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NUTRITIONAL STATUS OF SOME SELECTED INDIGENOUS LEAFY VEGETABLES OF ASSAM, INDIA

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Abstract

The study aimed to assess the nutritional status of 14 types of indigenous leafy vegetables, namely *Houttuynia cordata, Paederia foetida, Alternanthera sessilis, Amaranthus viridis*, *Eryngium foetidum, Bacopa monnieri, Polygonum chinense, Hydrocotyl rotundifolia, Talinum triangularae, Tetrastigma leucostaphylum, Pogostemon heyneanus, Celosia argentea, Glebionis coronaria* and *Peperomia pellucida.* All the indigenous leafy vegetables contained high amount of moisture, which ranged from 79.38 to 92.80%. The vitamin C content ranged from 41.86 to 537.24 mg/100 g, vitamin A from 35.87 to 8685 IU and protein content was found in between 1.25 to 8.63 g/100 g. Among the species, total phenol content ranged from 32.30 to 259.10 mg/100 g, total flavonoid from 138.20 to 288.90 mg/100 g, IC_{50} value for scavenging DPPH radicals from 24.06 to 214.56 µg/ml and alkaloid content from 0.16 to 3.18%. Leafy vegetable also possess good amount of minerals which ranged from 173.17 to 2109 mg/100g of calcium, 27.48 to 396.17 mg/100g of iron, 141.62 to 4037.00 mg/100 g of magnesium and total chlorophyll from 1.02 to 2.49 mg/100g fresh weight. The result of the study revealed that the indigenous leafy vegetables such as *A. viridis, P. foetida, T. leucostaphylum* and *A. sessilis* were found to be superior in terms of nutritional attributes with good antioxidant properties.

Introduction

Indigenous or traditional vegetables are important for the sustainability of economics, human nutrition and health and social systems. Indigenous leafy vegetables tend to be nutritious, well adapted to the specific area and are able to grow in extreme conditions and sometimes even consider as weeds in agricultural field. These are the sources of nutrients that can be found in their leaves, seed, berries, fruit, roots, tubers, stems and rhizomes. In many regions of the world, rural tribal communities rely on wild plants to meet their nutritional needs and they play crucial role in their food security. These plants have also become an essential component of their traditional and cultural life (Choudhury *et al*. 2018).

Indigenous leafy vegetables have a better nutritional value compared to the other known vegetables but the potential of these vegetables are not yet explored commercially. Although underutilized vegetables have a huge potential to improve livelihoods, dietary security and environmental sustainability but commercial study and cultivation of these crops is currently quite limited (Barooah *et al*. 2023). The underutilized vegetables are rich in protective elements and important source of photochemical required for treatment of various diseases and other age related diseases (Vanpoppei *et al*. 1994). It also contains antibacterial, hepatoprotective and anti-carcinogenic properties (Heywood1999). Thus, the present study was undertaken to make aware about nutritional status of some selected indigenous leafy vegetables for their sustainable utilization and their potential to improve socio-economic status of rural and urban communities.

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Materials and Methods

Indigenous leafy vegetables namely *Houttuynia cordata* (Masundari), *Paederia foetida* (Bhedailata), *Alternanthera sessilis* (Matikanduri), *Amaranthus viridis* (Khutura), *Eryngium foetidum* (Mandhania), *Bacopa monnieri* (Brahmi), *Polygonum chinense* (Madhuhuleng), *Hydrocotyl rotundifolia* (Saru manimuni), *Talinum triangularae* (Pirali paleng), *Tetrastigma leucostaphylum* (Nol tenga), *Pogostemon heyneanus* (Xukloti), *Celosia argentea* (Laheti sak), *Glebionis coronaria* (Babori sak) and *Peperomia pellucida* (Ponounuwa) were collected from the local area of Biswanath Chariali, Assam, India. Young and actively grown matured green leaves of each species were collected for biochemical analysis. Then, leaves were washed, cleaned and dried in the laboratory.

The area is situated at 26°30'N and 27°01'N latitude and 92°16'E and 93°43'E longitudes having an elevation of 86.70 m above mean sea level. The topography of the location is uniformly plain and is characterized by sub-tropical climate having hot and humid summer, dry and cool winter.

Moisture content was estimated by adopting the standard method of AOAC (1980) and total protein content was determined as per Lowry's method (Saini *et al.* 2012). Ascorbic acid was estimated by the visual titration method using 2, 6 dichlorophenol indophenol dye (Rangana 2011) and Vitamin A was estimated spectrophotometrically (Srivastava and Kumar 2017).

The wet ashing method (Saini *et al.* 2012) was used to determine the amounts of calcium, magnesium and iron present in indigenous leafy vegetables. Available potassium was estimated from triacid digested material using a flame photometer as described by Jackson (1973). The total chlorophyll content of mature fresh leaf was determined by non destructive method (Srivastava and Prasad 2010). Total phenolics was estimated using Folin- Ciocalteu reagent and total flavonoids contents of the sample was determined by aluminum chloride colorimetric method using quercetin for standard calibration curve (Kamtekar *et al*. 2014). Total alkaloids content was determined by titrimetric method (Debnath *et al*. 2015).The modified Brand-Williams *et al*. (1995) method was followed for determining the DPPH radical scavenging activity of sample extracts.

Statistical analysis of the result was carried out using the Microsoft Excel 2010 to compare between treatments means. Differences were considered significant when the p-value was less than 0.05 ($p<0.05$).

Results and Discussion

Significant variation in moisture contents was observed among the fourteen indigenous leafy vegetables (Table 1). All the vegetables had high moisture content ranged from 79.38 to 92.80%. Out of fourteen plant species, *P. pelluciada* had the highest (92.80 %) moisture content which was at par with *T. triangulare* (91.79%). Similarly, leaves of *H. rotundifolia*, *P. chinense* and *G. coronaria* also had sufficient moisture contents of 89.33, 90.82 and 90.90%, respectively while *P. foetida* had the lowest moisture content. The variation in moisture content of selected indigenous leafy vegetables might be due to their succulent nature and some of them are hardy type in nature, which showed low level of moisture.

Protein content of the leafy vegetable ranged from 1.15 to 8.63 g/100g. The highest protein content (8.63 g/100 g) was found in *P. pelluciada* followed by *T. triangulare* (4.80 g/100 g) while the lowest (1.15 g/100 g) was observed in *E. foetidum*. Different plant species possess protein as per their natural existence and there was no influence of any treatment. Variation may be due to cultivation practices and environment of the location. The present findings of the study were similar with the results of Mensah *et al*. (2008) and Natesh *et al.* (2017).

Table 1. Proximate composition and vitamin contents of indigenous leafy vegetables.

Sl. No.	Species	Moisture (%)	Protein (g/100 g)	Ascorbic acid (mg/100 g)	Vitamin A (IU)
1	*Houttuynia cordata* Thunb.	87.67	2.77	71.57	4975.00
2	*Talinum triangularae* Jacq.	91.79	4.80	276.63	5740.00
3	*Paederia foetida* L.	79.38	1.67	277.15	217.10
4	*Tetrastigma leucostaphylum* Dennst.	88.91	2.88	382.66	6825.00
5	*Amaranthus viridis* L.	88.81	3.09	719.82	7223.00
6	*Hydrocotyl rotundifolia* Roxb.	89.33	1.84	163.70	528.60
7	*Alternanthera sessilis* L.	82.92	2.16	537.24	8685.00
8	*Polygonum chinense* L.	90.82	3.49	348.27	3663.00
9	*Pogostemon heyneanus* Benth.	88.54	1.48	285.26	6334.00
10	*Celosia argentea* L.	86.73	1.56	105.28	2803.00
11	*Eryngium foetidum* L.	86.60	1.15	41.86	4002.60
12	*Bacopa monnieri* L.	83.75	1.78	43.65	35.87
13	*Glebionis coronaria* L.	90.90	2.57	123.53	2964.00
14	*Peperomia pellucida* Kunth.	92.80	8.63	206.76	3200.00
	Mean	**87.78**	**2.84**	**255.95**	**4085.44**
	CD (P=0.05)	**2.53**	**0.22**	**5.67**	**74.20**

The result showed variation in ascorbic acid level among the leafy vegetables (Table 1). The amount of ascorbic acid varied from 41.86 to 719.82 mg/100 g. The maximum ascorbic acid (719.82 mg/100 g) was obtained in *A. viridis* followed by *A. sessilis* and lowest in *E. foetidum*. All the leafy vegetable possessed ascorbic acid in higher amount except a few. The ascorbic acid content depends on many factors, such as cultivation, plant age, soil type and indoor/ outdoor cultivation. Similarly, variation was noticed in vitamin A content among the leafy vegetables. The level of vitamin A was found in between 35.87 to 8685.00 IU with highest (8685.00IU) in *A. sessilis* followed by *A. viridis*. This variation might be due to distinct plant species and the difference could be related to the area of production that can influence the composition of nutrient.

Results demonstrated the presence of significant amount of calcium, magnesium and iron in all the leafy vegetables (Table 2). Among the leafy vegetables, *P. foetida* showed the highest calcium (2109 mg/100 g), magnesium (4037 mg/100 g) content followed by *H. rotundifolia.* The amount of iron present in selected indigenous leafy vegetables ranged from 27.48 to 396.17 mg/100 g. It was found that *A. viridis* had maximum iron content of 396.17 mg/100 g, whereas *C. argentea* had the lowest amount of calcium and magnesium and iron. Simsek *et al*. (2017) also reported similar observation. The mineral present naturally in different plant showed variation among the plant species.

The data presented in Table 2 showed the level of potassium content in different leafy vegetable and significant variation was noticed. Among the vegetables, *T. triangularae* had higher potassium content of 8958.36 mg/100 g followed by *T. leucostaphylum*, while *P. foetida* exhibited lowest potassium content. Leafy vegetables contain minerals like calcium, magnesium, potassium, and iron and they all absorb from the soil together with water. Therefore, there are every possibilities of variation in their proportion depending on the plant characteristics which exhibited different levels of mineral content.

Total chlorophyll content of fresh indigenous leafy vegetables showed variation. Among the vegetable, the total leaf chlorophyll contents ranged from 1.02 to 2.49 mg/g fresh weight. *H. cordata* recorded the highest (2.49 mg/g fw) total chlorophyll content which was at par with *P. heyneanus* and minimum total chlorophyll content (1.02 mg/g fw) was observed in *B. monnieri*. The higher chlorophyll content in the present study might be due to the leaf character of the different plant species or better light distribution in the crop canopy.

Table 2. Mineral composition and total chlorophyll content of indigenous leafy vegetables.

Sl. No.	Species	Calcium (mg/100g)	Magnesium (mg/100g)	Potassium (mg/100g)	Iron (mg/100g)	Total Chl (mg/g fw)
1	*Houttuynia cordata* Thunb.	1040.38	520.02	3490.42	89.76	2.49
2	*Talinum triangularae* Jacq.	454.76	622.51	8958.36	55.21	2.15
3	*Paederia foetida* L.	2109.00	4037.00	871.25	46.28	2.17
4	*Tetrastigma leucostaphylum* Dennst.	452.02	803.05	7710.19	87.34	1.77
5	*Amaranthus viridis* L.	1282.53	1553.14	3750.08	396.17	1.60
6	*Hydrocotyl rotundifolia* Roxb.	1492.60	1637.50	3934.17	74.00	1.14
7	*Alternanthera sessilis* L.	748.20	298.73	6401.26	137.66	1.07
8	*Polygonum chinense* L.	1213.62	1385.10	3410.32	46.23	1.64
9	*Pogostemon heyneanus* Benth.	280.13	910.70	4056.51	124.77	2.46
10	*Celosia argentea* L.	173.17	141.62	3920.35	27.48	1.76
11	*Eryngium foetidum* L.	770.05	680.06	6765.11	52.74	2.28
12	*Bacopa monnieri* L.	201.58	466.21	1120.09	49.82	1.02
13	*Glebionis coronaria* L.	806.34	992.41	5024.30	228.65	2.35
14	*Peperomia pellucida* Kunth.	563.08	635.92	6988.24	139.31	2.02
	Mean	**827.67**	**1048.85**	**4742.90**	**111.10**	**1.85**
	CD (P=0.05)	**16.69**	**9.76**	**8.92**	**7.17**	**0.23**

All the leafy vegetables demonstrated a high quantity of total phenolic content and it varied from 32.30 to 259.10 mg/100 g (Table 3). The higher amount of total phenolic was found in *T. leucostaphylum*. The results showed the highest (288.90 mg/100 g) total flavanoids in *P. foetida*, whereas *T. triangulare* had lowest (138.20 mg/100 g) amount of total flavanoids. Matenge *et al.* (2017) observed similar findings in leafy vegetable with that of present study. The differences in phenolic and flavonoid content may be due to several factors such as biological and genetic diversity and environmental, soil, seasonal and year to year variation causes photochemical to vary (Kumar and Roy 2018).

The anti nutritional constituents such as alkaloids showed the variation in the levels among the fourteen indigenous leafy vegetables. Maximum alkaloids content was observed in fresh *C. argentea* and *H. rotundifolia* (3.18 % and 3.11 %), respectively, while *P. chinense* showed the lowest alkaloid content. The results of the present findings were in consistent with those reported by Szakiel *et al.* (2011) and Odufuwa *et al*. (2013). This may be attributed due to environmental factors and genetic constituents of the plants.

The result indicated that antioxidant activities of the plant species ranged from 24.06 to 214.56 µg/ml. The quality of the antioxidants in the extracts was determined by the IC_{50} values, denoting the concentration of the sample required to scavenge 50% of the DPPH free radicals. A lower IC_{50} value indicated a higher antioxidant of the plant species. Amongst the fourteen plant species, highest antioxidant activity (IC_{50} 24.06 µg/ml) was found in methanolic extracts of *A.*

sessilis whereas *E. foetidum* exhibited lowest antioxidant activity (IC_{50} 214.56 µg/ml). The difference in antioxidant activity of leafy vegetables could be due to the presence of higher amount of vitamin A and vitamin C or total phenolic and flavonoid content. Different agricultural practices such as the use of fertilizers, irrigation methods and pest and disease control measures, may also influence the antioxidant content of leafy vegetables.

Table 3. Phyto-chemicals and antioxidant activity of indigenous leafy vegetables.

Sl. No.	Species	Total phenol (mg/100g)	Total flavonoids (mg/100g)	Total alkaloids (%)	Antioxidant activity (%) [IC_{50} (µg/ml)]
1	*Houttuynia cordata* Thunb.	116.30	149.40	0.44	32.40
2	*Talinum triangularae* Jacq.	46.50	138.20	0.34	102.30
3	*Paederia foetida* L.	111.70	288.90	2.07	34.32
4	*Tetrastigma leucostaphylum* Dennst.	259.10	180.60	0.86	60.64
5	*Amaranthus viridis* L.	135.50	139.50	2.82	28.56
6	*Hydrocotyl rotundifolia* Roxb.	49.20	221.80	3.11	29.59
7	*Alternanthera sessilis* L.	130.40	224.60	1.47	24.06
8	*Polygonum chinense* L.	53.60	178.30	0.16	64.21
9	*Pogostemon heyneanus* Benth.	94.70	141.80	2.25	74.55
10	*Celosia argentea* L.	214.80	153.60	3.18	208.41
11	*Eryngium foetidum* L.	32.30	170.10	3.08	214.56
12	*Bacopa monnieri* L.	217.50	192.70	2.31	103.95
13	*Glebionis coronaria* L.	112.80	177.90	1.19	143.72
14	*Peperomia pellucida* Kunth.	109.10	146.20	0.42	112.53
	Mean	**120.25**	**178.82**	**2.84**	**88.13**
	CD (P=0.05)	**14.75**	**15.81**	**0.41**	**6.77**

It can be concluded from the study that all the selected indigenous leafy vegetables have good sources of vitamins, minerals and compound with antioxidant properties. These indigenous leafy vegetables offer sufficient nutritional potential for ensuring nutritional and food security of the rural people, as source of income and for maintenance ecological balance these indigenous leafy vegetables need to be conserved.

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