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Diversity of food composition and nutritive analysis of edible wild plants in a multi-ethnic tribal land, Northeast India: an important facet for food supply

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In view of increasing threat of climate change, extreme whether conditions, and recent financial crisis there has been a concern for augmenting agriculture and food supply to growing population, particularly to the rural areas. Fortunately the communities living near biodiversity rich areas depend on wide variety of plant resources for their survival; selected species have high potential for food supply in near future. In this study, we investigated a multi-ethnic area in North east India, a global hotspot, where communities show high dependence on wild plant resources for their sustenance. We addressed the issues of diversity of food plants being collected from wild habitats and their prospect as new food items, broad nutritive values of selected edible wild plants, and suggested some guiding policy concerns for management of these valuable resources. The investigation was done during 2006 to 2011; a total of 289 plants species were recorded used by selected tribal communities for diverse needs; 75 plant species used for their fruits, 65 as vegetables, 18 as mushrooms, 163 as medicinal plants, 13 as spices, and 11 species for making local drinks and beverages. Use of an algae *Prasiola crispa* as vegetable was found confined to *Monpa* and *Sherdukpens* only. Nearly 76 species were traded in markets involving a good annual turnover. Most promising medicinal plant species of the area comprised *Aconitum fletcherianum* G.Taylor, *Clerodendrum colebrookianum* Walp., *Swertia chirayita* H.Karst., *Cordyceps sinensis* (Berk.) Sacc., *Picrorhiza kurrooa* Royle, *Dendrobium nobile* Lindl., and *Artemisia nilagirica* (C.B.Clarke) Pamp. that were harvested on commercial scale for selling in national and international markets. More species were used at higher altitudes showing greater dependence on wild plant resources. Nutritive values of 16 most preferred edible species revealed that they comprised considerable proximate and macro-nutrients; some are well comparable with commercial fruits and crops in their nutritional quality. It is found the wild edible species play an important role in dietary nutritional balance, and access to these wild plant resources ensures communities to overcome uncertain food stocks particularly during adverse and extreme weather conditions. The study highlights the need to protect these plants in their wild habitats; selected species be domesticated by developing cultivation protocols. It is also emphasized that wild edible plants is an ignored facet of food supply, however if properly planned it can facilitate to develop multifunctional agricultural policies for securing food production along with sustaining landscapes, biodiversity and cultural heritage in rural areas at any part of the globe.

Keywords: Global hotspot, Indigenous communities, Non timber forest products, Commercial extraction, Consumption pattern, Forest management, Rural income, Community livelihood, Nutritive values, Wild edible plants, Mineral contents

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Major perception of recent global distresses such as climate change, extreme weather conditions and financial crisis, and their implications particularly in terms of grave food shortage, there has been a considerable interest to augment agriculture and food production and standard supply to growing population mainly in rural areas. It is urgently desired to take on researches on plants for their appropriateness as dietary alternatives to conventional foods. It is important because agricultural yields are increasingly failing to satisfy the need of our daily diet as population increase is geometric whereas crop production increases more or less arithmetically[1]. To meet this challenge, the use of some alternate food source in our diet becomes indispensable. Alternate food literally means some healthy and readily available supplements excluding the conventional stables of our daily diet. Tribal people intimately depend on the natural resources and thus live in harmony with nature. They collect diverse plant materials from surrounding forests for their day to day needs. The communities comprised rich traditional

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knowledge base regarding the utility of plant resources that are used for food, medicine, oil seeds, fibre, beverages, fodder, fuel, etc[2,7,8,9]. The importance of evaluating and estimating of the nutritional quality of the lesser known wild edible plants has been realized to the greater extent by the scientific world in recent years[3,4,5,6,].

The usage of wild edibles collected by indigenous communities have high potential of enhancing food supply option to rural people, thus comprise promising possibilities for future generations. At the same time, it is also desired that the quality of the edible wild plants be assessed for their nutritional values so as to validate the scientific basis of consumption of these species. Considering that the present investigation was undertaken to assess heterogeneity of wild edible plants used by tribal communities in North east India with an effort to assess the nutritional quality of some promising ones. The study addressed a few questions: what is the diversity of food plants being collected from wild habitats and is there any prospect for them as new food items? What are the broad nutritive values of selected edible wild plants and do they have a role in sustainable nutritional balance of the rural communities? And is there any possibility for developing some policy for its utilization and conservation? It is expected that the diversity of plants used and analysis of wild edible plants products will increase awareness and attitude of people about these traditionally used resources in rural areas.

Material and methods

Study area and village surveys

The study area falls in western part of Arunachal Pradesh state (26°28' and 29° 30' N latitude and 91°30' and 97°30' E longitude), which is located between China (Tibet) in North and North east, Myanmar (Burma) on South east, and Bhutan in West. The state is widely acclaimed as being among most significant biodiversity hotspot. It forms the phytogeographical confluence of the South east Asian (Indo Malayan) and East Asian (Sino Japanese, Formosan and Korean) floras, which perhaps is responsible for such diversity[10]. The forests in the area change with elevations; it comprised tropical/sub-tropical evergreen forests up to an elevation of 900 m, subtropical pine forests between 900-1800 m, temperate broad-leaved and conifer forests between 1800 to 3000 m, sub-alpine forests between 3000-4000 m and alpine vegetation >4000 m. The area is inhabited by 5 indigenous tribes (viz. *Aka, Miji, Monpa, Sherdukpen* and *Bugun*) that use a wide variety of wild plant resources for their need and also possess huge knowledge on their management. Further details of the study area are already available[11,12].

For the purpose of generating detailed information on use of wild edible plant resources, a total of 10 villages were randomly selected, two each for 5 ethnic groups[11]. These villages cover an elevational range of 1000 to 3000 m above sea level that comprised main human habitation zone of North east India. The percentage of literacy among villages ranged from 14.6 to 92.8%. In total 40-60% households in each village were investigated for generating information using semi-structured questionnaires[2,13,14]. The communities were investigated about diversity of wild plant species being used in tribal system, their mode of collection, consumption pattern, and purpose of use (as food, medicine, spices, beverages, and other usage). Information was also collected on the local name of the species, its habit and place of occurrence, plant parts used, period of collection, and altitudinal distribution of species. Samples of each species was collected and made into herbarium and subsequently identified to genera and species with the help of experts of Botanical Survey of India and State Forest Research Institute, Itanagar, Arunachal Pradesh. The herbariums and voucher specimens of species were deposited in the Department of Ecology and Environmental Science, Assam University, Silchar as well as G B Pant Institute of Himalayan Environment and Development, North east Unit, Itanagar, Arunachal Pradesh. Three major markets of the state (Bomdila, Bhalukpong and Itanagar) were surveyed to assess number of wild edible species being sold, their prices and quantities available, number of retailers selling the produce, and net income from selling the produce[15]. More details of the survey procedures are available with Saha[11].

Nutrient analysis

For analyzing the nutritive values, samples of edible parts of selected species were collected separately from wild habitats, all samples were washed, oven dried at 60 ^{0}C till constant weight, and thereafter ground to fine powder. The powdered material was sieved and packed in airtight containers for nutrient analysis. The quantitative analysis of the

wild edibles was broadly done for proximate analysis as well as ultimate analysis. The proximate analysis provides useful information on organic dry matter of the food stuff, e.g. fats, carbohydrates, proteins, sugars, fibres, ash, acidity, etc. The ultimate analysis comprised analysis of selected element (e.g. N, P, K, Na, etc.) that are considered important within food materials. At least three samples were used for each nutrient analysis for a species. Crude fibre was determined by acid and alkali digestion methods using Fibretec apparatus. It is essentially the residue left after sequential hot digestion with H_2SO_4 and NaOH. It mainly consists of cellulose together with a little lignin. Crude fat was determined by extracting a known weight of powdered plant material with petroleum ether using Soxhlet apparatus. The ether was evaporated and the residue weighted. Protein was determined by micro-kjeldhal methods by multiplying nitrogen with 6.25, it is based on the assumption that plant proteins consist of 16% of nitrogen. Carbohydrates at first hydrolyzed to liberate simple sugars, which was done by using dilute mineral acids. More details of the analytical procedures are available elsewhere[5,16].

Nitrogen was determined through micro-kjeldahl method by digesting a known weight of plant sample and treating it with alkali. The liberated ammonia was collected in boric acid and titrated with HCL. Phosphorus was estimated calorimetrically by treating the digested sample with Ammonium molybdate and freshly prepared ascorbic acid. Spectrophotometer apparatus was used to measure the absorbance at 880 nm. Potassium and sodium were determined using Flame photometer. The flame exited atoms of potassium and sodium emit radiation at different specific wavelengths, which was measured using different filters. All the analyzed nutrients were treated for estimating the means and standard error values from different replicates.

Data analysis

Simple statistical procedure was applied for testing differences in household and village responses to wild edible species data inventory and number of species used. Variations in intensity of use of diverse edible wild plant category were calculated with respect to the plant diversity in each category. The altitudinal distribution of the species with respect to parts used as well as the specific tribe who use these plants was calculated and presented in percentage. As the data gathered for the pattern of species availability, collection, variation in utility, distribution pattern, and local use of species was qualitative, transcribed texts of interviews, group discussions, and key informants' discussions were collectively analyzed with direct field observations and were ethnographically evaluated in order to interpret people's underlying thoughts about wild food plant resources[2]. To present nutritive values of species, mean values are presented along with standard deviations

Results

Diversity of food composition of wild plants

The field surveys and interviews with communities (viz. *Aka, Bugun, Miji, Monpa* and *Sherdukpen*) revealed high dependency of the tribal people along with huge indigenous knowledge regarding the utilization and management of these plants. It was interesting to record that these communities use as many as 343 plant species (varying from 254 genera and 133 families) for different needs, of which 289 species were used for food, medicine, and beverage purpose (Table 1). Maximum number of species were used for medicinal purpose (48%), followed by edible fruits (22%) and vegetable (19%) (Table 1). Most species used for their leaves and fruits, followed by seeds, root stocks, stem, barks, flowers, etc. *Monpa* used 71%, *Akas* 51%, *Mijis* 47%, *Sherdukpens* 47% and *Buguns* 45% of all screened plant species (Table 1). *Akas* and *Mijis* showed high affinity in species use. *Akas* prefer young shoot of *Dendrocalamus hamiltonii* Nees & Arn ex Munro, leaves of *Clerodendrum glandulosum* Lindl. (syn. *Clerodendrum*

Table 1-Diversity of food plants used by selected tribal commun
North east India

Species used*	Total No of species used				
	Aka	*Bugun*	*Miji*	*Monpa*	*Sherdu -kpen*
Edible wild fruits	38	24	32	52	33
Edible wild vegetables	46	36	40	37	29
Edible wild mushrooms	9	14	10	14	10
Medicinal plants	68	57	59	118	70
Spices and condiments	8	5	7	9	7
Local drink and beverages	3	2	2	10	6
Edible pith/flowers	3	4	3	3	3
Millets and seeds	1	2	2	3	3
Total	177	156	157	234	159

* Selected species come under more than one use category

colebrookianum Walp.), *Houttuynia cordata* Thunb., *Polygonum molle* D Don, *Piper sylvaticum* Roxb., *Acmella paniculata* (Wall. ex DC.) R.K.Jansen (syn. *Spilanthes paniculata* Wall ex DC.), *Zanthoxylum oxyphyllum* Edgew and *Solanum ferox* L., underground tubers of *Manihot esculenta* Crantz and *Dioscorea* sp., floral bud of *Musa velutina* H.Wendl. & Drude, *Amomum dealbatum* Roxb., fruiting body of *Cantharellus cibarius* Fr., *Agaricus* sp, *Schizophyllum communis* Nutt., *Pleurotus sajor-caju (Lentinus sajor-caju* Fr.), *Termitomyces clypeatus* R. Heim as vegetables. They also used bark of *Myrica esculenta* Buch.-Ham. ex D. Don, *Entada pursaetha* DC. (syn. *Entada rheedii* Spreng.), *Drymaria cordata* (L.) Willd. ex Schult., *Cuscuta reflexa* Roxb., and *Butea minor* Baker (syn. *Meizotropis buteiformis* Voigt) for medicinal purpose, seeds/fruits of *Perilla frutescens* (L.) Britton and *Litsea citrata* Blume (syn. *Litsea cubeba* (Lour.) Pers.) as spices, and fruits of *Solanum torvum* Sw., *Hodgsonia macrocarpa* (Blume) Cogn., *Ficus hirta* Vahl, *Citrus medica* L., *Castanopsis tribuloides* (Sm.) A.DC. There was also fair affinity of species use by *Buguns* with both *Monpas* and *Akas*. Use of an algae *Prasiola crispa* f. as vegetable was found confined to *Monpa* and *Sherdukpens* only. The later community also collects a lichen, *Ramalina himalayensis* Rasanen, and uses it as vegetable after boiling and air drying. Besides, extraction of starch from the pith of *Wallichia densiflora* Mart. (syn. *Wallichia oblongifolia* Griff.) was found confined among *Aka, Miji* and *Bugun*. Shoots of *Dendrocalamus hamiltonii* Nees &Arn. Ex Munro, *Schizophyllum commune* Nutt., tender leaves of *Amaranthus spinosus* L., *Oenanthe javanica* (Blume) DC., and fruits of *Litsea citrata* Blume (syn. *Litsea cubeba* (Lour.) Pers.), *Zanthoxylum armatum* DC., *Myrica esculenta* Buch.-Ham. Ex D. Don, *Persea robusta* (W.W.Sm.) Kosterm. (syn. *Machilus robusta* W.W. Sm.), *Prunus persica* (L.) Batsch and *Malus sikkimensis* (Wenz.) Koehne ex C.K.Schneid. were most preferred by *Buguns.*

A discussion with communities revealed that most prospective wild edible species of the area were *Arundinaria racemosa* Munro (consumed for shoots), *Oenanthe javanica* (Blume) DC., *Diplazium esculentum* (Retz) Sw. (tender leaves and shoots), *Dioscorea bulbifera* L. (tubers), *Actinidia callosa* Lindl., *Cornus capitata* Wall., *Diospyros peregrina* (Gaertn.) Gürke (syn. *Diospyros malabarica* (Desr.) Kostel.), *Holboellia latifolia* Wall., *Persea fructifera* Kosterm., *Pyrus pashia* Buch.-Ham. ex D.Don (fruits), *Auricularia auricular judae* (Bull.) J. Schrot, *Hericium erinaceus* (Bull.) Persoon, *Boletus edulis* Bull. (as mushroom), *Zanthoxylum armatum* DC., *Illicium griffithii* Hook.f. & Thomson, *Litsea citrata* (spices), *Rhus hookeri* K.C. Sahni & Bahadur is (syn. *Toxicodendron hookeri* (K.C. Sahni & Bahadur) C.Y. Wu & T.L. Ming) (seed oil), *Acer pectinatum* Wall. ex G.Nicholson (leaf-beverage), and *Elaeagnus parviflora* Wall. Ex Royle, *Eleusine coracana* (L.) Gaertn., *Cornus capitata* (used for making fermented drinks). Most of these species were easily available at present therefore being collected from forests.

All communities had rich traditional knowledge regarding use of medicinal plants as they collect 153 species for this purpose, the number varying between 57-118 species among different tribes (Table 1). The medicinal plants were used either as raw or in various preparations for curing diseases. Most promising medicinal plant species of the area comprised *Aconitum fletcherianum* G. Taylor, *Clerodendrum colebrookianum, Swertia chirayita* H.Karst, *Cordyceps sinensis* (Berk.) Sacc., *Picrorhiza kurrooa* Royle, *Dendrobium nobile* Lindl., and *Artemisia nilagirica* (C.B.Clarke) Pamp. that were harvested on commercial scale for selling in national and international markets. Many other species were also used as spices, liquor and beverages.

Selected wild edible species and medicinal plants (76 in number) were also sold in local markets that provide good income to collectors. Among the three studied markets of the state (Bomdila, Bhalukpong and Itanagar) a total of 76 plant species were recorded sold, Itanagar market has maximum (56 plant species), followed by Bhalukpong (47 species) and Bomdila (44 species). The most commonly sold plant products were tender shoots, roots, bulb, leaves, etc. Six species, viz. *Auricularia auricula-judae, Calamus flagellum* Griff ex Mart., *Dendrocalamus hamiltonii, Litsea citrata, Piper pedicellatum* C. DC., *Diplazium esculentum, Persea robusta, Zanthoxylum oxyphyllum* and *Spilanthes paniculata* were sold in all three markets. On an average at least 9 plant products were available at any given date in the local markets. Selling of edible wild plants is mainly done by farmers with lower income groups; *Monpa* community was most commonly involved in it.

Altitudinal distribution of species

The species were distributed at all altitudinal gradients from 200 to 4000 m above sea level (Table 2).

Nearly 26% species were distributed at low hills (<900), 23% at mid hills (900-2000 m), and 35% at upper hills (>2000 m) (Table 2). Besides, a few other species showed wider distribution as 28% species were low-mid hill (300-1500 m), 31% species to mid-upper hills (1500-2500 m) and 13% low-upper hills (300-2500 m) (Table 2). The quantum of species use increased with increase in altitude showing high dependence on wild plants resources at high hills.

Table 2-Altitudinal distribution of locally used plant species in North east India

Category	Number of species						
	LH	LMH	MH	MUH	UH	LUH	Total
Edible wild fruits	12	15	10	12	24	2	75
Edible wild vegetables	11	15	10	12	11	6	65
Edible wild mushrooms	1	4	6	6	1	0	18
Dye and colour fixer	3	3	4	4	4	2	20
Medicinal plants	25	21	23	36	38	20	163
Spices and condiments	1	3	1	4	2	2	13
Local drinks & beverages	0	1	1	1	6	2	11

LH= Low hill, 200-900 m; LMH= Low-mid hill, 300-1500 m; MH= Mid hill, >900-2000 m; MUH= Mid-Upper hill, 1500-2500 m; UH= Upper hill, >2000 m; LUH= Low-upper hill, 300-2500 m.

Nutritive values of wild edible plants

Nutritive values were estimated for 16 species, the details are presented in the Tables 3 & 4. The moisture content of the tested species varied from 65-85% being high in *Pyrus pashia*, *Prasiola crispa*, *Wallichia densiflora*, *Illicium griffithii*, *Houttuynia cordata*, *Persea fructifera* and *Persea robusta* (Table 3). The fibre content ranged between 2.75-30.10% for different species, it was high for *Auricularia auricular-judae* and *Pyrus pashia*. Contrarily, the fruits of *Laetiporus sulphureus* (Bull.) Murrill, *Diospyros peregrina* and *Wallichia densiflora* estimated having low fibre content (Table 3). The total carbohydrate was determined highest for *Wallichia densiflora* (51.17%) (Table 3), and it varied between 21.7 to 33.72% for *Cornus capitata*, *Holboellia latifolia*, *Houttuynia cordata*, *Malus sikkimensis* and *Laetiporus sulphureus.* Other species recorded low carbohydrate content (Table 3). The estimated fat content varied between 0.51 to 22.48%

Table 3-Composition of proximate analysis (%) in dried plant material of edible wild plants in Arunachal Pradesh (values are ± SE)

Plant species	Part analyzed	Moisture (%)	Fiber (%)	Carbo-hydrate (%)	Protein (%)	Fat (%)
Amanita sp.	Fruiting body	64.58	8.72±0.14	7.93±0.30	26.38±0.43	12.00±0.97
Auricularia auricula-judae (Bull.) J. Schrot.	Fruiting body	77.00	16.23±1.06	15.09±2.21	15.33±0.51	10.12±2.11
Cornus capitata Wall.	Fruit	69.53	10.43±0.54	33.72±0.20	2.58±0.15	2.50±0.25
Diospyros peregrine *(Gaertn.) Gürke*	Fruit	67.22	4.04±0.12	9.83±0.13	3.54±0.18	2.01±0.02
Holboellia latifolia Wall.	Fruit	63.00	6.22±0.63	31.71±3.38	8.42±0.15	7.53±0.51
Hottuynia cordata Thunb.	Root	79.50	9.23±0.08	33.03±1.55	10.42±0.08	3.12±0.43
Illicium griffithii Hook.f. & Thomson	Fruit	79.51	30.10±0.79	11.75±0.27	6.08±0.04	1.10±0.02
Laetiporus sulphureus (Bull.) Murrill	Fruiting body	66.67	4.12±0.23	21.71±1.70	21.00±0.14	2.45±0.57
Persea fructifera *Kosterm.*	Fruit	71.66	8.46±0.35	16.36±0.05	4.96±0.33	20.45±2.12
Persea robusta *(W.W. Sm.) Kosterm.*	Fruit	73.13	13.91±0.16	12.24±0.13	12.67±0.33	22.48±0.54
Phoebe lanceolata *(Nees) Nees*	Fruit	69.91	9.61±0.10	8.18±0.09	15.21±0.23	12.53±0.50
Pleurotus sajor-caju (Fr.) Singer	Fruiting body	72.67	8.30±0.55	13.62±0.59	37.92±0.79	1.02±0.04
Malus sikkimensis (Wenz.) Koehne ex C.K.Schneid.	Fruit	77.43	11.14±0.05	29.50±0.17	1.79±0.11	0.36±0.15
Pyrus pashia Buch.-Ham. ex D.Don	Fruit	84.97	16.18±0.73	17.93±1.52	3.29±0.21	0.45±0.16
Prasiola crispa f.	Whole plant	82.50	8.28±0.26	16.36±0.89	37.88±0.14	14.53±0.50
Wallichia densiflora Mart.	Stem Pith	80.33	2.75±0.02	51.17±2.18	1.25±0.07	0.51±0.48
Commercial fruits (range)*		4.50-90.10	0.30-4.80	0.80-67.10	0.10-21.20	0.10-64.50
Himalayan edible wild plants (range)**		4.0-90.0	1.30-21.20	4.50-84.07	0.90-75.0	0.10-36.40
Edible wild plants-other areas (range)***		4.34-75.6	0.90-12.00	4.10-94.70	0.30-27.03	0.10-64.50

* Range of proximate analysis values for commercial fruits (viz. Almond, Apple, Avocado, Banana, Bel, Ber, cashewnut, Fig, Grape, Guava (hills), Jackfruit, Jamun, Karonda, Lemon, Lime, Litchi, Mango (ripe), Orange, Papaya, Passion fruit, Peach, Pear, Pineapple, Plum and Walnut)[6, 22]

** Range of proximate analysis values for Himalayan edible plants[3,4,5,18,20,22,27]

*** Range of proximate analysis values for edible wild plants for other areas[18,24,28]

for different species (Table 3). It was high for *Persea robusta,* followed by *Prasiola crispa*, *Phoebe lanceolata* and *Amanita* sp. Other species had low fat content (Table 3). Protein content was high for *Pleurotus sajor-caju* (*Lentinus sajor-caju* Fr) (37.92%) and *Prasiola crispa* (37.88%), while other species had moderate to low protein content (Table 3). A comparison of the nutritive values recorded in this study with those of other wild edible plants and commercial fruit species reveled that our data are well within the comparable range with them (Table 3).

The edible part of the plant species was also estimated for assessing nitrogen, potassium, phosphorus and sodium content (Table 4). Among all, nitrogen was estimated maximum, followed by phosphorus, potassium and sodium. Nitrogen content varied between 0.20 to 6.07%, being minimum in stem pith of *Wallichia densiflora* and highest in the fruiting bodies of *Pleurotus sajor-caju* (Table 4). A relatively low value of nitrogen content was determined in *Illicium griffithii*, *Persea fructifera*, *Diospyros peregrina*, *Pyrus pashia*, *Cornus capitata* and *Malus sikkimensis* (Table 4)**.** Potassium content ranged between 0.03 to 1.03% among various species with *Phoebe lanceolata* (Nees) Nees (syn. *Ocotea lancifolia* (Schott) Mez) comprising maximum and *Wallichia densiflora* minimum potassium contents (Table 4). The sodium content among various plant species varied from 0.019-0.088% (Table 4). It was estimated highest for *Pyrus pashia* and lowest for *Wallichia densiflora.* A comparison of mineral contents of wild edible species as estimated in this investigation and those reported for other wild edible species and commercial fruits showed that our data are well within the comparable range with them (Table 4). The data revealed that the wild edible species are good source of nutrients, particularly protein, carbohydrate, fat, and various other minerals, which possibly play an important role in sustainable nutritional balance of the tribal communities.

Discussion

In this investigation community dependence on edible wild plant resource that are gathered from their surrounding forests as fruits, young shoots, roots, twigs, leaves, flowers, tubers, piths, was investigated in North east India, a global hotspot. The study revealed as many as 343 plants species being used by five tribal groups for diverse purposes which signifies the rich community knowledge about use and management of wild plant resources. Use of wide variety of species for a particular purpose is an advantage to reduce pressure on few species. A large number of edible wild species consumed for domestic needs and harvests of such species are reported well within the carrying capacity. Selected species were

Table 4-Macro-mineral composition of dried material of important edible wild plants of Arunachal Pradesh (values are ± SE)

Plant species	N (%)	K (%)	Na (%)	P (%)
Amanita sp.	4.22±0.07	1.00±0.04	0.03±0.01	0.45±0.015
Auricularia auricula-judae	2.45±0.08	0.43±0.08	0.02±0.01	0.49±0.023
Cornus capitata	0.41±0.02	0.46±0.01	0.02±0.00	0.77±02
Diospyros peregrina	0.57±0.03	0.64±0.01	0.02±0.00	0.19±0.04
Holboellia latifolia	1.35±0.02	0.32±0.01	0.02±0.00	0.23±0.05
Hottuynia cordata	1.67±0.01	0.81±0.12	0.03±0.00	0.005±0.004
Illicium griffithii	0.97±0.01	0.34±0.00	0.02±0.00	0.26±0.02
Laetiporus sulphureus	3.36±0.02	0.60±0.03	0.03±0.00	0.056±0.12
Persea fructifera	0.79±0.05	0.38±0.01	0.02±0.00	0.13±0.12
Persea robusta	2.03±0.05	0.72±0.15	0.02±0.00	0.24±0.10
Phoebe lanceolata	2.43±0.04	1.03±0.04	0.02±0.00	0.091±0.03
Pleurotus sajor-caju	6.07±0.13	0.85±0.07	0.02±0.00	0.34±0.12
Malus sikkimensis	0.29±0.02	0.35±0.01	0.03±0.00	0.16±0.02
Pyrus pashia	0.53±0.03	0.50±0.03	0.09±0.00	0.90±0.11
Prasiola crispa	6.06±0.02	0.24±0.02	0.04±0.00	0.46±0.21
Wallichia densiflora	0.20±0.01	0.03±0.00	0.02±0.00	0.60±0.02
Commercial fruits (range)*	0.032-3.39	2.02-3.96	0.02-2.18	0.01-0.70
Himalayan edible wild plants (range)**	0.08-4.86	0.002-4.96	0.002-1.28	0.005-0.84
Edible wild plants-other areas (range)***	0.05-4.32	0.27-4.29	0.002-0.168	0.02-0.51

* Macro-mineral range values for commercial fruits (as per references in Table 3)
** Macro-mineral range values for Himalayan edible plants (as per references in Table 3)
******* Macro-mineral range values of edible wild plants for other areas (as per references in Table 3)

sold in local market to earn cash and generally people from lower strata of the society were involved in this activity. Interestingly most edible species are available during different months/seasons of the year. Wild edible plants form a large share of tribal food in all seasons, more so during lean period[17, 18,19,21]. These species are important source of protein, carbohydrate, fat, vitamin and other minerals[14,15]. In the Himalaya, there are few studies that address the nutritional value of edible wild plants that are consumed in traditional food diets[3,4,5,19,20,21,22]. The carbohydrate content was high for most of the wild edible species and similar reports have been reported from the Sikkim Himalaya as well as other Himalayan region[5,21,22]. The fat content of *Persea robusta* was comparable with the fruits of *Machilus edulis* and commercial avocado *Persia americana*[5,23], though it was lesser than walnut, almond and cashew nut. As such the wild edible plants reveal rich sources of protein, carbohydrate and fat in the Himalayan regions[5,18,20]. Similar reports are available for the wild edible species from the other parts of the globe[24,25,26].

A comparison of the mineral contents of various wild edible species with the commercial fruit species revealed higher phosphorus contents in *Cornus capitata.* Similarly, high potassium content was determined in *Phoebe*. Potassium and sodium contents were determined high in selected species. By and large the tendency of nutrients in different plant parts was determined high in fruiting bodies of mushroom, followed by algal thallus and fruit parts of other species. Our results are similar to those reported for other regions[24,25,26]. The nutritional values of different species in this investigation were well within the comparable range with the wild edible species from different parts of the Himalaya as well as other region[3,4,5,20,21,22,,24,27,28]. Assuring food supply to the rural areas, particularly in developing countries is one of the biggest challenges. Use of wild edible plants is an important but ignored facet for food supply in such areas. This study revealed that wild plant species form good quality food to tribal communities thus plays an important role in nutritional security to rural areas. However, they need proper focus in policies and conservation. Perhaps a proper documentation of TK related to utilization of such resource is an urgent need in states like Arunachal Pradesh. Subsequently it is recommended that, since these species provide food security to tribal communities, there is a need to exploit the role of wild edible plants to the fullest extent possible with a vision of solving food supply to ever increasing human population. Selected species should be introduced in the traditional agricultural system as well as in wasteland development programmes, thus can play significant role in uplifting socio-economic status of the rural people as well as save the germplasm in natural habitats. As most wild edible species are disease resistance with important biological characters, they can be exploited in genetic improvement programmes of many other food species through plant breeding, genetic engineering and tissue culture practices. Cultivation and plantation of selected edible species around villages, schools, and academic institutions should be promoted not only to preserve gene pool but also to create awareness about role of wild edible plants in local diets as well as improving nutritional uptake through them. There is a need to make people, planners, leaders and other influential persons more aware about the scientific basis of taking wild edible plants in local diets. It can be safely said that promoting wild edible plants would certainly strengthen multifunctional agricultural policies for securing food and livelihood security and environmental sustainability in rural areas. At the same time it would also facilitate in sustaining rural landscapes, biodiversity and cultural heritage.

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