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Nutritional analysis of some selected wild edible plants consumed by the tribal people of Meghalaya state in India

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Abstract

The nutritional potential of five wild leafy vegetables e.g. *Gnetum gnemon, Prenanthes hookeri, Smilax perfoliata*, *Blumea lanceolaria and Pilea melastomoides* collected from Meghalaya state in India, were evaluated by determining their proximate and minerals composition. These wild edible plants form an important constituent of traditional diets in the Meghalaya. The present study revealed that for different plant species, the crude fat content ranged between 0.94±0.03 - 5.25±0.05 %. The crude protein content was determined high in the leaves of *P. hookeri* (21.62±0.07%), *G. gnemon* (21.49±0.02%) and *P. melastomoides* (18.69±0.03 %) while the available carbohydrate content was highest in the leaves of *S. perfoliata* (73.49±0.03 %). The energy content ranged from 308.44±0.19 - 397.38±0.49 kcal/100g in the various wild edible plants. Among the various macronutrients estimated in the samples of plants under study, potassium was present in the highest quantity (15.63±0.23- 47.31±0.25 mg/g) followed by calcium (12.52±0.04-28.16±0.04 mg/g) and sodium (0.30±0.002-0.42±0.005 mg/g). The micronutrients, such as iron, zinc, copper, manganese and magnesium were analyzed. The result indicates that nutritional values and mineral contents of these plants under investigation were richer than that of the commercial vegetables and could be used for nutritional purpose. The present study also gives an account of ethnobotanical significance of the wild plants under investigation.

Keywords: wild edible plants, Meghalaya, nutritional composition, mineral contents

1. Introduction

Food situation is a major problem in most developing tropical countries due to the rapid growth of population, shortage of land for cultivation, high prices of available staples and restrictions on the importation of food. This has resulted in a high incidence of starvation and peoples are suffering from malnutrition. The poor people frequently collect wild edible plants for food and other plants from natural habitats to meet their subsistence needs. Different biochemical methods have been developed to cultivate some desired plant species in large scale in the garden and fields to meet the caloric requirements of human being. It has also been reported in current studies that cultivated plants with high chemical inputs such as fertilizers, plant growth regulator, herbicides etc, has lost their natural taste, appearance and nutritive values [1]. Recently a lot of interest is currently being focused to evaluate various wild edible plants for their nutritional features. Meghalya is a small state in north-eastern India. It comprises of South Garo hills, West Garo hills, East Garo hills, West Khasi hills, East Khasi hills, Ribhoi and Jaintia Hills districts [2]. The forests of Meghalaya are notable for their biodiversity of mammals, birds, and plants [3]. A large part of the region is botanically under-explored or even unexplored. The local inhabitants manage to survive on limited agriculture and local products of plant and animal origin. The area is, thus, very interesting ethnobotanically [4].

The forests of Meghalaya provide a large number of plants whose fruits, seeds, tubers, shoots etc make an important contribution to the diet of the tribal people. These wild plants serve as an indispensable constituent of human diet supplying the body with minerals, vitamins and certain hormone precursors, in addition to protein and energy [5]. These plants also provide some useful products like medicine, fibre, fodder, dyes etc [3]. The study of wild edible plants is important to identify the potential sources which could be utilized as alternative food.

The present study explores the nutritional status of five wild plants viz. *Gnetum gnemon, Prenanthes hookeri, Smilax perfoliata*, *Blumea lanceolaria and Pilea melastomoides* reportedly consumed by the tribal people of Meghalaya state. The main target of our research was to find out the nutritional potential of these wild edible plants. The traditional use and ethnobotanical importance of these plants has also been mentioned.

Gnetum gnemon L. known as 'Pelh' in Mizoram belongs to the family Gnetaceae. It is native from Assam (Northeast India) and is an important agroforestry species in Southeast Asia and Melanesia. The young leaves, inflorescences and tender tips of this plant are edible and used as a vegetable in Assam, mostly by Karbi tribe. The tender leaves are eaten as vegetables by the different ethnic people in the entire NE India. *Gnetum gnemon* has been used in folk medicines for the treatments of arthritis, bronchitis and asthma [6].

Smilax perfoliata Lour. known as 'Tikoni Barua' in Assam, belonging to the family Smilacaceae is found in various parts of India and has tuberous rhizomes. The plant is also widely used in traditional cuisine by many tribes of North- east India. The various parts of this plant are reported to be used as anticancer and antidysenteric and in urinary complaints [7].

Blumea lanceolaria (Roxb.) Druce known as 'Buarze' in Mizoram belonging to the family Asteraceae has been used in traditional folklore medicine for their analgesic, antipyretic and anti-inflammatory activities. It is also useful for the treatment of ulcer by the tribal people of Mizoram [8].

Pilea melastomoides Poir belongs to the family Urticaceae. The leaves of the plant are used to cure allergies at the time of child birth [9].

2. Materials and Methods

Plant materials

The five plant materials e.g. the leaves of *G. gnemon, P. hookeri, S. perfoliata, B. lanceolaria and P. melastomoides* were collected from different places of Meghalaya State on August 2011 and authenticated in our office. The voucher specimens were preserved in the Plant Chemistry department of our office under registry no BSITS 64, BSITS 65, BSITS 66, BSITS 67 and BSITS 68, respectively. The plant parts were shed-dried, pulverized and stored in an airtight container and proximate composition and mineral contents were carried out in our laboratory.

Estimation of ash

5 g of each sample was weighed in a silica crucible and heated in muffle furnace for about 5-6 h at 500 °C. It was cooled in a desiccator and weighed. It was heated again in the furnace for half an hour, cooled and weighed. This was repeated consequently till the weight became constant (ash became white or grayish white). Weight of ash gave the ash content [10].

Estimation of moisture

2 g of each sample was taken in a flat-bottom dish and kept overnight in an air oven at 100–110°C and weighed. The loss in weight was regarded as a measure of moisture content [10].

Estimation of crude fat

2 g moisture free of each sample was extracted with petroleum ether (60-80°C) in a Soxhlet apparatus for about 6-8 h. After boiling with petrol, the residual petrol was filtered using Whatman no. 40 filter paper and the filtrate was evaporated in a pre-weighed beaker. Increase in weight of beaker gave crude fat [10].

Estimation of crude fibre

2 g of moisture and fat-free material of each sample was treated with 200 mL of 1.25 % H_2SO_4. After filtration and washing, the residue was treated with 1.25 % NaOH. It was the filtered, washed with hot water and then 1 % HNO_3 and again with hot water. The washed residue was dried in an oven at 130 °C to constant weight and cooled in a dessicator. The residue was scraped into a pre-weighed porcelain crucible, weighed, ashed at 550 °C for two hours, cooled in a dessicator and reweighed. Crude fibre content was expressed as percentage loss in weight on ignition [10].

Estimation of crude protein

The crude protein was determined using micro Kjeldahl method. 2 g of each sample compound was decomposed by digestion with concentrated sulphuric acid in the presence of a catalyst, ammonium sulphate is produced. An excess of sodium hydroxide solution was added to the diluted reaction mixture, the liberated ammonia was distilled in steam and absorbed in a measured excess of standard sulphuric acid. Titration of the residual mineral acid with standard sodium hydroxide gives the equivalent of ammonia obtained from the weight of the sample taken. From this the percentage of nitrogen in the compound can was calculated. On the basis of early determinations, the average nitrogen (N) content of proteins was found to be about 16 percent, which led to use of the calculation N x 6.25 (1/0.16 = 6.25) to convert nitrogen content into protein content [10].

Estimation of available carbohydrate

Percentage of available carbohydrate was given by: 100-(percentage of ash + percentage of fat + percentage of protein + percentage of crude fibre) [10].

Estimation of nutritive value (energy)

The three components of foods which provide energy are protein, carbohydrate and fat. One gram carbohydrate and protein yield 4 kcal energy whereas one gram fat yield 9 kcal energy. Therefore the energy content of each plant samples were determined by multiplying the values obtained for protein, fat and available carbohydrate by 4.00, 9.00 and 4.00, respectively and adding up the values [10-11].

Estimation of minerals in plant material

Plant material was taken in a pre-cleaned and constantly weighed silica crucible and heated in a muffle furnace at 400°C till there was no evolution of smoke. The crucible was cooled at room temperature in a desiccator and carbon-free ash was moistened with concentrated sulphuric acid and heated on a heating mantle till fumes of sulphuric acid ceased to evolve. The crucible with sulphated ash was then heated in a muffle furnace at 600°C till the weight of the content was constant (~2–3 h). One gram of sulphated ash obtained above was dissolved in 100 mL of 5 % HCl to obtain the solution ready for determination of mineral elements through atomic absorption spectroscopy (AAS) (AA 800, Perkin-Elmer Germany). Standard solution of each element was prepared and calibration curves were drawn for each element using AAS [12]. All assays were carried out in triplicate and values were obtained by calculating the average of three experiments and data are presented as Mean ± SEM.

3. Results and Discussion

The edible parts of fresh plant materials *e.g* the leaves of *G. gnemon, P. hookeri, S. perfoliata, B. lanceolaria and P. melastomoides* collected from different places of Meghalaya market have a relatively high moisture content when compared to ash, crude protein, crude fat, dietary fibre and available carbohydrate content (Table 1).

Table 1: Proximate composition of the wild edible leaves collected from Meghalaya state

Name of the Plant	Parts used	Ash %	Moisture %	Crude fat %	Crude fibre %	Protein % 6.25x % of N	Carbohydrate %	Nutritive value kcal/100g
G.gnemon	Leaves	2.0±0.02	75.62±0.03	2.07±0.06	1.24±0.03	21.49±0.02	73.18±0.03	397.38±0.49
P. hookeri	Leaves	18.74±0.03	62.38±0.10	5.25±0.05	2.01±0.05	21.62±0.02	52.37±0.13	343.27±0.04
S. perfoliata	Leaves	4.94±0.03	78.24±0.04	0.94±0.03	0.76±0.03	19.86±0.03	73.49±0.03	381.88±0.30
B. lanceolaria	Leaves	19.97±0.06	72.21±0.06	1.80±0.03	5.17±0.03	16.11±0.03	56.94±0.14	308.44±0.19
P. melastomoides	Leaves	16.72±0.04	77.41±0.05	2.55±0.07	1.49±0.03	18.69±0.02	60.53±0.13	339.91±0.29

Each value in the table was obtained by calculating the average of three experiments (n=3) and data are presented as Mean ± SEM

The edible parts of all plants contain minerals like sodium, potassium, calcium, manganese, magnesium, iron, zinc and copper in varying concentration with potassium having highest concentration (Table 2).

Table 2: Minerals content of the wild edible leaves collected from Meghalaya state

Name of the Plant	Parts used	Minerals present mg /g (Mean ± SEM)							
		Na	K	Ca	Mn	Cu	Fe	Mg	Zn
G.gnemon	Leaves	0.42±0.005	33.98± 0.13	12.52± 0.03	0.46± 0.001	0.018±0.001	0.28±0.001	0.84±0.001	0.87±0.001
P. hookeri	Leaves	0.33±0.005	47.31± 0.25	28.16± 0.04	0.46± 0.001	0.029±0.001	1.20±0.001	1.03±0.001	0.80±0.001
S. perfoliata	Leaves	0.34±0.005	37.40± 0.37	14.65± 0.07	0.26± 0.001	0.051±0.001	1.97±0.001	11.35±0.00	1.31±0.001
B. lanceolaria	Leaves	0.30±0.002	30.76± 0.25	24.30± 0.43	0.21±0.001	0.032±0.002	2.59±0.001	1.50±0.002	1.32±0.001
P. melastomoides	Leaves	0.40±0.007	15.63± 0.23	27.91± 0.23	0.34±0.001	0.031±0.002	1.57±0.001	1.32±0.001	1.23±0.001

Each value in the table was obtained by calculating the average of three experiments (n=3) and data are presented as Mean ± SEM

The proximate analyses of the nutritive contents of five plants are depicted in Table 1. The results obtained from analytic chemical analysis of all five wild edible leaves establishes that nutritive value of the leaves of *G. gnemon* was maximum (397.38±0.49 kcal/100g) followed by the leaves of *S. perfoliata* (381.88±0.40 kcal/100g) and leaves of *P. hookeri* (343.27±0.04 kcal/100g). The leaves of *B. lanceolaria* were found to be of less nutritive value (308.44±0.34 kcal/100g) as compared to other plants under investigation. The crude protein contents ranged from 21.62±0.04 % (leaves of *P. hookeri*) to 16.11±0.03% in the leaves of *B. lanceolaria*. The crude protein content in *P. hookeri* found to be very much comparable with those of almond (20.80 %), cashewnut (21.20 %) [13].

The crude protein content in the leaves of *G. gnemon* (21.49±0.02 %), *S. perfoliata* (19.86±0.02 %), *P. melastomoides* (18.69±0.03%) and *B. lanceolaria* (16.11±0.03 %) were very much high than the protein content in some commercial fruits like apple (0.2 %), wood apple (7.1 %) and litchi (1.1 %) (Table 3) [14].

These indicate that low cost plant samples are very good sources of protein. The leaves of *S. perfoliata*, *G. gnemon* and *P. melastomoides* with high content of available carbohydrates (73.49±0.03 %, 73.18±0.03 % and 60.53±0.12 % respectively) compared well to that reported for almond (10.50 %), apple (13.7 %) [13], wood apple (18.1 %), potato (20.9 %) and ripe mango (14.9%) (Table 3) [13-14] and these could be a supplements in feed formulations. The ash content was found lowest in *G. gnemon* (2.01±0.01 %) and highest in *B. lanceolaria* (19.97±0.05 %). The fat content in the leaves of *P. hookeri* (5.25±0.05 %) was particularly high and well compared to that reported for some common vegetables like spinach (0.7 %), lettuce (0.20 %) (Table 3) [13]. The leaves of *B. lanceolaria* contained the highest amount of crude fibre (5.17±0.03 %) and the lowest amount is detected in the leaves of *S. perfoliata* (0.76±0.03 %) and similar to commercial fruits and vegetables like apple (3.2 %), broad beans (8.9 %), cabbage (2.8 %), potato (1.7 %), spinach (2.5 %) (Table 3) [14].

Table 3: Proximate composition of some common vegetables and fruits

0	Ash (%)	Moisture (%)	Crude fat (%)	Protein (%) (6.25x % of N)	Available Carbohydrate (%)	Crude fibre (%)	Nutritive value (kcal /100g)
Apple	1.2	84.6	0.3	0.2	10.5	3.2	58
Brinjal	1.6	88.7	0.3	1.4	1.7	6.3	24
Broad beans	2.8	82.4	0.1	4.5	1.3	8.9	48
Cabbage	1.6	91.9	0.1	1.8	1.8	2.8	27
Cauliflower	2.2	90.8	0.4	2.6	0.3	3.7	30
Lettuce	1.7	93.4	0.3	2.1	-	-	21
litchi	1.0	84.1	0.2	1.1	-	-	61
Mango ripe	1.1	81.0	0.4	0.6	14.9	2.0	74
Papaya ripe	1.3	90.8	0.1	0.6	4.6	2.6	32
Potato	1.0	74.7	0.1	1.6	20.9	1.7	97
Spinach	2.3	92.1	0.7	2.0	0.4	2.5	26
Wood apple	6.9	64.2	3.7	7.1	18.1	-	134

The mineral composition of edible parts of the plants are shown in Table 2. High concentrations of sodium (Na) was present ranging from 0.30±0.002 mg/g (*B. lanceolaria*) to 0.42±0.005 mg/g (*G. gnemon*). The sodium levels of some cultivated vegetables and fruits vary between 30-1249 mg/kg (Table 4) [14]. The potassium (K) content was highest in the leaves of *P. hookeri* (47.31±0.25 mg/g) and least in the leaves of *P. lmelastomoides*. (15.63±0.23 mg/g). Na and K take part in ionic balance of the human body and maintain tissue excitability. Na plays an important role in the transport of metabolites and K is important for its diuretic nature. The ratio of K/Na in any food is an important factor in prevention of hypertension and arteriosclerosis, with K depresses and Na enhances blood pressure [15].

Table 4: Minerals content in some common vegetables and fruits

Name of the Plant	Minerals present mg/g							
	Na	K	Ca	Mn	Cu	Fe	Cr	Zn
Apple	0.280	0.750	0.100	0.0014	0.0010	0.0066	0.0008	0.0060
Brinjal	0.030	2.000	0.180	0.0013	0.0012	0.0038	0.0007	0.0022
Broad beans	0.435	0.390	0.500	-	0.0017	0.014	-	-
Cabbage	-	-	0.390	0.0018	0.0002	0.008	0.0005	0.003
Cauliflower	0.530	1.380	0.330	0.001	0.0013	0.0123	0.0003	0.0040

The ratio of K/Na were significant in the leaves of *P. hookeri* (143.36), *S. perfoliata* (110.00) and *B. lanceolaria* (101.20) and very much compared with some common fruits (Amla 45, papaya ripe 11.5, tomato 11.31, *Castanea sativa* 56.67, *Punica granatum* 1400.00) [13]. The calcium (Ca) content was highest in the leaves of *P. hookeri* (28.16±0.04 mg/g) followed by *P. melastomoides* (27.91±0.23 mg/g) and *B. lanceolaria* (24.30±0.43 mg/g). The Ca levels of some cultivated vegetables and fruits vary between 0.1-1.300 mg/g (Table 4). Calcium constitutes a large proportion of the bone, human blood and extracellular fluid. It is also very much required for the normal functioning of the cardiac muscles, blood coagulation, milk clotting and the regulation of cell permeability [12].

Copper (Cu) is another trace element essential in human body where it exists as an integral part of copper proteins ceruplasmin, the enzyme that catalyzes the oxidation of iron ion [15] Sufficient amount of Cu was present in *S. perfoliata* (0.051±0.0006 mg/g), *B. lanceolaria* (0.032±0.0002 mg/g) and in *P. melastomoides* (0.031±0.0001 mg/g).

An appreciable quantity of Zinc (Zn) was found to be present ranging from 0.80±0.001 mg/g (*P. hookeri*) to 1.32±0.001 mg/g (*B. lanceolaria*). Zn is an essential element in the nutrition of human being where it functions as an integral part of numerous enzymes including some enzymes which play a central role in nucleic acid metabolism. In addition, Zn is a membrane stabilizer and a stimulator of the immune response. Its deficiency leads to growth failure and poor development of gonadal function [16].

The Manganese (Mn) concentrations of the plants studied varied between 0.21±0.0001 to 0.46±0.0001 mg/g. The highest Mn value was found in the leaves of *G. gnemon* (0.46±0.001 mg/g) and appreciable amount of this element were observed in all other plants and our results were in the limits. This element is very much essential for haemoglobin formation [12].

Mn is one of the most important minerals for human physiology and daily requirement for healthy person is 4.50 mg [1].

High concentrations of Iron (Fe) were present in the leaves of *B. lanceolaria* (2.59±0.001 mg/g) and *S perfoliata* (1.97±0.001 mg/g). This high Fe levels in some wild edible plants studied could be clarified with different soil characteristics of the growing area. A daily Fe requirement of human body is 15 mg and the deficiency causes illness like anemia. Wild edible plants studied had sufficient and high Fe levels for human health [1].

The Magnesium (Mg) concentrations of the plants studied varied between 0.84±0.001 to 1.50±0.002 mg/g. The highest Mg value was found in the leaves of *B. lanceolaria* (1.50±0.002 mg/g). A very good amount of Mg was also present in the leaves of *S. perfoliata* (1.35±0.002 mg/g) and *P. melastomoides* (1.32±0.002 mg/g). So the mineral findings of all these plants obtained from present study were similar and comparable to the commercial vegetables and fruits.

Conclusion

The study showed that the wild edible plants collected from Meghalaya State in India were rich in protein, available carbohydrate, total dietary fibre and minerals, and we believe that these plants could be used for nutritional purpose of human being due to their good nutritional qualities and adequate protection may be obtained against diseases arising from malnutrition.

The experimental findings also revealed that these wild edible plants are good source of nutrient for tribal population, and also well comparable with various commercial vegetables. So the cultivation of these wild edible species need to be adopted in large scale which will produce economic benefits for poor farmers.

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