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Nutritional evaluation of some wild edible plants of Meghalaya State in India and their ethnobotanical importance

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ABSTRACT

The nutritional composition and minerals content of some wild edible plants of different botanical families growing in the Meghalaya state, India e.g the bulb of Dioscorea bulbifera, the underground stem of Homalomena aromatica, flowers of Phlogacanthus curviflorus, leaves of Medinilla erythrophylla, Ardisia humilis and fruits of Careya arborea, used by the local tribal people were analysed. For different plant species the crude fat content ranged between 0.17±0.008-1.39±0.03 %. The crude protein c ontent was found to be the highest in the leaves of Ardisia humilis (12.71±0.33%) while the available carbohydrate content was the highest in the fruits of Careya arborea (88.08±0.23%) and very good amount of it was foundi n Dioscorea bulbifera and in Phlogacanthus curviflorus. The energy content ranged from 296.37±1.83- 388.03±0.56 kcal /100g in various wild edible plants. Among the various macronutrients estimated in the plant samples of different wild edible plants, calcium was present in the highest quantity (7.42±0.18 -17.87±0.20 mg/g) followed by p otassium (3.16±0.16-16.88±0.17 mg/g) and sodium (0. 22±0.01-0.98±0.02 mg/g). Whereas the micronutrients, such as iron, zinc, copper, manganese and chromium were also analyzed in different plant specimens. The results indicated that these wild edible plants under investigation could be a good supplement for protein, carbohydrate, sodium, potassium and calcium were richer than that of the commercial vegetables and could be used for nutritional purposes.

Key words : Wild edible plants; Meghalaya; nutritional composition; mineral contents

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INTRODUCTION

In developing countries various types of wild edible plants are exploited as sources of food and thus provide adequate level of nutrition to the inhabitants [1]. 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 [2]. According to FAO (Food and Agricultural Organisation) report, more than one billion people are using wild plants as their diet [3]. Meghalya is a small state in north-eastern India. The Meghalaya subtropical forests eco-region encompasses the state; its mountain forests are distinct from the lowland tropical forests to the north and south [4]. The forests of Meghalaya are notable for their biodiversity of mammals, birds, and plants [5]. A large part of the region is botanically under-explored or even unexplored. 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 local people and tribal people (Khasi, Jaintia, Mizo, Garo). These plants also provide some useful products like medicine, fibre, fodder, dyes etc [5]. The study of wild edible plants is important not only to identify the potential sources which could be utilized as alternative food but also to select promising types for domestication.

The present communication deals with the analysis of the bulb of *Dioscorea bulbifera*, the underground stem of *Homalomena aromatica*, flowers of *Phlogacanthus curviflorus*, leaves of *Medinilla erythrophylla, Ardisia humilis* and fruits of *Careya arborea* collected from different market of Meghalaya state, India for their nutritional composition and mineral contents. The main target of our research was to find out the nutritional potential of these wild edible plants. The ethnobotanical importance of the plants under investigation are give below.

Dioscorea bulbifera L. is known as Phan-shynreh in Meghalaya State , belongs to the family Dioscoreaceae. The tubers are cooked and eaten as vegetable, and also sold in the market [6].

Homalomena aromatica Sch is known as Kimchit nokam (Garo) Shriew (Khasi) in Meghalaya State , belongs to the family Araceae. The underground stem and petiole of this plant are cooked as vegetable [5].

Phlogacanthus curviflorus (Wall.) Nees is known as Jathang in Meghalaya State , belongs to the family Acanthaceae. In Manipur, the boiled leaf juice of this plant is used as tea like drink to cure cough and fever. Flowers are eaten raw or fried as tonic. In Arunachal pradesh pounded flowers are used as condiment [7].

Medinilla erythrophylla Lindl. belonging to the family Melastomaceae is known as Shkor Blang (Khasi) in Meghalaya State . Leaves of this plant are cooked as vegetable. Young stems, leaves and fruits of this plant, all tastes sour, are cooked with dry fish [8].

Ardisia humilis Vahl. belonging to the family Myrsinaceae is known as Ja-jew (Khasi) in Meghalaya State. It has been traditionally used by the folklore medicinal practitioners of Bangladesh to treat cancer, heart diseases and liver diseases. Leaves of this plant are cooked as vegetable. They are also eaten raw [9].

Careya arborea Roxb. belonging to the family Lecthyidaceae is commonly known as Wild Guava in English and Kumbhi in Hindi. It is known as soh-kundur (Khasi) in Meghalaya state. The Stem bark of *C. arborea* is traditionally used for the treatment of tumours, bronchitis, epileptic fits, astringents, as an antidote to snake-venom and skin disease. It is also used as remedy for diarrhoea, dysentery with bloody stools and ear pain. Antipyretic, leech repellant, fish poison and antivenin activities were also reported in the literature. The aqueous extract of fresh root bark has been used as fish poison [10].

EXPERIMENTAL SECTION

Plant materials

The six plant materials e.g the bulb of *D. bulbifera*, the underground stem of *H. aromatica*, flowers of *P. curviflorus*, leaves of *M. erythrophylla, A. humilis* and fruits of *C. arborea*, were purchased from different markets of Meghalaya state, India on December 2012 and authenticated in our office. The voucher specimens were preserved in the Plant Chemistry department of our office under the registry no BSITS 50, BSITS 53, BSITS 54, BSITS 60, BSITS 61, BSITS 63 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

Five gms of each sample were weighed in a silica crucible and heated in muffle furnace for about 5-6 h at 500^0C. 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 untill the weight became constant (ash became white or grayish white). The ash content was calculated from the weight of ash [11].

Estimation of moisture

Two gms of each sample were taken in a flat-bottom dish and kept overnight in an air oven at 100–110°C and weighed. The loss in weight gave moisture content [11].

Estimation of crude fat

Two gms of moisture free of each of the plants were extracted with petroleum ether (60-80^{o}C) in a Soxhlet apparatus for about 6-8h. After boiling with petrol, the residual petrol was filtered using Whatman no. 40 filter paper and the filtrate was evaporated in a preweighed beaker. Increase in weight of beaker gave crude fat content [11].

Estimation of crude fibre

Two gms of moisture and fat-free material of each sample were 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 130^0C to constant weight and cooled in a dessicator. The residue was scraped into a pre-weighed porcelain crucible, weighed, ashed at 550^0C for two hours, cooled in a dessicator and reweighed. Crude fibre content was expressed as percentage loss in weight on ignition [11].

Estimation of crude protein

The crude protein was determined using micro Kjeldahl method. Two gms of each sample were decomposed by digestion with concentrated sulphuric acid using catalyst and ammonium sulphate was 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 solution. Titration of the residual mineral acid with standard sodium hydroxide gave the equivalent of ammonia obtained from the weight of the sample taken. From this, the percentage of nitrogen in the sample was calculated. According to the standard literature, protein content of the sample is 6.25 times of the nitrogen content of the sample [11].

Estimation of available carbohydrate

Available carbohydrate was estimated by difference, by subtracting the total sum of percent crude protein, crude fat, crude fibre and ash from 100% dry weight of the plant [11].

Estimation of nutritive value

Nutritive value (kcal/100g) of each plant sample was determined by multiplying the values obtained for protein(%), fat (%) and available carbohydrate (%) by 4.00, 9.00 and 4.00 respectively and by adding up the values [11].

Estimation of minerals in plant material

The plant material was taken in a precleaned and constantly weighed silica crucible and was 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 the 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].

RESULTS AND DISCUSSION

The edible parts of fresh plant materials *e.g* the bulb of *D. bulbifera*, the underground stem of *H. aromatica,* flowers of *P. curviflorus,* leaves of *M. erythrophylla, A. humilis* and fruits of *C. arborea* collected from different places of Meghalaya market have a relatively high moisture content when compared to ash, crude protein, crude fat, crude fibre and available carbohydrate content (Table 1).

Table 1. Proximate composition of the wild edible plants collected from Meghalaya state

Name of the Plant	Ash %	Moisture %	Crude fat %	Crude fibre %	Protein % 6.25x % of N	Carbohydrate %	Nutritive value kcal/100g
D. bulbifera	7.09±0.06	70.30±0.38	0.17±0.008	5.66±0.26	0.42±0.03	86.64±0.25	349.82±0.91
H. aromatica	24.97±1.90	72.49±0.03	1.14±0.02	2.36±0.03	0.75±0.03	70.76±1.88	296.37±1.83
P.curviflorus	10.25±0.04	44.63±0.12	0.58±0.02	11.22±0.04	2.25±0.03	75.68±0.06	317.04±0.11
M. erythrophylla	8.35±0.13	92.83±0.02	1.39±0.03	10.62±0.05	7.03±0.04	72.60±0.10	331.08±0.38
A. humilis	2.43±0.20	90.16±0.03	0.80±0.01	9.69±0.04	12.71±0.33	74.36±0.17	355.50±0.59
C.arborea	1.47±0.13	94.13±0.03	0.76±0.02	2.48±0.04	7.19±0.04	88.08±0.23	388.03±0.56

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, chromium, iron, zinc and copper in varying concentrations with calcium at the maximum level and it is shown in Table 2.

Table 2. Minerals content of the wild edible plants collected from Meghalaya state

Name of the Plant	Minerals present mg /g							
	Na	K	Ca	Cu	Zn	Mn	Fe	Mg
D. bulbifera	0.98±0.02	16.88±0.17	7.59±0.12	0.004±0.0001	0.07±0.0001	0.02±0.0003	0.02±0.0001	0.72±0.0001
H. aromatica	0.55±0.01	3.16±0.16	7.56±0.15	0.035±0.0001	0.77±0.0003	0.29±0.0002	0.09±0.0007	0.89±0.0002
P.curviflorus	0.41±0.01	15.93±0.15	17.87±0.20	0.008±0.0001	0.42±0.0002	0.25±0.0001	0.87±0.0003	1.09±0.0001
M. erythrophylla	0.41±0.01	9.63±0.18	12.13±0.79	0.066±0.0001	0.42±0.0001	0.10±0.0002	0.61±0.0003	0.97±0.0001
A. humilis	0.22±0.01	9.04±0.21	8.68±0.19	0.016±0.0002	0.18±0.0003	0.03±0.0003	0.25±0.0001	0.88±0.0001
C.arborea	0.38±0.01	13.21±0.19	7.42±0.18	0.005±0.0001	0.34±0.0001	0.03±0.0001	0.16±0.0002	0.92±0.0001

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 analysis of the nutritive contents of six plants are depicted in Table 1. The ash content, which is an index of mineral contents, ranged from 1.47±0.13 % (*C. arborea*) to 24.97±1.90 % (*H. aromatica*) and these values are very much comparable with commercial leafy vegetables (Table 3) [13].

Moisture content of the leaves of six plant species ranged from 44.63±0.12 % in *P. curviflorus* to 94.13±0.03 % in *C. arborea* and comparable to the moisture content in broad beans (85.4%), cabbage (91.9%), spinach (92.1%), potato (74.7%) [14].

The crude protein contents ranged from 0.42±0.03% (*D. bulbifera*) to 12.71±0.33 % in the leaves of *A. humilis*. The crude protein content in *C. arborea, A. humilis* and in *M. erythrophylla* are very much higher than the protein contents in some commercial fruits and vegetables like broad beans (4.5 %) wood apple (7.1%), spinach (2.0%) and lichi (1.1%) (Table 3) [13]. So the present study reveals that the nutritive values of the plants under investigation are richer than the cultivated vegetables specially in respect of protein contents.

Table 3. Proximate composition of some common vegetables and fruits

Name of the Plant	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
Lettuice	1.7	93.4	0.3	2.1	-	-	21
lichi	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

Crude fat contents of the plants investigated varied between 0.17±0.008 % (bulb of *D. bulbifera*) and 1.39±0.03 % (in the leaves of *M. erythrophylla*) and the crude fat content of these plants were more than the reported values (0.1-3.7%) for some well known vegetables consumed in India (Table 3) [13].

The bulb of *D. bulbifera*, the underground stem of *H. aromatica*, flowers of *P. curviflorus*, leaves of *M. erythrophylla, A. humilis* and fruits of *C. arborea* with high content of available carbohydrates (86.64±0.25%, 70.76±1.88 %, 75.68±0.06 %, 72.60±0.10 % , 74.36±0.17 % and 88.08±0.23% respectively) compared well to that reported for almond (10.50%), apple (13.7%) [14], wood apple (18.1%), potato (22.6%) and ripe mango (16.9%) (Table 3) [13] and these could be a supplement for feed formulations.

The flowers of *P. curviflorus* contained the highest amount of crude fibre (11.22±0.04 %) and the least amount of fibre was found in the underground stem of *H. aromatica*. The crude fibre content in the plants under investigation were comparable to the fibre content in some commercial fruits and vegetables like apple (3.2%), broad beans (8.9%), cabbage (2.8%), potato (1.7%), spinach (2.5%) (Table 3) [13].

The results obtained from the analytic chemical analysis of all six wild edible plants show that the energy content in the fruits of *C. arborea* is maximum (388.03±0.56 kcal /100g) followed by the leaves of *A. humilis* (355.50±0.59

kcal /100g), bulb of *D. bulbifera* (349.82±0.91 kcal /100g) and leaves of *M. erythrophylla* (331.08±0.38 kcal /100g). It indicates that these plants could be an important source of dietary calorie. High calorific content of the plants could be attributed to high carbohydrate and protein contents.

The mineral composition in edible parts of the plants are shown in Table 2. High concentrations of sodium (Na) were present, ranging from 0.22±0.01 mg/g (*A. humilis*) to 0.98±0.02 mg/g (*D. bulbifera*). The sodium levels of some cultivated vegetables vary between 0.28 mg /g to 1.249 mg/g (Table 4) [13].

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	Z
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
Lettuice	0.580	0.330	0.500	-	0.0008	0.024	-	-
lichi	1.249	1.590	0.100	-	0.003	0.007	-	
Mango ripe	0.260	2.050	0.140	0.0013	0.0011	0.013	0.0006	0.0027
Papaya ripe	0.060	0.690	0.170	-	0.0020	0.005	-	-
Potato	0.110	2.470	0.100	0.0013	0.0016	0.0048	0.0007	0.0053
Spinach	0.585	2.060	0.730	0.0056	0.001	0.0114	0.0005	0.003
Wood apple	-	-	1.300	0.0018	0.0021	0.0048	0.0006	0.0046

The potassium (K) content is the highest in the bulb of *D. bulbifera* (16.88±0.17 mg/g) and the least in the underground stem of *H. aromatica* (3.16±0.16 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]. The ratio of K/Na is significant in the leaves of *A. humilis* (41.09), *M. erythrophylla* (23.48), in the fruits of *C. arborea* (34.76) and in the flower *P. curviflorus* (38.85) and compared to the commercial vegetables and fruits like potato (22.45), cabbage 17.5, tomato 47.1, beet 3.9. mango ripe (7.88), brinjal (66.66) etc. [14].

The calcium (Ca) content is the highest in the flower *P. curviflorus* (17.87±0.20 mg/g) followed by that in the leaves of *M. erythrophylla* (12.13±0.79 mg/g) and in the leaves of *A. humilis* (8.68±0.19 mg/g). An appreciable amount of calcium was also present in *C. arborea*, *D. bulbifera* and in the flower of *P. curviflorus*. The calcium levels of some cultivated vegetables and fruits vary between 10.0-130.0 mg/100g (Table 4) [13]. Ca constitutes a large proportion of the bone, human blood and extracellular fluid. It is also essential for the normal functioning of the cardiac muscles, blood coagulation, milk clotting and the regulation of cell permeability [15].

Copper 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]. The sufficient amount of Copper (Cu) is present in *M. erythrophylla* (0.066±0.0001 mg/g), *H. aromatica* (0.035±0.0001 mg/g) and in *A. humilis* (0.016±0.0002 mg/100g).

An appreciable quantity of Zinc (Zn) is found to be present ranging from 0.07±0.0001 mg/g (*D. bulbifera*) to 0.77±0.0003 mg/g (*H. aromatica*). Zn is a co-factor of a number of enzymes including some enzymes which play vital 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 functions [12,15]

The Manganese (Mn) concentrations of the plants studied varies between 0.02±0.0003 to 0.29±0.0002 mg/g. The highest Mn values is found in the stem of *H. aromatica* and appreciable amount of this element is observed in all other plants and our results are within the limits. This element is very much essential for haemoglobin formation [12]. Manganese is one of the most important minerals for human physiology and daily requirement for healthy person is 4.50 mg [16].

High concentration of iron (Fe) is present in the flowers of *P. curviflorus* (0.87±0.0003 mg/g), *M. erythrophylla* (0.61±0.0003 mg/g), and in the leaves of *A. humilis* (0.25±0.0001 mg/g).

The Magnesium (Mg) concentrations of the plants studied varies between 0.72±0.0001 to 1.09±0.0001 mg/g. The highest amount of Mg is found in the flowers of *P. curviflorus* (1.09±0.0001 mg/g). A very good amount of Mg is also present in the leaves of *M. erythrophylla* (0.97±0.0001 mg/g), *A. humilis* (0.88±0.0001 mg/g) and in the fruits of *C. arborea* (0.92±0.0001mg/ g).

So the mineral findings of all these plants obtained from present study are similar and comparable to the commercial vegetables and fruits (Table 4) [13].

CONCLUSION

The study shows that the wild edible plants collected from Meghalaya State in India are rich in protein, available carbohydrate, crude fibre and minerals and the results suggest that consumption of such plants in sufficient amount could be used for nutritional purpose of human being and provides adequate protection against diseases caused by malnutrition.

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