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Evaluation of Nutritional Potential of Wild Edible Plants, Traditionally Used by the Tribal People of Meghalaya State in India

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ABSTRACT

The nutritional potential of some wild edible plants e.g., the leaves of *Bauhinia purpurea* Linn. (Fabaceae) , *Diplazium esculentum* (Retz.) Sw. (Athyriaceae), the fruits of *Elaeagnus latifolia* Linn. (Elaeagnaceae), *Elaeagnus pyriformis* Hook. f. (Elaeagnaceae) and the flowers of *Dillenia pentagyna* Roxb. (Dilleniaceae), were evaluated by determining proximate and phytochemical composition. These plants are used by the different tribal people of Meghalaya state of India as their food. The present study revealed that for different plant species, the crude fat content ranged between 11.3±0.70-15.1±0.30 g kg^{-1}. The crude protein content was determined high in the fruits of *E. pyriformis* (231.8±0.50 g kg^{-1}), *E. latifolia* (148.2±0.80 g kg^{-1}) and in the leaves of *D. esculentum* (143.8±2.0 g kg^{-1}) while, the available carbohydrate content was highest in the flower of *D. pentagyna* (824.5±1.60 g kg^{-1}) and very good amount in *B. purpurea* and *E. latifolia*. The nutritive value ranged from 3413.16±2.46-3827.03±5.45 kcal kg^{-1} in the various wild edible plants. Among the various macronutrients estimated in the plant samples of different wild edible plants potassium was present in the highest quantity (13580±80.0-43730±110.0 mg kg^{-1}) followed by calcium (5860±40-13330±70 mg kg^{-1}) and sodium (815±27.0-1180±72.0 mg kg^{-1}). Micronutrients, such as iron, zinc, copper, manganese and chromium were 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

Meghalaya 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 sqm (22,720 km^2). 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 (Mao *et al*., 2009). The forests of Meghalaya are notable for their biodiversity of mammals, birds and plants (Kayang, 2007). 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 (Jain and Dam, 1979). 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 (Akubugwo *et al*., 2007). These plants also provide some useful products like medicine, fibre, fodder, dyes etc. (Kayang, 2007). 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 leaves of *Bauhinia purpurea* Linn. (Fabaceae) , *Diplazium esculentum* (Retz.) Sw. (Athyriaceae), the fruits of *Elaeagnus latifolia* Linn. (Elaeagnaceae), *Elaeagnus pyriformis* Hook. f. (Elaeagnaceae) and the flowers of *Dillenia pentagyna* Roxb. (Dilleniaceae) 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 traditional use and ethnobotanical importance of these plant has also been mentioned.

Bauhinia purpurea Linn. is known as Megong (Garo) and Muyung-laphang (Khasi) in Meghalaya state, belongs to the family Fabaceae. Traditionally this plant is used in the treatment of dropsy, pain, rheumatism, convulsions, delirium, septicemia, etc. (Asolkar *et al*., 2000). The bark of the plant is used as an astringent in the treatment of diarrhoea. Its decoctions are recommended for ulcers as a useful wash (Kirthikar and Basu, 2001). The leaves and flowers of this plant are cooked as vegetable (Kayang, 2007).

Dillenia pentagyna Roxb. is known as Agachi (Garo) and Dieng Soh Karbam (Khasi) in Meghalaya state, belongs to the family Dilleniaceae. The flower-buds and young fruits have a pleasant, acid flavor and are eaten raw or cooked in Oudh and central India. The ripe fruits are also eaten. According to Ayurveda, the plant pacifies vitiated vata, kapha, anal fistula, wounds, diabetes, diabetic carbuncle, neuritis, pleurisy, pneumonia and burning sensation. The Fruits of this plant are cooked as vegetable and also used for making chutney. Root decoction (25-50 mL) is used to cure body pain. The people suffering from diabetes used to take one-teaspoon bark powder (5-10 g) of this plant with water. Bark powder is also given in the treatment of diarrhoea and dysentery. Bark decoction (25-50 mL) is given to woman after delivery as a tonic and also used for bath to prevent from any infection (Dubey *et al*., 2009).

Diplazium esculentum (Retz.) Sw. is known as Jhur-tyrkhang (Khasi) in Meghalaya state, belongs to the family Athyriaceae. The fresh immature fronds are wiped with a cloth to remove red petiolar hairs and boiled. Boiled fronds are cut and fried in cooking oil with spices such as seeds of *Cleome viscosa* L. (Misra *et al*., 2008). The Fronds of this plant are cooked as vegetable (Kayang, 2007).

Elaeagnus latifolia Linn. belongs to family Elaeagnaceae locally known as Soh-shang in Khasi hills of Meghalaya. The people of Meghalaya have found many uses of Soh-shang fruit besides enjoying it as fresh fruit. In North Eastern states, it is quite common in Sibsagar (Dikho valley of Assam), Naga hills (Nagaland), Khasi and Jaintia hills of Meghalaya. The fruits are eaten raw with salt and used for making chutney and fruit pulp is used for making jam, jelly and refreshing drink (Patel *et al*., 2008).

Elaeagnus pyriformis Hook. f. belongs to family Elaeagnaceae locally known as heiyai in Khasi hills of Meghalaya. It bears small fruits which are eaten by local people. The fruits are also offered for sale at the local markets. In fact heiyai fruits are very similar to those of soh shang in taste. The external appearance is also same except that the fruits of heiyai are somewhat pear shaped where as those of soh shang are of uniform thickness (Parmar, 2008).

MATERIALS AND METHODS

Plant materials: The five plant materials e.g., the leaves of *B. purpurea*, *D. esculentum*, the fruits of *E. latifolia*, *E. pyriformis* and the flowers of *D. pentagyna* 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 15, BSITS 16, BSITS 17, BSITS 18, BSITS 19, 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 grams 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 (AOAC, 1990).

Estimation of moisture: Two grams 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 (AOAC, 1990).

Estimation of crude fat: Two grams 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 preweighed beaker. Increase in weight of beaker gave crude fat (AOAC, 1990).

Estimation of crude fibre: Two grams 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 2 h, cooled in a dessicator and reweighed. Crude fibre content was expressed as percentage loss in weight on ignition (AOAC, 1990).

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 (AOAC, 1990).

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) (AOAC, 1990).

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 (Guil-Guerrero *et al*., 1998).

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 (Indrayan *et al*., 2005). All assays were carried out at least in triplicate and values were obtained by calculating the average of three experiments and data are presented as Mean±SEM.

RESULTS AND DISCUSSION

The edible parts of fresh plant materials e.g., the leaves of *B. purpurea* , *D. esculentum*, the fruits of *E. latifolia* , *E. pyriformis* and the flowers of *D. pentagyna* 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 parameters of the plants collected from Meghalaya

Name of the plant	Local name at Meghalaya	Parts used	Ash (g kg^{-1})	Moisture (g kg^{-1})	Crude fat (g kg^{-1})	Protein (g kg^{-1}) (6.25 × % of N)	Available Carbohydrate (g kg^{-1})	Crude fibre	Nutritive value (kcal kg^{-1})
Bauhinia purpurea	Megong	Leaves	87.06±0.80	744.1±1.90	12.4±0.507	6.2±0.5081	0.93±1.801	3.4±0.4	3660.13±2.90
Dillenia pentagyna	Agachi	Flowers	98.16±1.20	895.4±2.70	12.6±0.600	7.1±0.4082	4.50±1.605	7.5±0.4	3440.36±8.60
Diplazium esculentum	Jhur-tyrkhang	Leaves	122.03±0.58	876.2±1.91	1.3±0.700	143.8±2.06	83.94±2.40	38.8±0.5	3413.16±2.46
Elaeagnus latifolia	Soh-shang	Fruits	86.16±0.96	864.3±2.60	15.1±0.300	148.2±0.80	743.40±0.40	7.0±0.3	3702.73±4.90
Elaeagnus pyriformis	Heiyai	Fruits	54.03±0.84	836.4±1.60	14.9±0.500	231.8±0.50	691.36±0.78	7.8±0.4	3827.03±5.45

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: Mineral value of plants collected from Meghalaya

Name of the plant	Local name at Meghalaya	Parts used	Minerals present (mg kg^{-1}) Na	K	Ca	Mn	Cu	Fe	Cr	Zn
Bauhinia purpurea	Megong	Leaves	1180±72.0	24280±210	5860±40	35±0.60	15±0.20	168±0.20	NT	210±1.6
Dillenia pentagyna	Agachi	Flowers	815±27.0	33150±110	13330±70	104±0.30	38±0.20	162±0.40	NT	168±1.7
Diplazium esculentum	Jhur-tyrkhang	Leaves	1180±72.0	43730±110	8730±80	51±0.10	26±0.20	257±1.8	NT	167±1.8
Elaeagnus latifolia	Soh-shang	Fruits	965±8.0	13580±80	5860±40	21±0.20	6±0.20	172±0.20	NT	248±1.3
Elaeagnus pyriformis	Heiyai	Fruits	950±10.0	14410±80	6260±100	36±0.20	13±0.30	159±0.10	NT	76±1.5

Each value in the table was obtained by calculating the average of three experiments (n = 3) and data are presented as Mean±SEM, NT = Not traceable

Table 3: Nutritional parameters of some common vegetables and fruits

Name of the plant	Ash (%)	Moisture (%)	Crude fat (%)	Protein (%) (6.25 × % of N)	Available carbohydrate (%)	Crude fibre (%)	Nutritive value (kcal kg^{-1})
Apple	1.20	84.60	0.3	0.21	0.5	3.2	580
Brinjal	1.60	88.70	0.3	1.40	1.7	6.3	240
Broad beans	2.80	82.40	0.1	4.50	1.3	8.9	480
Cabbage	1.69	1.90	0.1	1.80	1.8	2.8	270
Cauliflower	2.29	0.80	0.4	2.60	0.3	3.7	300
Lettuce	1.79	3.40	0.3	2.10	-	-	210
Lichi	1.08	4.10	0.2	1.10	-	-	610
Mango ripe	1.10	81.00	0.4	0.60	14.9	2.0	740
Papaya ripe	1.39	0.80	0.1	0.60	4.6	2.6	320
Potato	1.07	4.70	0.1	1.62	0.9	1.7	970
Spinach	2.39	2.10	0.7	2.00	0.4	2.5	260
Wood apple	6.96	4.20	3.7	7.10	18.1	-	1340

The proximate analysis of the nutritive contents of five plants are depicted in Table 1. The results obtained from analytic chemical analysis of all five wild edible plants establishes that nutritive value of the fruits of *E. pyriformis* was maximum (3827.03±5.45 kcal kg^{-1}) followed by the fruits of *E. latifolia* (3702.73±4.90 kcal kg^{-1}) and leaves of *B. purpurea* (3660.13±2.9 kcal kg^{-1}) and. The leaves of *D. esculentum* were found to be of less nutritive value (3413.16±2.46 kcal kg^{-1}) but due to high moisture content (876.2±1.90 g kg^{-1}) it has a very good nutritive value and may be used as fodder. The crude protein contents ranged from 231.8±0.5 g kg^{-1} (fruits of *E. pyriformis*) to 7.1±0.40 g kg^{-1} in the (flowers of *D. pentagyna*). The crude protein content in *E. pyriformis* was found to be higher than those of almond (20.80%), cashew nut (21.20%) (Sundriyal and Sundriyal, 2004). The crude protein content in the fruits of *E. latifolia* (148.2±0.80 g kg^{-1}), in the leaves of *D. esculentum* (143.8±2.0 g kg^{-1}) and *B. purpurea* (76.2±0.50 g kg^{-1}) were very much high 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) (Gopalan *et al*., 2004), the protein content in the flowers of *D. pentagyna* (7.1±0.40 g kg^{-1}) was also higher than ripe mango (0.60%) and papaya (0.50%) (Sundriyal and Sundriyal, 2004). These indicates that low cost plant samples are very good sources of protein. The flowers of *D. pentagyna*, leaves of *B. purpurea* and fruits of *E. latifolia* with high content of available carbohydrates (824.5±1.60, 810.93±1.80 and 743.4±0.40 g kg^{-1}, respectively) compared well to that reported for almond (10.50%), apple (13.7%) (Sundriyal and Sundriyal, 2004), wood apple (18.1%), potato (22.6%) and ripe mango (16.9%) (Gopalan *et al*., 2004) and these could be a supplements in feed formulations. The ash content was found lowest in *E. pyriformis* (54.03±0.84 g kg^{-1}) and highest in *D. esculentum* (122.03±0.58 g kg^{-1}). The fat content in the fruits of *E. latifolia* (15.1±0.3 g kg^{-1}) and *E. pyriformis* (14.9±0.50 g kg^{-1}) was particularly high and well compared to that reported for some common fruits like wood apple (3.7%), litchi (0.20%) and ripe mango (0.4%) (Gopalan *et al*., 2004). The flowers of *D. pentagyna* contained the highest amount of crude fibre (57.5±0.40 g kg^{-1}) and *E. latifolia* the lowest content (7.0±0.30 g kg^{-1}) and similar to commercial fruits and vegetables like apple (3.2%), broad beans (8.9%), cabbage (2.8%), potato (1.7%), spinach (2.5%) (Gopalan *et al*., 2004). The proximate composition of these plants were very much comparable to some other wild edible plants like *Morus indica*, *Myrica nagi*, *Myrica esculenta*, *Parkia roxburghii*, *Prunus nepalensis*, *Terminalia bellerica* etc. collected from different tribal market of Meghalaya (Seal, 2011).

Table 4: Mineral contents 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	0.6
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
Lettuce	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	1.01	1.4	0.05	3.0
Wood apple	-	-	1300	1.8	2.1	4.8	0.06	4.6

The mineral composition in edible parts of the plants are shown in Table 2. High concentrations of sodium (Na) were present, ranging from 815±27.0 mg kg^{-1} (*D. pentagyna*) to 1.180±72.0 mg kg^{-1} (*B. purpurea* and *D. esculentum*). 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 *D. esculentum* (43730±110.0 mg kg^{-1}) and least in the fruits of *E. latifolia* (13580±80.0 mg kg^{-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 (Saupi *et al.*, 2009). The ratio of K/Na were significant in the flowers of *D. pentagyna* (40.67), in the leaves of *D. esculentum* (37.05), *B. purpurea* (20.58), fruits *of E. pyriformis* (15.16) and *E. latifolia* (fruits) (14.07) and compared with leafy vegetables (cabbage 17.5, tomato 47.1, beet 3.9) (Sundriyal and Sundriyal, 2004). The calcium (Ca) content was highest in the flowers of *D. pentagyna* (13330±70.0 mg kg^{-1}) followed by in the leaves of *D. esculentum* (8730±80.0 mg kg^{-1}), fruits of *E. pyriformis* (6260±100.0 mg kg^{-1}) and leaves of *B. purpurea* (5860±40.0 mg kg^{-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 (Indrayan *et al.*, 2005).

Copper is another trace element essential in human body where it exists as an integral part of copper proteins ceruloplasmin, the enzyme that catalyzes the oxidation of iron ion (Saupi *et al.*, 2009). The sufficient amount of copper (Cu) was present in *D. pentagyna* (38±0.20 mg kg^{-1}), *D. esculentum* (26±0.20 mg kg^{-1}) and in *B. purpurea* (15±0.20 mg kg^{-1}). An appreciable quantity of Zinc (Zn) was found to be present ranging from 76±1.5 mg kg^{-1} (*E. pyriformis*) to 248±1.3 mg kg^{-1} (*E. latifolia*).

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. Its deficiency leads to growth failure and poor development of gonadal function (Ihedioha and Okoye, 2011).

The Manganese (Mn) concentrations of the plants studied varied between 21±0.20 to 104±0.30 mg kg^{-1}. The highest Mn values was found in the flower of *D. pentagyna* (104±0.30 mg kg^{-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 (Indrayan *et al.*, 2005). Manganese is one of the most important minerals for human physiology and daily requirement for healthy person is 4.50 mg (Sekeroglu *et al.*, 2006). High concentration of iron (Fe) were present in the leaves of *D. esculentum* (257±1.8 mg kg^{-1}), *B. purpurea* (168±0.20 mg kg^{-1}), in the flowers of *D. pentagyna* (162±0.40 mg kg^{-1}) and in the fruits of *E. latifolia* (172±0.20 mg kg^{-1}) and *E. pyriformis* (159±0.10 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 (Sekeroglu *et al.*, 2006). 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 of human being due to their good nutritional qualities and adequate protection may be obtained against diseases arising from malnutrition.

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