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Nutritive Value and Mineral Composition of Some Wild Edible Plants from Meghalaya State in India

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Abstract: Plants are the richest source of food and also provide medicinal agents. In most of the developing tropical countries the food situation is a major problem due to population growth, shortage of fertile land, high prices of available staples and restrictions on the importation of food. Most reports on wild edible plants and unconventional crops indicate that they could be good sources of nutrients and may be used for the treatment of various ailments. The nutritional potential of seven wild edible plants e.g the *Allium schoenoprasum*, *Carica papaya*, *Neptunia olearacea*, *Eurya acuminata*, *Hodgsonia heteroclita*, *Brassica nigra* and *Flacourtia jangomas* were evaluated by determining proximate and mineral composition. The proximate composition and mineral contents were carried out using various statndard scientific methods. The present study revealed that for different plant species, the protein content ranged between 7.39±0.02 -42.24±0.03%. The crude fat content was determined highest in the fruits of *H. heteroclita* (28.60±0.04), while the available carbohydrate content was highest in the bulb of *A.schoenoprasum* (77.88±0.02%) and very good amount in the fruits of *F. jangomas* (77.48±0.10%) and in the leaves of *E. acuminata* (76.14±0.07%). The energy content in the various wild edible plants ranged from 320.99±0.03 -521.90±0.03 kcal/100g. Among the various macronutrients estimated in the plant samples of different wild edible plants potassium was present in the highest quantity (8.18±0.09- 55.44±0.97 mg g^{-1}) followed by calcium (2.91±0.08-26.83±0.08 mg g^{-1}) and sodium (0.19±0.002-1.20±0.006 mg g^{-1}). Micronutrients, such as iron, zinc, copper, manganese and magnesium were also analyzed in the different plant specimens. 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 importance of the wild plants under investigation.

Key words: Wild Edible Plants · Meghalaya · Nutritional Composition · Mineral Contents

INTRODUCTION

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. This state is bounded in north by Assam and by Bangladesh on the south. This state about 300 km long (east-west) and 100 km wide, with a total area of about 8,700 sq m (22,720 km²). About one third of the state is forested. The Meghalaya subtropical forests ecoregion encompasses the state; its mountain forests are distinct from the lowland tropical forests to the north and south [1]. The forests of Meghalaya are notable for their biodiversity of mammals, birds and plants [2]. A large part of the region is botanically under-explored or even unexplored. In the hilly regions, population density is very low. Most of the area lacks industrialization and communications and, consequently, is under-developed. The local inhabitants subsist on limited agriculture and local products of plant and animal origin. The area is, thus, very interesting ethnobotanically [3]. 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 [4]. These plants also provide some useful products like

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medicine, fibre, fodder, dyes etc [2]. 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 proximate composition and mineral content of the leaves of *Allium schoenoprasum*, *Carica papaya*, *Neptunia olearacea*, *Eurya acuminata*, *Hodgsonia heteroclita*, *Brassica nigra* and *Flacourtia jangomas* collected from different market of Meghalaya state, India. 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 plant has also been mentioned.

Allium schoenoprasum Linn. known as Jyllang (Khasi) in Meghalaya state, belongs to the family Amaryllidaceae. This plant is smallest species of edible onions and reported to have mild stimulant, diurectic and antiseptic properties [5]. The bulb and young leaves of the plant are eaten as substitute of onion by different tribal people of Meghalaya state.

The flowers of ***Carica papaya*** are known as Amita phal (Garo) in Meghalaya state and belongs to the family Caricaceae. Flowers are cooked or fried as vegetable and eaten by the local people.

Neptunia olearacea Lour is known as Dumjong (Mizo) in Meghalaya state, belongs to the family Mimosaceae. The fresh leaf juice is taken as refrigerant and astringent and stem juice is poured into ear to get relief from earache [6].

Eurya acuminata DC. belongs to family Theaceae locally known as shinah (Mizo) in Meghalaya. The wood of this plant is used for fire-wood, decoction of leaves is used against cholera, diarrhoea and other stomach-diseases. Leaves are ground to make chutney and cooked as vegetable by the Mizo people [7].

Hodgsonia heteroclita Hook.f. & Thoms belongs to family Cucurbitaceae locally known as soh-mynthar in Khasi hills of Meghalaya. The large, oil-rich seeds are an important source of food. Hard seeds are roasted and eaten by khasi people. In Assam state fresh or dry extracts of fruit juice of this plant is taken 2-3 tea spoon in empty stomach [8].

Brassica nigra (Family: Brassicaceae) commonly known as Jaiing in Meghalaya State, has both edible and medicinal value. This plant has been traditionally used for treatment of inflammation and rheumatism; also it has been used as simple rubefacient, diuretic, emetic, pneumonia, bronchitis, nerve stimulation and vesicant [9].

Flacourtia jangomas (Loureiro) Raeusch commonly known as Soh-mlum in Meghalaya belongs to the family Flacourtiaceae. The bark of this plant are dipped overnight in water and next day morning taken orally in empty stomach to get relief from dyspepsia. The fruits of this plant are known for mainly the anti-diabetic and cytotoxic activity [10].

MATERIALS AND METHODS

Plant Materials: The five plant materials e.g *Allium schoenoprasum* (Bulb), *Carica papaya* (Flower), *Neptunia olearacea* (Stem), *Eurya acuminata* (leaves), *Hodgsonia heteroclita* (Seeds), *Brassica nigra* (leaves) and *Flacourtia jangomas* (Fruits) were purchased from different market of Meghalaya state, India on March 2010 and authenticated in our office. The voucher specimens were preserved in the Plant Chemistry department of our office under registry no BSITS 34, BSITS 35, BSITS 41, BSITS 42, BSITS 44, BSITS 46 and BSITS 47 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: 5g 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 [11].

Estimation of Moisture: 2g 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 [11].

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 6-8h. 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 [11].

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 [11].

Estimation of Crude Protein: The crude protein was determined using micro Kjeldahl method. The total protein was calculated multiplying the evaluated nitrogen by 6.25 [11].

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) [11].

Estimation of Nutritive Value (energy) : Nutritive value 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 [12].

Estimation of Minerals in Plant Material: Plant material was taken in a precleaned 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 [13].

Statistical Analysis: All assays were carried out at in triplicate and values were obtained by calculating the average of three experiments using microsoft office excel 2003 format and data are presented as Mean ± SEM.

RESULTS AND DISCUSSION

The edible parts of fresh plant materials *e.g A. schoenoprasum* (Bulb), *C. papaya* (Flower), *N.olearacea* (Stem), *E. acuminata* (leaves), *H. heteroclita* (Seeds), *B. nigra* (leaves*)* and *F. jangomas* (Fruits) 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).

The edible parts of all plants contain minerals like sodium, potassium, calcium, manganese, chromium, iron, zinc and copper in varying concentration with potassium having highest concentration and it is shown in Table 2.

Table 1: Nutritional composition of wild edible plants collected from Meghalaya

Sl No	Name of the Plant	Local name at Meghalaya	Parts used	Ash %	Moisture %	Crude fat %	Crude fibre %	Protein % (6.25x% of N)	Available Carbohydrate %	Energy content (kcal /100g)
1	*A.schoenoprasum*	Jyllang	Bulb	2.90±0.02	77.76±0.06	0.49±0.02	8.88±0.03	9.84±0.03	77.88±0.02	355.33±0.28
2	*C. papaya*	Amita phal	Flower	15.52±0.01	90.75±0.03	1.93±0.03	6.64±0.02	30.16±0.03	45.75±0.03	320.99±0.03
3	*N. oleracea*	Dumjong	Stem	12.11±0.01	77.12±0.02	0.49±0.02	3.52±0.03	33.21±0.02	50.67±0.02	339.93±0.10
4	*E. acuminata*	Shinah	Leaves	4.45±0.02	57.72±0.02	1.40±0.03	3.30±0.03	14.72±0.04	76.14±0.07	376.01±0.0.08
5	*H.heteroclita*	Soh ben	Seeds	3.68±0.06	60.35±0.01	28.60±0.04	1.60±0.03	35.80±0.02	30.31±0.10	521.90±0.03
6	*B. nigra*	Jaiing	Leaves	13.11±0.01	89.69±0.02	4.30±0.03	4.65±0.02	42.24±0.03	35.70±0.02	350.46±0.10
7	*F. jangomas*	Soh mlum	Fruits	1.20±0.01	65.27±0.01	4.09±0.04	9.85±0.02	7.39±0.02	77.48±0.10	376.25±0.08

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

Table 2: Minerals content in the wild edible plants collected from Meghalaya

Sl. No	Name of the Plant	Local name at Meghalaya	Parts used	Minerals present mg g^{-1} Na	K	Ca	Mn	Cu	Fe	Mg	Zn
1	*A.schoenoprasum*	Jyllang	Bulb	0.19±0.002	11.51±0.10	2.91±0.08	0.025±0.0007	0.008±0.0002	0.227±0.001	0.637±0.001	0.142±0.001
2	*C. papaya*	Amita phal	Flower	0.40±0.003	52.78±0.78	8.77±0.08	0.045±0.0006	0.002±0.00001	0.306±0.0009	0.007±0.0002	0.008±0.0001
3	*N. oleracea*	Dumjong	Stem	1.20±0.006	52.67±0.58	15.04±0.14	0.210±0.0008	0.008±0.0001	0.134±0.001	0.749±0.001	0.187±0.001
4	*E. acuminata*	Shinah	Leaves	0.42±0.005	8.21±0.10	4.28±0.12	0.508±0.001	0.009±0.0004	0.060±0.001	0.698±0.001	0.085±0.001
5	*H.heteroclita*	Soh ben	Seeds	0.42±0.003	8.18±0.09	3.49±0.06	0.017±0.0001	0.015±0.0002	0.004±0.0006	0.728±0.001	0.135±0.001
6	*B. nigra*	Jaiing	Leaves	0.29±0.004	55.44±0.97	26.83±0.08	0.110±0.0001	0.010±0.0001	0.254±0.001	0.790±0.001	0.265±0.001
7	*F. jangomas*	Soh mlum	Fruits	0.24±0.004	20.39±0.23	7.01±0.08	0.136±0.0008	0.013±0.0001	0.043±0.001	0.696±0.001	0.185±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

Table 3: Nutritional 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 kg $^{-1}$)
Apple	1.2	84.6	0.3	0.2	10.5	3.2	580
Brinjal	1.6	88.7	0.3	1.4	1.7	6.3	240
Broad beans	2.8	82.4	0.1	4.5	1.3	8.9	480
Cabbage	1.6	91.9	0.1	1.8	1.8	2.8	270
Cauliflower	2.2	90.8	0.4	2.6	0.3	3.7	300
Lettuice	1.7	93.4	0.3	2.1	-	-	210
lichi	1.0	84.1	0.2	1.1	-	-	610
Mango ripe	1.1	81.0	0.4	0.6	14.9	2.0	740
Papaya ripe	1.3	90.8	0.1	0.6	4.6	2.6	320
Potato	1.0	74.7	0.1	1.6	20.9	1.7	970
Spinach	2.3	92.1	0.7	2.0	0.4	2.5	260
Wood apple	6.9	64.2	3.7	7.1	18.1	-	1340

The proximate analysis of the nutritive contents of seven plants are depicted in Table 1. The results obtained from analytic chemical analysis of all seven wild edible plants establishes that nutritive value of the seeds of *H. heteroclita* was maximum (521.90±0.03 kcal /100g) followed by the fruits of *F. jangomas* (376.25±0.08 kcal /100g) and leaves of *E. acuminata* (376.01±0.0.08 kcal/100g). The flowers of *C. papaya* were found to be of less nutritive value (320.99±0.03 kcal /100g) but due to high moisture content (90.75±0.03%) it has a very good nutritive value and may be used as fodder. The crude protein contents ranged from 42.24±0.03% (leaves of *B. nigra*) to 7.39±0.02% in the (fruits of *F. jangomas*). The crude protein content in the leaves of *B. nigra*, *N. oleracea*, seeds of *H. heteroclita* and flower of *C. papaya* were found to be higher than those of almond (20.80%), cashewnut (21.20%) [14] and lesser known leafy vegetables like *Momordica balsamina* (11.29± 0.07%) & *Moringa oleifera* (20.72%) [15]. The crude protein content in the fruits of *F. jangomas* (7.39±0.02%), in the leaves of *E. acuminata* (14.72±0.04%) and bulb of *A.schoenoprasum* (9.84±0.03%), were very much higher than the protein content in some commercial fruits like apple (0.2%), wood apple (7.1%), lichi (1.1%) and commercial leafy vegetables like cabbage (1.8%), cauliflowers (2.6%), broad bean leaves (4.5%) (Table 3) [16]. These indicates that low cost plant samples are very good sources of protein.

The bulb of *A.schoenoprasum*, fruits of *F. jangomas*, leaves of *E. acuminata* and stem of *N. olearacea* with high content of available carbohydrates (77.88±0.02%, 77.48±0.10%, 76.14±0.07% and 50.67±0.02% 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) [16] and these could be a supplements in feed formulations. The ash content was found lowest in *F. jangomas* (1.20±0.01%) and highest in *C. papaya* (15.52±0.01%). The fat content was found highest in the seeds of *H. heteroclita* (28.60±0.04%). and the fat content of other leafy vegetables and fruits like *F. jangomas* (4.09±0.04%), *B.nigra* (4.30±0.03%) and *C.papaya* (1.93±0.03%) were particularly high and well compared to that reported for some common fruits like wood apple (3.7%), litchi (0.20%), ripe mango (0.4%) (Table 3) [16]. The fruits of *F. jangomas* contained the highest amount of crude fibre (9.85±0.02%) and the amount of crude fibre in other leafy vegetables and fruits under investigation were simmilar to some commercial fruits and vegetables like apple (3.2%), broad beans (8.9%), cabbage (2.8%), potato (1.7%), spinach (2.5%) (Table 3) [16]. The proximate composition of these plants were very much comparable to some other wild edible leafy vegetables like leaves of *Bauhinia purpurea, Diplazium esculentum* [17]*, Ficus geniculata, Ficus pomifera, Gentiana pedicellata* etc [18] collected from different tribal market of Meghalaya.

The mineral composition in edible parts of the plants are shown in Table 2. High concentrations of sodium (Na) were present, ranging from 1.20±0.006 mg g^{-1} (*N. oleracea*) to 0.19±0.002 mg g^{-1} (*A.schoenoprasum*). The sodium levels of some cultivated vegetables and fruits vary between 30-1249 mg kg^{-1} (Table 4). The potassium (K) content was higher in the leaves of *B. nigra* (55.44±0.97 mg g^{-1}) and least in the fruits of *H.heteroclita* (8.18±0.09 mg g^{-1}). 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 [19]. The ratio of K/Na were significant in the leaves of *B. nigra* (191.17),

Table 4: Minerals content in some common vegetables and fruits

	Minerals present mg kg^{-1}							
Name of the Plant	Na	K	Ca	Mn	Cu	Fe	Cr	Zn
Apple	280	750	100	1.4	1.0	6.6	0.08	0.60
Brinjal	30	2000	180	1.3	1.2	3.8	0.07	2.2
Broad beans	435	390	500	-	1.7	14.0	-	-
Cabbage	-	-	390	1.8	0.2	8.0	0.05	3.0
Cauliflower	530	1380	330	1.0	1.3	12.3	0.03	4.0
Lettuice	580	330	500	-	0.8	24.0	-	-
lichi	1249	1590	100	-	3.0	7.0	-	
Mango ripe	260	2050	140	1.3	1.1	13.0	0.06	2.7
Papaya ripe	60	690	170	-	2.0	5.0	-	-
Potato	110	2470	100	1.3	1.6	4.8	0.07	5.3
Spinach	585	2060	730	5.6	1.0	11.4	0.05	3.0
Wood apple	-	-	1300	1.8	2.1	4.8	0.06	4.6

flowers of *C. papaya* (131.95), fruits of *F. jangomass* (84.95) and bulb of *A.schoenoprasum* (60.57) and compared with leafy vegetables (Cabbage 17.5, tomato 47.1, beet 3.9) [14].

The calcium (Ca) content was highest in the leaves of *B. nigra* (26.83±0.08 mg g^{-1}) followed by in the stem of *N. oleracea* (15.04±0.14 mg g^{-1}) least amount of Ca was found in the bulb of *A.schoenoprasum* (2.91±0.08 mg g^{-1}). The calcium levels of some cultivated vegetables and fruits vary between 100-1300 mg kg^{-1} (Table 4). Ca 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 [13].

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 [19]. The sufficient amount of Copper (Cu) was present in the seeds of *H. heteroclita* (0.015±0.0002 mg g^{-1}), fruits of *F. jangomass* (0.013±0.0001 mg g^{-1}) and in the leaves of *B. nigra* (0.010±0.0001 mg g^{-1}). An appreciable quantity of Zinc (Zn) was found to be present ranging from 0.265±0.001 mg g^{-1} (leaves of *B. nigra*) to 0.187±0.001mg g^{-1} (Stem of *N. oleracea*).

Zinc 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 [20]. Its deficiency causes clinical consequences, including growth delay, diarrhoea, pneumonia, disturbed neurophyshological performance and abnormalities of foetal development [21].

The Manganese (Mn) concentrations of the plants studied varied between 0.017±0.0001 to 0.508±0.001 mg g^{-1}. The highest Mn values was found in the leaves of *E. acuminata* (0.508±0.001 mg g^{-1}) 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 [13]. Manganese is one of the most important minerals for human physiology and daily requirement for healthy person is 4.50 mg [20].

High concentration of iron (Fe) were present in *C. papaya* (0.306±0.0009 mg g^{-1}), *B. nigra* (0.254±0.001 mg g^{-1}), *A. schoenoprasum* (0.227±0.001 mg g^{-1}) and in *N. oleracea* (0.134±0.001 mg kg^{-1}). 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 some illness like anemia. Wild edible plants studied had sufficient and high Fe levels for human health [22].

The Magnesium (Mg) concentrations of the plants studied varied between 0.790±0.001 to 0.007±0.0002 mg g^{-1}. The highest Mg values was found in the leaves of *B. nigra* (0.790±0.001 mg g^{-1}). A very good amount of Mg is also present in all other plants except in the plant of *C. papaya*.

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 investigated and we believe that these plants could be used for nutritional purpose purpose of human being due to their good nutritional qualities and adequate protection may be obtained against diseases arising from malnutrition.

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