of the GLV. The insoluble dietary fiber (IDF) in the GLV was found to be in the range of 1.56–6.23g/100g except for *Cocculus hirsutus* and *Delonix elata* wherein it was found to be 10.45 and 8.16 g/100g, respectively. *Gynandropsis pentaphylla* had a soluble dietary fiber (SDF) content of 0.07 g/100g while in the rest of the greens it varied from 0.29 to 1.39 g/100g. Significant differences were found in the IDF and SDF content among the GLV ($P < 0.001$). The total dietary fiber, which is calculated as the sum of IDF and SDF ranged between 2.99 and 7.27 g/100 g except for *Coleus aromaticus* that had a low dietary fiber content of 1.87 g/100g and *Delonix elata* and *Cocculus hirsutus* which had high dietary fiber content of 8.80 and 11.08 g/100 g, respectively. These GLV were found to have a higher dietary fiber content when compared to the conventional GLV where in the dietary fiber varied from 4.0 to 4.9 g/100 g (Khanum, Siddalingaswamy, Sudarshanakrishna, Santhanam, & Vishwanathan, 2000). Phytate is hexaphosphate of inositol and binds iron, zinc, calcium and magnesium rendering them unavailable (Raghuvanshi et al., 2001). The phytic acid content of the analysed GLV was found to be in the range of 0.92–13.06 mg/100 g fresh vegetable. These values are considerably lower than those reported by other workers in non-conventional vegetables (Gupta et al., 1989; Aletor & Adeogun, 1995; Raghuvanshi et al., 2001) indicating that the lower phytic acid content in the analysed vegetables will provide a better bioavailability of minerals. Statistically significant differences were found in the phytic acid content of the analysed vegetables ($P \leqslant 0.001$).

The nutrient composition of underutilized GLV revealed them to be good sources of many nutrients like iron, calcium, ascorbic acid and β-carotene that could help in overcoming micronutrient malnutrition at a negligible cost. They also had a high fiber content and hence would also serve as a natural source of fiber. This investigation can serve as a basis for selecting promising species for further, more detailed, multi-year, multi-plot studies on GLV to meet the nutritional requirements.

Because of their high nutrient content, greens can be recommended to alleviate micronutrient malnutrition in developing countries. Cultivation of these GLV could be taken up to augment total food supplies also.

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