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NUTRITIVE VALUES OF WILD EDIBLE FRUITS, BERRIES, NUTS, ROOTS AND SPICES CONSUMED BY THE KHASI TRIBES OF INDIA

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Fourteen wild edible berries, fruits, roots, and nuts consumed by the Khasi tribe of Meghalaya were botanically identified and analyzed for their nutrient contents in terms of macronutrients, minerals, and vitamins. The study revealed that *Coix lachryma* jobi, a nut, was rich in protein (13.3 g %), *Zanthoxylum acanthopodium,* a spice, rich in fat (20.9 g %), and *Solanum indicum,* a berry, rich in crude fiber (47.2 g %). *Castanopsis indica,* a nut, contained good amounts of calcium (1540 mg %), *Kaempfaria galanga,* a root, considerable amounts of iron (69.91 mg %) and zinc (8.4 mg %), and *Vangeria spinosa,* a fruit, a good amount of zinc (23.0 mg %). The berry *Solanum indicum* contained 826.4 mg % of vitamin C, whereas *Prunus nepalensis* contained β-carotene (257.1 μg %) and vitamin C (608.9 mg %). It can be concluded that the wild edibles eaten by the Khasi are a good source of nutrients, and

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considering their low cost and easy availability, need to be popularized and recommended for commercial exploitation.

KEYWORDS Wild edibles, fruits, berries, roots, nuts, nutritional content, Khasi tribals

India's recognition as one of the four-mega diversity countries of Asia is derived from two of its important diversity attractions: the Himalayas, including the northeastern part of India and the Western Ghats in peninsular India (Ramakrishna, 2000). Indigenous tribal groups constitute the major segment of the population of these two regions and live in environments characterized by defined areas with specific food habits, dialects, cultural homogeneity, and a unified social organization. The rich biological diversity of the area is managed and utilized by these native communities in a variety of ways. Edible wild plants are common food resources among these tribes. Barks, flowers, fruits, leaves, nuts, roots, seeds, and tubers can be primary foods or secondary condiments to dishes prepared from domesticated cultivars.

The northeastern region of India is inhabited by a number of small and large tribes, and in comparison to the rest of India, is dominated by a tribe, constituting up to 75% of the population of the area. Meghalaya is one of the seven sister states in the northeastern part of India where 85.5% of the population is tribal (National Centre for Health Statistics, 1987). The Khasis of Meghalaya are an important tribe in bio-diversity rich Northeast India. Meghalaya is rich in fauna and flora and this natural environment has inevitably made a deep impact on the people, and the physical features of the land may be considered partly responsible for their unique food habits (Mathur, 1979). Their staple food is rice, meat, potatoes, and other locally grown vegetables and fruits. For centuries, the Khasis have used indigenous wild plants to satisfy their requirements for energy and essential nutrients (Agrahar-Murugkar and Pal, 2004). Maikhuri and Gangwar (1993) have catalogued a total of 105 plants used for food and medicine by the Khasi tribe of Meghalaya. Recently, it has been observed that the traditional cultures of these communities, including their knowledge and uses of wild plants, are rapidly changing through contact with other cultures. With this loss of traditional cultures goes the knowledge of native plants (Maikhuri, 1991). Dietary deficiencies of carotene, calcium, iron, etc. have been observed in the community (Agrahar-Murugkar and Pal, 2004). One of the reasons for the observed

deficiencies could be the decreased use of traditional wild edibles available in the region.

Still, nutritional data on these so called "lesser foods" remain scarce (Ogle and Grivetti, 1985; Grivetti et al., 1987). Wild foods are valuable sources of energy and micronutrients in the diets of isolated communities. Further, such plants may serve as income sources and may be marketed or traded locally, regionally, even internationally, and the primary importance of edible wild species during periods of drought and or social unrest or war is well documented (Grivetti, 1978).

To date, there has been no systematic study and presentation of the nutrient values of the foods from this cultural group. These data would be useful for the evaluation of dietary use information, and therefore helpful in a public health context. Therefore, an attempt has been made in this study to catalogue these wild edibles and determine the amounts of major nutrients they contain.

METHODS

Demographic particulars. The Meghalaya plateau is an eastward extension of the massive block of peninsular India lying to the east of the great gap in the Archenh terrain, which subsequently filled up with alluvium deposited jointly by the Ganga and Brahamaputra. Meghalaya or the "Abode of Clouds" is so-named due to the climatic phenomenon that brings torrents of rain to its mountainous terrain. The state is approximately 22,429 square kilometers and lies between 251 ^{o}–265 ^{o}North and longitudes 85.49 ^{o}–92.53 ^{o}E. It is bounded by Assam in the north and east and the plains of Bangladesh in the south and west. The total cropped area is 15,111,000 hectares.

Identification and collection of the wild plants. A group of six Khasi elders described the most commonly consumed unconventional fruits, nuts, berries, spices, and roots eaten by the Khasi tribals for their availability in the region as well as the methods of use. Wild foods are sold in small village markets after being harvested from the nearby forests. Foods found on the outskirts of the forests are picked by the tribal peoples on their way to the forests and are generally not sold in the market. During the harvest time of the foods between 2001–2003, the elders accompanied the collection team to the spots where the foods were being

harvested. At least 500g of each sample was collected from several plants (at least 20) for analysis. The samples collected of each species were then pooled for nutrient analysis. The samples were then botanically identified at the National Bureau of Plant Genetic Resources, Indian Council of Agricultural Research (ICAR), Barapani, Meghalaya and Botanical Survey of India, Shillong, Meghalaya, India.

Sample preparation. The fruits and berries were first washed to remove mud and other extraneous material.They were blotted dry till the excess moisture was absorbed. The larger fruits and berries were then cut into small pieces. The thick stalks and other inedible portions were discarded. The samples were then weighed and dried in the oven at 60° C. After complete drying, the sample was ground to obtain a fine powder. This powder was sealed and stored in vacuum desiccators until use further for analysis. For Vitamin C analysis, the fruits and berries were weighed immediately (within 12), ground with 6% meta phosphoric acid, and stored in the freezer until analysis.

Analyses

Macronutrients. The crude protein content of the samples was estimated by the MacroKjeldal method (Association of Official Analytical Chemists, 1984) where the sample was digested with a known quantity of acid in the KelPlus digestion apparatus. The digested material was distilled with the addition of alkali into the digested material. The released ammonia was collected in 4% boric acid in the KelPlus Automatic Distiller. The resultant boric acid, which now contained the ammonia released from the digested material, was then titrated against 0.1N HCL manually. The nitrogen content thus determined was multiplied with a factor of 6.25 to arrive at the amount of crude protein (Raghuramulu et al., 1983). Fat in the samples was determined by extracting a known weight of powdered plant sample with petroleum ether using the Labconco ether extract apparatus (AOAC, 1984). Crude fiber was determined by acid and alkali digestion methods using a Fibra Plus Fibre tech apparatus on the fat extracted sample (Raghuramulu et al., 1983). The ash content was determined by combusting the plant material in silica crucibles in a muffle furnace at 620° C for 3 h (AOAC, 1984).

Minerals. The ash obtained after combustion in the muffle furnace was used to prepare the ash solution, which was in turn used for the estimation

of calcium and phosphorus. Calcium was precipitated in acidic medium as insoluble calcium oxalate by adding saturated ammonium oxalate solution. The precipitate was dissolved in dilute sulphuric acid (1:9), heated and the oxalic acid thus released was titrated against standard potassium permanganate solution in warm condition (60°C) to get the calcium content of the sample (Raghuramulu et al., 1983). Phosphorus was determined spectrophotometrically using the Vendate's solution (AOAC, 1984).

The micronutrients (Fe, Cu, Zn, Mn, Mg, Se) were determined by the atomic absorption spectrophotometric method. The samples, which were digested in a tri acid solution of H_2SO_4, HCl, and HNO_3, were passed through Atomic Absorption Spectrophotometry (AAS) using different lamps and, calibrated for different micronutrients. Potassium and sodium was determined through flame photometer after tri-acid digestion (AOAC, 1984).

Vitamins. Ascorbic acid was determined by a reduction method using a dye, (2, 6 dichlorophenol indophenol), which turns blue in alkaline solution and red in acid solution, and is reduced to colorless by the addition of ascorbic acid (Raghuramulu et al., 1983). The β-carotene was estimated by the Food Research and Analysis Centre (New Delhi) by using the method of Siong et al., (1995).

RESULTS AND DISCUSSION

Soh ot, (*Quercus robur),* Soh ot rit (*Castanopsis indica),* Sohma (*Rhus semialata*), and Riew magain (*Coix lachryma* jobi) were the nuts studied. They were available between August through December. Tribal peoples reported that Soh ot (*Q. robur*), Sohot rit (*C. indica*), Riew mangain (*C. lacryma* jobi) are shelled and eaten raw. Sohma (*R. semilata)* is eaten raw and is also soaked in water overnight till it disintegrates to be drunk with the water as a medicine for diarrhea. The dried form is powdered, stored, and used as a cure for stomach disorders (Table 1).

Berries available between August through December include Sohlang (*Viburnum corylifolia*), Sohiong (*Prunus nepalensis*), and fruits available between July through November included Sohmaten (*Vangerias pinosa)*, Sohngang heh (*Solanum gilo*), Sohthang (*Solanum xanthocarpum*), Sohngang rit (*Solanum indicum*), and Sohthliem (*Gomphogyne cissiformis*). Sohlang (*V. corylifolia*), a red juicy berry, is eaten as such.

Table 1. Local names, botanical names and seasonality of nuts, fruits, berries, spice, root and tuber consumed

Classification	Common Name	Botanical Name	Common Name	Seasonality
Nuts	Soh ot	*Q. robur*	Common oak	August–November
	Riew mangain	*C. lachrymal* jobi	Job's tears	November–December
	Sohma	*R.semialata*		September–November
	Soh ot rit	*C. indica*		November–January
Fruits & berries	Soh gang heh	*S. gilo*		July–October
	Soh thang	*S. xanthocarpum*	Kantikari	August–November
	Sohmaten	*V. spinosa*		September–November
	Sohthliem	*G. cissiformis*		August–November
	Sohngang rit	*S. indicum*	Indian night shade	July–October
	Sohlang	*V. corylifolia*		September–November
	Sohiong	*P. nepalensis*		August–December
Spice	Jaiur	*Z. acanthopodium*	Indonesian lemon pepper	June–August
Root	Sying smoh	*K. galanga*	Galanga peacock/ Sugandhavcha	August–November
Tuber	Sohphlang	*F. vestita*	-	September–December

Apart from its culinary use it is also used as a bait to catch fish. Sohiong *(P. nepalensis*) is eaten as such and also made into jams, juices, and squashes. Sohmaten *(V. spinosa*) is eaten as such, and also dried for preservation as a dried fruit. Sohngang heh (*S. gilo*) is cooked along with potatoes, as a replacement for tomatoes in any vegetable dish as it looks like a tomato with a slightly bitter taste. Sohthang (*S. xanthocarpum*), Sohngang rit (*S. indicum*) are eaten like "*chutney"* ground with onions, green chilies, salt, and/ fermented fish (*Puntias sophore*). Sohthliem (*G. cissiformis*) is eaten as a salad or cooked vegetable (Table 1).

Among the unconventional foods identified in this group, Sying smoh (*Kaempfaria galanga*) is a medicinal root, eaten like "*chutney"* ground with onions, green chilies, salt, and fermented fish (*Puntias sophore*), Jaiur (*Zanthoxylum acanthopodium),* a spice, with a pleasant smell like mint used in a variety of typical Khasi preparations both in the raw form and as a dried powder and Sohplang *(F. vestita*), a tuber, is eaten raw as such or with roasted sesame seed dip (Table 1).

Macronutrient content

Nuts and oilseeds known to be good sources of fat and protein are consumed in the winters. These nuts are generally dry and contain low levels of moisture. The moisture content of conventional nuts is very varied and ranged between 1.7 g % in groundnut seeds to 90.8 g % in fresh coconut (Gopalan et al., 1989). In the unconventional nuts, the range was from 51.3 in *Q. robur* to 91.1 in *C. lacryma jobi*, the variations within the group being smaller.

Unlike the conventional nuts like groundnut, which contained high amounts of protein (40 g %), the unconventional nuts studied were low in protein between 4.9 g % in *C. indica* to 13.3 g % in *C. lacryma* jobi. Therefore, although these are called nuts they don't necessarily compare with common nuts.

The fat content in nuts ranged from 0.3 g % in *C. indica* to 12.3% in *R. semialata.* These nuts are consumed in the winter months and provide a concentrated source of energy in terms of fat essential to keep warm in the severe winter of the Khasi hills.

The content of fiber in most conventional nuts is low, being around 11–12 g % (Gopalan et al., 1989). In the same line, the fiber values for the unconventional nuts were also low and varied from 2.3 g % in *C. indica* to 12.3 g % in *R. semilata*. Similarly, the lowest levels of Acid Detergent Fibre (ADF) (3.0 g %) and cellulose (2.3 g %) were seen in *C.indica,* whereas low levels of lignin were observed in *Q. robur* (0.4). The range for Neutral Detergent Fibre (NDF) akin to dietary fiber was within a very narrow rage of 50.9 g % in *C .lachryma* to 69.9 g % in *Q.robur.* The surprising factor was that the levels of NDF were much higher than those expected or seen in the other fiber fraction content (Table 2).

Fruits and berries usually contain a large percentage of moisture. Depending on the pulpiness of the fruits, *G. cissiformis,* a soft spongy fruit, contained 4.8 g % dry matter and the small dry *S. indicum* contained 21.3 g % of dry matter. The wide variation in moisture contents were also seen in the conventional fruits, the range being from 15% in dried dates to 90% in *Spondias mangifera* (Gopalan et al., 1989).

Fruits and berries are generally not considered very good sources of protein. In spite of this, the contents of protein in the wild fruits were comparatively higher than the conventional counterparts. The range for protein varied between 2.7 g % in *V.spinosa* to 14.4 g % in *G.cissiformis.* In conventional fruits, the highest protein content was seen in black currant at 3.3 g %. Though protein is not a limiting factor in the Khasi

Table 2. Macronutrient content of fruits, roots, nuts, berries, and spices.

Botanical Name	Dry Matter	Protein	Fat	Crude Fiber	ADF	NDF	Lignin	Cellulose	Hemi-cellulose	Ash
	g% on dry weight basis									
Q. robur	51.3	6.9	1.5	2.6	3.1	69.9	0.4	2.9	66.8	2.4
*C. lachryma*jobi	91.1	13.3	7.0	11.2	7.9	50.9	2.6	5.3	43.0	1.6
R.semialata	72.3	7.0	12.3	12.3	36.7	59.6	3.6	30.8	22.9	3.1
C. indica	65.1	4.9	0.3	2.3	3.0	64.7	0.5	2.3	61.7	1.5
S. gilo	8.6	11.0	3.6	28.2	43.9	48.9	5.3	39.2	5.1	7.7
S. xanthocarpum	20.9	11.3	1.5	27.1	28.5	41.0	3.2	33.9	12.5	6.8
V. spinosa	25.1	2.7	0.4	11.1	20.1	22.7	7.9	12.0	2.6	3.8
G. cissiformis	4.8	14.4	3.6	16.7	29.6	38.7	2.6	25.4	9.1	11.9
S. indicum	21.3	14.1	8.8	47.2	43.9	48.9	5.3	39.2	5.1	4.9
V. corylifolia	19.1	5.5	11.2	18.4	26.9	41.3	9.8	21.5	14.4	3.5
P. nepalensis	18.7	4.6	0.7	7.2	16.5	36.3	1.2	14.4	19.8	4.9
Z. acanthopodium	91.5	11.3	20.9	33.9	40.9	42.3	11.8	32.4	1.4	9.2
K. galanga	21.3	4.7	10.2	8.3	15.6	62.9	0.5	12.7	47.3	8.4
F. vestita	30.7	5.4	0.4	1.4	4.9	9.1	1.5	4.2	5.1	2.0

diet (Agrahar-Murugkar and Pal, 2004), the additional protein from fruits is an added benefit.

Fruits are an essential component of low calorie diets due to the low fat content. All the wild fruits and berries also exhibited low levels of fat, except *V.corylifolia* (11.2 g %), which was unusual. Avacado pear (*Persea Americana*), a conventional fruit, had very high levels of fat at 84 g % on dry matter basis. Fruits like *V.corylifolia* could be classified as high-energy yielding fruits—a valuable supplement for underweight women and children.

An important reason why fruits are advocated for health is due to the high levels of fiber in them. All the samples analyzed showed high levels of crude fiber, dietary fiber, and fiber fractions. The ranges for the different fractions of fiber were also similar with the lowest levels of crude fiber (7.2 g %), ADF (15.5 g %), and lignin (1.2 g %) in the soft fleshy fruit *P. nepalensis*and the highest levels of crude fiber (47.2 g %), ADF (43.9 g %), NDF (48.9 g %), cellulose (39.2 g %), and lignin (5.3 g %) in the hard dry *S. indicum* and *S. gilo.* Coincidentally, *S. gilo* also had the least amount of moisture in this category. The levels of fiber are also significant as fruits are considered as a storehouse of minerals whose absorption could be affected due to the high levels of fiber (Table 2).

The macronutrient composition of the fruits was comparable to those of agricultural fruits, although they were somewhat higher in crude protein, carbohydrate, and energy and somewhat lower in fat (Rawat et al., 1994; Murray et al., 2000; Achinewu et al., 1995; Kuhnlein et al., 1994).

Spices are rarely used in Khasi cooking and most of the food is bland. Apart from turmeric and ginger, the only other spice is *Z. acanthopodium.* Since the spice is dried and used, naturally the dry matter content is 91.5 g %, which is similar to the conventional spice pepper (86 g %). The protein content was 11.3 g% and fat content 20.9 g %, both of which can be considered high. However, this dried spice is used as a seasoning in small quantities in the diet; thereby its contribution to the macronutrient profile of the diet is negligible.

Unconventional roots and tubers include *K. galangal,* the medicinal root, and *F. vestita*, a tuber. The dry matter contents of both of them were similar being 21.3 g % in *K. galanga*and 30.7 g % in *F. vestita*. Protein levels were 4.7 g % in *K. galanga* and 5.4 g % in *F. vestita*. None of the items under these categories had significant amounts of protein and are not considered rich sources (Table 2).

Minerals

Conventional nuts like sesame seeds contain high amounts of calcium (1450 mg %). Similarly, the nut *C.indica* contained 1000 mg % of calcium on fresh weight basis. Other nuts had lower amounts of calcium. Generally, around 50 grams of nuts are consumed in winter by these tribes (Agrahar-Murugkar and Pal, 2004) supplying almost 100% of RDA.

Iron levels were found to be low in both conventional and unconventional nuts. In these unconventional nuts, the iron content was in a narrow range between 2.35 mg % in *C.lachryma* jobi and 4.70 mg % in *C.indica*. But with reference to zinc, the picture was just the opposite, *i.e.*, *C.indica* had the lowest value (1.53 mg %) while *C.lachryma* jobi showed the highest (5.10 mg %). A similar range for zinc was observed among conventional nuts (Gopalan et al., 1989).

All the nuts had negligible levels of sodium, which is a great advantage in patients suffering from hypertension. Interestingly, it has been observed that most Khasis suffer from low blood pressure rather that hypertension (Agrahar-Murugkar and Pal, 2004). The low sodium contents of the foods consumed by them may be an important contributing factor in this regard (Table 3).

Fruits and berries are a good storehouse of minerals. Generally, Khasis reportedly consume around 20 grams of fruits per day (Agrahar-Murugkar and Pal, 2004). However, the intake of wild fruits/berries and their specific nutritional contribution to the Khasi diet is difficult to quantify since most of these foods are used as snacks. Fruits are usually consumed when away from home while working or walking around the forests for collecting firewood and other minor forest produce. Therefore, it can safely be presumed that the Khasis get adequate quantities of micronutrients from fruits.

Calcium levels in conventional fruits varied widely between 10 mg % in *Nephelium longana* to 364 mg % in *Ficus benghalensis* (Gopalan et al., 1989). The unconventional counterparts were in the narrower range of 130.5 mg % in *V.spinosa* to 276.9 mg % in *S. indicum* on a fresh weight basis. *S.indicum* can be considered as a good source of calcium as the fruit has high dry matter content. The wild berries *Ribes divaricatum* contained 124 mg % (Kuhnlein, 1989) and *Adansonia digitata*had 116 mg% (Saka et al., 1992) of calcium, which are similar to the amounts found in the present study.

Table 3. Mineral profile of fruits, roots, nuts, berries, and spices.

Botanical Name	Ca	P	Fe	Mn	Cu	Zn	Na	K	Mg	Se µg%
	mg% on dry weight basis									
Q. robur	410	150	4.70	5.63	1.66	1.59	0.13	8.27	126.19	0.2
*C. lachryma*jobi	1100	330	2.35	-	0.82	5.10	0.03	3.61	193.49	0.5
R. semialata	1020	160	4.17	-	0.63	2.37	0.03	8.41	111.10	0.9
C. indica	1540	80	2.60	2.35	0.77	1.53	0.03	4.33	12.68	0.6
S. gilo	590	440	3.69	4.61	1.70	1.49	0.23	29.51	353.46	0.2
S. xanthocarpum	990	290	3.22	6.53	1.75	1.75	6.39	39.49	-	-
V. spinosa	520	10	2.14	4.98	0.43	22.99	0.05	13.59	101.65	0.4
G. cissiformis	1170	290	6.24	2.35	0.53	3.82	0.16	59.38	93.65	X
S. indicum	1300	240	4.47	5.67	1.38	3.58	0.13	16.44	284.27	X
V. corylifolia	630	140	3.55	9.63	1.27	1.62	0.11	11.13	161.39	0.2
P. nepalensis	1220	70	10.70	6.62	1.22	1.49	0.10	16.05	217.74	0.5
Z. acanthopodium	960	210	3.52	6.83	1.48	3.58	0.15	28.10	324.10	X
K. galanga	950	60	69.91	42.65	0.91	8.35	0.32	12.23	293.92	1.2
F. vestita	1440	130	1.70	3.72	0.66	9.20	0.06	6.53	290.77	0.2

*(-) Analysis not done, (X) negligible amounts

Red cherries contain high amounts of iron (8.5 mg %) among conventional fruits on a fresh weight basis. *P.nepalensis,* looking similar to the red cherries (*Prunus cerasus*), contained only 3 mg % iron on fresh weight basis. In a study of the nutrient values of the indigenous berries used by Nuxalk people of Bella Coola, British Columbia, Kuhnlein (1989) reported that berries like *Sambucus racemosa* contained 1.1 mg % of iron on a dry weight basis, within the range of the present study. In short, wild fruits compared rather poorly with the conventional sources as far as iron is considered.

Copper contents of the wild variety were in the range of 0.1 mg % in *V.spinosa* to 0.4 mg % in *S.xanthocarpum* on a fresh weight basis and are similar to the range of conventional fruits (0.05 mg percent in dates to 0.43 mg % in *Annoma squamosa*) as per the report by Gopalan et al. (1989). The amounts in the fruits could take care of the meager requirement of copper of 2–3 mg / d.

Zinc plays an important role in many of the cellular functions of the body. The estimated requirement for Indians for zinc is 15 µg /d through dietary sources including fruits (Indian Council for Medical Research, 1989). The fruits contained zinc levels between 1.5 g % in *P.nepalensis* to

23.0 mg % in *V.spinosa* and compared well with that of other wild berries where *Shepherdia canadens is* contained 1.4 mg % of the mineral (Kuhnlein, 1989).

Sodium levels are generally not expected to be high in fruits. But certain conventional fruits like *Nephelium longana* have levels up to 124.9 mg % on fresh weight basis (Gopalan et al., 1989). The unconventional sources, however, had low levels ranging from 0.05 mg % in *V.spinosa*to 6.39 mg % in *S. xanthocarpum*.

The fruits and berries analyzed contained on average around 200 mg % of magnesium, which may be adequate considering that this mineral is available from many other sources. *S.gilo* contained 350 mg % of the mineral and can be considered a good source (Table 3). Kuhnlein et al. (1994) analyzed berries like *Vaccinium myrtilloides, Ribes oxyancanthoides, Vaccinium vitis-idaea,* and they also reported that the berries were a rich source of magnesium.

Many workers agree that berries may not be a good source of macronutrients but were a very good source of minerals and vitamins, especially a rich source of ascorbic acid. Workers also reported that the edible wild plants were often the highest in mineral concentration as compared to the exotic reference foods (Smith et al., 1996; Sundriyal and Sundriyal, 2001), which has also been seen in the present study.

The spice *Z. acanthpodium* contained calcium (0.96 mg %), iron (3.52 mg %), zinc (3.58 mg %), copper (1.48 mg %), and sodium (0.15 mg %) with all the levels being comparable to that of the conventional spice black pepper.

The roots and tubers *K. galanga*and *F.vestita*were rich in many important minerals. *F.vestita* contained 442 mg % of calcium on fresh weight basis, much higher than any conventional source. Iron content was the highest in the medicinal root *K. galanga* (69.91 mg %). Not only was the content of iron in *K galanga* higher than its conventional counterparts, it was the highest in the entire group of nuts, fruits, and berries. The high level of iron could be one of the contributing factors to its being considered medicinal. Zinc levels in both of the foods were adequate and within a narrow range of 8.4 mg % in *K.galanga* to 9.2 mg % in *F.vestita.* Sodium levels in *K.galanga* were higher (3.2 mg %) than *F.vestita*. On the other hand, conventional roots and tubers contained much higher sodium (e.g., 63.5 mg % in radish). Magnesium content of 290.8 mg % can be considered adequate, keeping in mind the requirement

of magnesium. Selenium levels were almost negligible in both the root and the tuber (Table 3).

Vitamins

Nuts are not traditionally a good source of vitamin C and all the nuts except *C.indica* showed negligible amounts. Similarly, the β-carotene content of *C. indica* was high at 154.7 μg % and comparable to the β-carotene content of mustard seeds at 162 μg % (Gopalan et al., 1989).

Fruits and berries are often recommended for their high contents of vitamin C. Levels ranged from 79.25 mg % in *S.gilo* to a high of 826.4 mg % in *S.indicum*. The amounts of vitamin C found in *P.nepalensis* (609 mg %), was higher compared to the highest amount found in the conventional Indian gooseberry (*Emblica officinalis*) at 600 mg % (Gopalan et al., 1989). Meng and Hu (1991) in their study of the wild fruit germplasm resources of the Linxia region of China reported that these species had more than 500 mg of vitamin C per 100 g. Amongst all the fruits analyzed, they made a special mention of *Rosa davidii*, which contained 2354 mg % vitamin C.This means that some of the wild fruits are excellent sources of the vitamin and their consumption can take care of the dietary ascorbic acid requirements. This is reflected in the vitamin C consumption by the Khasis of around 68 mg/d (Agrahar-Murugkar and Pal, 2004) when the Indian recommended dietary allowance is 40-mg/d. In general, the researchers unanimously agreed that wild fruits and berries were an excellent source of ascorbic acid (Saka et al., 1992; Kuhnlein, 1989). β-carotene levels were analyzed only in *S.indicum* and *P.nepalensis*. The latter contained 257 (μg %), within the range for conventional fruits, though on the lower side.

In totality, it was observed that the wild fruits and berries were good sources of vitamins C and A, as well as of minerals like calcium and iron. Studies by other researchers have corroborated this view where wild fruits are important sources of micronutrients especially for women and children (Fleuret & Fleuret, 1980; Campbell, 1987; Omori and Greksa, 1996; Lockett, 1999).

K. galanga, the medicinal root, was analyzed only for the β-carotene content. The amount of 182.3 (μg %) was moderate and comparable to conventional roots like yam (260 μg %). However, in comparison with roots like carrots (Gopalan et al., 1989), the vitamin content was quite low. *F.vestita* contained 419 mg % of vitamin C much higher than any of

Table 4. Vitamin content of fruits, roots, nuts, berries, and spices.

Botanical Name	VitC (mg %)	Carotene (μg %)
Q. robur	X	-
R.semialata	X	14.6
C. indica	8.1	154.7
S.xanthocarpum	321.5	-
G. cissiformis	273.5	-
S. indicum	826.4	38.4
V. corylifolia	238.7	-
P. nepalensis	608.9	257.1
K. galangal	-	182.3
F. vestita	419.1	-

*(-) Analysis not done, (X) negligible amounts

its conventional counterparts. Another advantage is that the tuber is consumed raw, increasing the availability of the vitamin considerably (Table 4).

The wild nuts, fruits and berries, roots and tubers, and spices available in different parts of the world were varied, and not much similarity existed between what was found in different parts of the world in comparison to what was found in the Khasi hills of Meghalaya. Inspite of the varietal difference, a common thread ran through all of them in terms of the nutritional composition. The nuts were high in fat and fruits and berries were low in fat and high in fiber, which made them ideal snack foods. All of the foods in this group were a rich storehouse of minerals and vitamins. Nuts like *C.lacryma* jobi were rich in calcium and zinc; fruits and berries like *S.indicum* were rich in calcium, magnesium, and vitamin C; *P.nepalensis* was rich in iron, vitamin C, and β-carotene, while V.spinosa was rich in zinc. The tuber *F.vestita* was rich in calcium, zinc, and vitamin C, while the root *K.galanga* in zinc, iron, and β-carotene.

CONCLUSION

Wild plants are an important food resource for the Khasi people of India. The nutritive values of the wild edibles are good. In many cases, the nutritive values of the edibles analyzed are superior to conventional foods consumed. This article contributes to the scientific notation and adds to the knowledge of the nutritional properties of these foods, which have not been previously documented.

The nutrient profile of the various wild edible fruits, roots, tubers, and nuts observed during the course of study re-emphasizes the need for including these food groups in regular community nutrition programs conducted by governmental and other agencies and can play an important role in mitigating the various nutritional deficiency problems amongst the population of not only India, but elsewhere where such species would be available. Considering their low cost and easy availability, these wild edibles can be popularized and recommended for commercial exploitation.

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