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NUTRITIONAL AND PHYTOCHEMICAL EVALUATION OF SOME WILD AROMATIC PLANTS USED AS SOURCES OF FOOD AND MEDICINES BY THE BODO TRIBES OF KOKRAJHAR DISTRICT, ASSAM, INDIA

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Abstract

Throughout history, natural products from plants have played sustaining roles in the lives of humans, especially for food sources and for medicinal products. Oral interviews with local and village elders have enumerated 50 species of economically important wild aromatic plants used as vegetables, spices, condiments and medicines for curing different ailments. Of these six aromatic plants were analyzed to evaluate nutritional and bioactive compounds. The results revealed that it contains moisture content in the range of 66-87% of fresh weight, ash content 20-43% of dry weight, crude protein in 12-25% of dry weight, total solids in 13-34% of dry weight, carbohydrates in a range of 7-42% of dry weight and crude fat in 0.68-2.0% of dry weight. Qualitative phytochemical analysis of these plants confirms the presence of bioactive compounds like steroids, alkaloids, flavonoids, tannins, saponins and trace amounts of micro nutrient elements. Thus, preliminary study and qualitative analysis draws attention on the signifance of these phytochemicals with respect to the role of wild plants in traditional medicinal system and the need for further studies in treatment of many diseases.

Keywords: *Wild plants; Bioactive compounds; Bodos; Ethnobotany; Kokrajhar district*

Introduction

Aromatic plants possess odorous volatile substances which occur as essential oil, gum exudates, balsam and oleoresin in one or more parts namely root, wood, bark, stem, foliage, flower and fruit [1]. These plants produce an amazing array of organic chemicals with an enormous diversity of structural types essential for plant growth and development. Many of these phytochemicals have beneficial effects on long-term health when consumed by humans, and can be used to effectively treat human diseases [2, 3]. These phytochemicals are divided into primary metabolites such as sugars and fats, which are found in all plants and secondary metabolites, which are found in a smaller range of plants, serving a more specific function [4]. The characteristic aroma in these plants is due to the presence of a variety of complex chemical compounds. Essential oils and aroma chemicals constitute a major group of industrial products which forms indispensable ingredients of necessities in many spheres of human activity. The term essential oil is concomitant to fragrance or perfumes because these fragrances are oily in nature that represents the essence or active constituents of the plants. There are over

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20,000 species of wild edible plants in the world, yet fewer than 20 species now provide 90% of our food. A large number of wild aromatic plants are used as sources of indigenous medicines, cosmetics, food flavors, spices, vegetables, condiments and in religious and rituals. Some are used as food while others are used as astringent and tonic [5]. Many wild aromatic species belonging to different families have been used in Ayurvedic preparations and other native systems of medicine since time immemorial. However, there are hundreds of less well known edible plants from all around the world which are both delicious and nutritious. The amount of vitamins, minerals and other nutrients in wild food, according to many sources, is on the average greater in wild foods. Natural resources applied by human are influenced by different factors such as history, cultural system and their availability [6]. The tribal people inhabiting the different parts of the world, especially those in tropical countries have very close connection with the vast resources of nature and posses a rich botanical lore. Through the ages they have learnt the uses of immediately available natural resources to meet their day to day needs. Almost all such aboriginal people depend largely upon wild plants so far as magi co- religious beliefs for treatment of various ailments. At least 6,500 species are used in Asia alone as home remedies for various ailments [7]. The vast forest areas of Kokrajhar district are very rich in wild plants and large number of such plants is being used by the local people to treat their major and minor diseases. Thus the present study have been carried out to highlight the reports of use of various wild edible aromatic plants used by the natives of this area along with an effort to compile phytochemical and bioactive compounds present in these plants which would be helpful for future pharmaceutical research leading to the discovery of many novel drugs.

Materials and Methods

Study site

Kokrajhar district is located in the North western part of Assam, in North East India. It is located between 26^0 25' N longitude and 99^0 16' 38" E latitude and $26^0$15' N to $26^0$55' N latitude. It is bounded by Bhutan on the North, the Sonkosh River, Cooch Bihar and Jalpaiguri district of the West Bengal on the west and riverine tract of Brahmaputra valley (Goalpara and Dhubri district) on the south and on the eastern side by Chirang district respectively. The two forest divisions that fall completely under Kokrajhar district are Haltugaon and Kachugaon forest division under the Western Assam circle conservancy covering an area of 1071sq km and 1393sq km with a total population of 3771 and 2182 respectively. The temperature of the district ranges from 10°C to 37°C with an average annual rainfall of 1500mm to 2600mm. The district has total forest cover of 88.18 % of its total geographic area and the forest can be grouped as tropical evergreen forest, sub-tropical forest and bamboo brakes.

Data collection

The present study was carried out in the two tropical forest tracts of Haltugaon and Kachugaon forest range under the Western Assam circle conservory of Kokrajhar district (Fig. 1). Two villages under Kachugaon block namely Simlaguri and Patgaon along with two villages under Haltugaon block namely Titaguri and Karigaon was selected. The surveys were conducted in three consecutive years, i.e., November, 2012; January, June–July, October, 2013; February–March, August–September and November 2014.

Two hundred fourteen semi structured interviews were performed which resulted in 215 cited plant species (Fig 1). The sample included both men (n = 76) and women (n = 138) in different age categories i.e. men in the age range of 18-34 (n = 14), 35-50 (n = 26), 51< (n = 36) and women in the age range of 18-34 (n = 19), 35-50 (n = 49), 51< (n = 70). During the interview the informants were followed into the field to show us the described species and at times local field experts were hired to locate and collect fresh materials of the plants. The plant specimens were collected, processed and documented in the form of herbarium following the procedure of Jain and Rao [8]. The data collection also included vernacular names, habitats,

parts used and ethnobotanical uses. Photographs were also taken (Fig. 2) and the specimens were identified with the help of standard floras and literatures [9-13], by consulting herbarium at BSI, Shillong, Meghalaya and taxonomy specialists were also consulted in case of doubtful specimens. Voucher specimens were deposited at the Department of Botany (Herbarium code *Brahma*) North Eastern Regional Institute of Science and Technology, Itanagar.

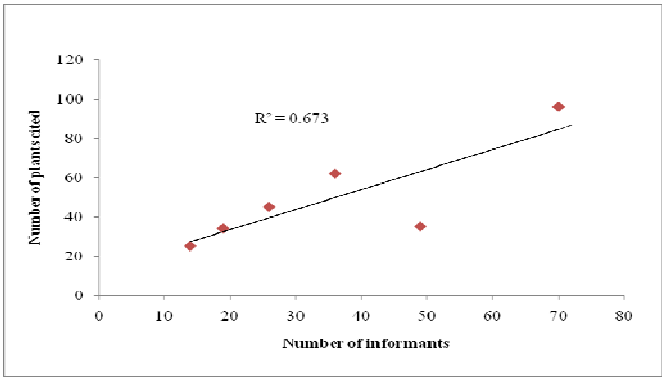

Fig. 1. Indigenous knowledge in relation to age and total number of plants cited in Kokrajhar district

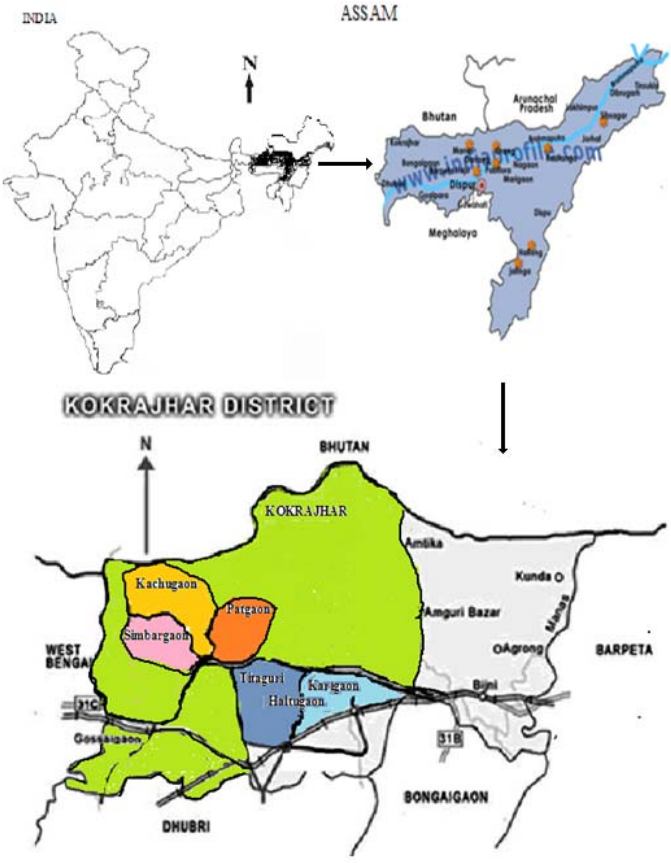

Fig. 2. Map of the study area showing different forest ranges and villages of Kokrajhar district

The information on its uses was collected through interviews with a number of local villagers, vendors and with knowledgeable local participants having medicinal knowledge and the data obtained were then analyzed to study the nutritional components of some selected aromatic plants. During the survey some ethno botanically important species of wild aromatic plants were collected and nutritional analysis were done to determine the potent bioactive compounds present in them. Total ash and moisture content was determined by using the methods as described by AOAC [14], nitrogen was determined by using Kjeldahl method [15] and the quantity of protein was calculated as 6.25 x N [16]. Determination of total fats and proteins was done by following the methods as described by James [17], total carbohydrates and total solids were determined by different method as described by FDA and James [17] and nutritive values were determined by the method as mentioned by FAO [18]. Test for the presence of mineral elements were carried out after acid digestion. The supernatant was decanted and the liquid was analyzed for measuring the levels of magnesium, manganese, iron, zinc, copper and molybdenum present using standard procedures. Trace elements like magnesium, copper, zinc, iron, molybdenum and manganese levels were analyzed by Atomic Absorption Spectrophotometer (AAS) at Sophisticated Analytical Instrumentation Facility (SAIF), NEHU, Shillong. Test for secondary metabolites and reducing sugars was carried out in aqueous extract and on powdered specimen using standard procedures to identify the constituents [19-23].

Result and Discussion

Ethnobotanical survey

The present study indicated that 50 species of wild aromatic plants are used as sources of food, spices and medicines. Of these 9 genera of Zingiberaceae, 8 genera of Asteraceae, 6 genera of Verbenaceae, 5 genera of Brassicaceae, 3 genera of Piperaceae and Rutaceae, 2 genera of Amerilidaceae, Apiaceae, Rubiaceae, Labiatae, Lauraceae, Poaceae and 1 genera each of Maranthaceae, Saurauiaceae, Araceae and Oleaceae are used for ethno medicinal, ornamental, religious and ritual purposes. The species were arranged in alphabetical order with each genus along with botanical names, vernacular names, habitats, plant parts and their ethnobotanical uses (Table 1).

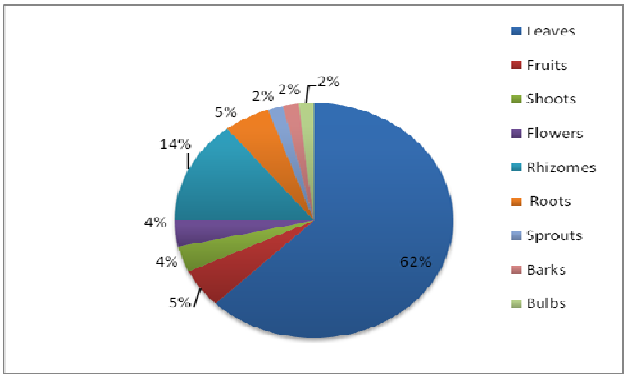

Fig. 3. Pie chart showing percentage of different plant parts used for ethnobotanical purposes

Analysis of ethnobotanical uses of the families have shown that the genus *Rorippa* has the highest uses with 4 species followed by 3 species of *Alpinia* and 2 species of *Clerodendron*, *Curcuma*, *Cymbopogon*, *Lippia*, *Piper*, *Zanthoxylum* and *Zingiber*. The rest genus of *Ageratum*, *Blumea*, *Bidens*, *Eryngium*, *Houttuynia*, *Homalomena*, *Kaempferia*, *Leucas*, *Maranta*, *Mentha*, *Oenanthe*, *Paederia*, *Premna*, *Peperomia*, *Piper*, *Smilax*, *Sphaeranthus*, *Vernonia*, *Vitex* and

Globba are represented by one species each. The most frequently used parts are leaves, with 35 species (62%); rhizomes with 8 species (14%); roots with 3 species (5.0%); fruits with 3 species (5.0%); shoots with 2 species (4.0%); flowers with 2 species each (4.0%), sprouts with 1species (2.0%) , bulbs and barks with 1 species each (2%) as shown in Figure 3.

Table 1. List of ethno-botanical uses of wild aromatic plants documented in the study area

Sl no	Botanical taxon and voucher no.	Local name	Family	FL & FR	Parts used	Uses
1.	*Alpinia galanga* (Willd.), Brahma 109	Jermou	Zingiberaceae	Fl.& Fr.4-12	Rhizome	Digestive disorders, diabetics and urinary problems
2.	*Alpinia allughas* (Roscoe), Brahma 86	Thorai	Zingiberaceae	Fl.& Fr.1-5	Tender shoots	Diabetics, respiratory disorders, urinary problems
3.	*Alpinia bracteata* (Roxb.), Brahma 89	Thorai	Zingiberaceae	Fl.& Fr.1-5	Tender sprouts	Vegetable
4.	*Ageratum conyzoides* (L.), Brahma 149	Barmadari	Asteraceae	Fl.4	Leaves	Cuts & wounds
5.	*Blumea lanceolaria* (Druce), Brahma 108	Jaglori	Asteraceae	Fl.rainy season ; Fr . 9 -10	Leaves	Fever, cold and body ache
6.	*Bidens pilosa* (L.), Brahma 75	Jari tongla	Asteraceae	Throughout the year	Leaves	Eye, skin troubles & cuts
7.	*Cardamine hirsute* (L.), Bahma 53	Basordaba	Brassicaceae	Fl.2-4, Fr.6-7	Leaves	Used as vegetables
8.	*Cleodendron serratum* (L.), Brahma 79	Nangalbhanga	Verbenaceae	Fl.4-8;Fr.Cold season	Leaves	Leaves and flowers are eaten cooked as vegetable. Root is used in febrile and catarrhal affections.
9.	*Clerodendrum colebrookianum* (Walp.), Brahma 61	Nepafu	Verbenaceae	Fl. and fr. Aug-Dec	Leaves	Decoction of leaves is used in high blood pressure, diabetics and distended breast milk.
10.	*Cinnamomum verum* (J. Presl.), Brahma 77	Madamgra mosola	Lauraceae	Fl. 6-8	Barks and roots	Barks and roots are used as spices
11.	*Curcuma amada* (Roxb.), Brahma 87	Amada	Zingiberaceae	Fl.7-8	Rhizome	Respiratory disorder, intestinal disorder
12.	*Curcuma caesia* (Roxb.), Brahma 69	Haldai gwswm	Zingiberaceae	Fl.7-8	Rhizome	Reproductive disorders, toothache & urinary disorders
13.	*Crinum amoenum* (Roxb.), Brahma 93	Gwthwini sambram	Amerilidaceae	Fl. 5-6	Leaves & Bulbs	Skin disease
14.	*Cymbopogon citrates* (Stapf), Brahma 136	Citronella hagra	Poaceae	NT	Leaves	Leaves are used as flavoring curries
15.	*Cymbopogon* sp.(Spreng.), Brahma 205	Jasa hagra	Poaceae	NT	Leaves	Leaves are used as flavoring curries
16.	*Eclipta alba* (Hassk.), Brahma 56	Daudi zalla	Asteraceae	Fl.8-9;Fr.10-12	Leaves	Skin disease & spleen enlargement
17.	*Eryngium foetidum* (L.), Brahma 122	Gongardundia	Apiaceae	Fls.5; Fr. Cold season	Leaves	Leaves used as aromatic herb
18.	*Gnaphalium luteo–album* (L.), Brahma 124	Bardaimula	Asteraceae	Fl.&Fr.3-8	Leaves	Used as pot herb
19.	*Globba racemosa* (Sm.), Brahma157	Hagrahaijeng	Zingiberaceae	Fl.6-9	Rhizome	Used in soups and flavoring agent.
20.	*Houttuynia cordata* (Thunb.), Brahma 49	Maisundri	Saurauiaceae	Fl.4-6; Fr.7-8	Leaves	Skin troubles, reproductive disorders & stomach disorders.
21.	*Homalomena aromatica* (Schott.), Brahma 123	Bon channa	Araceae	Fl.&Fr.Jan to April	Leaves& rhizomes	Jaundice, Stomach disorders, cold & fever.
22.	*Kaempferia galanga* (L.), Brahma 199	Somfera	Zingiberaceae	Fl.9-10	Leaves& rhizomes	Used in cold, cough & as eye drop; rhizomes is used for dyspepsia, headache & malaria
23.	*Leucas aspera* (Link), Brahma 19	Khansisa	Labiatae	Fl.& Fr.Cold & hot season	Leaves &flowers	Used as vegetable & epistatis
24.	*Lippia alba* (Mill.), Brahma 101	Onthaibazab	Verbenaceae	Throughout the year	Leaves	Hypertension, digestive problems.
25.	*Lippia nodiflora* (L.), Brahma 191	Hagrani helanchi	Verbenaceae	Fl.&Fr.April-August	Leaves	Pot herb
26.	*Litsea cubeba* (Lour.) Brahma 180	Hagrani maigong	Lauraceae	Fl.2;Fr.4	Fruits	Fruits are taken as spices, and as medicines for relief from cold and cough
27.	*Maranta arundinacea* (L.), Brahma 98	Chini befang	Maranthaceae	Fl. Jun--Aug	Tuberous roots	Urinary stones
28.	*Mentha sativa* (L.), Brahma 25	Podina	Labiatae	Fl. & Fr, Hot	Leaves	Used as vegetable & epistatis

				season		
29.	*Murraya koenigii* (Spreng.), Brahma 2	Nwrshing	Rutaceae	Flr.2-3,Fr.4-5	Leaves	Fever & body ache
30.	*Nyctanthes Arbor- tristis* (L.), Brahma 13	Sephalee	Oleaceae	Fl.8-10;Fr.2-3	Leaves & flowers	Fever and diabetes
31.	*Oenanthe javanica* (DC.), Brahma 147	Dauphenda	Apiaceae	Fl.3;Fr.10	Leaves	Used as vegetables
32.	*Pavetta indica* (L.), Brahma 6	Hagrani maitha	Rubiaceae	Flr. & Fr. 5-8	Leaves	Used as purgative, antidropsical, aperients tonic.
33.	*Paederia foetida* (L.), Brahma 18	Khefee bendang	Rubiaceae	Flrs.7-10; Fr. Cold weather	Leaves	Stomach problems
34.	*Premna herbacea* (Roxb.), Brahma 79	Kheradaphini	Verbenaceae	Fl. & Fr.10-5	Leaves	Fever & body ache
35.	*Peperomia pellucida* (Kunth), Brahma 83	Jarigufut	Piperaceae	Fl.5-12	Tender shoots	Used as vegetables
36.	*Piper attenuatum* (Buchanan-amilton), Brahma 21	Mosla madamgra	Piperaceae	Fl. Oct-Dec.	Fruits & seeds	Used as aromatic flavors
37.	*Piper pedicellatum*, Brahma 60	Mosla madamgra	Piperaceae	Fl. Oct-Dec.	Leaves	Leaves are used as aromatic flavors
38.	*Rorippa sylvestris* (L.), Brahma 45	Hagrani basor	Brassicaceae	Fls.&Fr. In cold season	Leaves	Used as vegetables
39.	*Rorippa indica* (L.), Brahma 179	Daeodai gakha	Brassicaceae	Fl.9-11, Fr.11-1	Leaves	Used as vegetables
40.	*Rorippa nasturtium* (Beck.), Brahma 161	Daieni basor	Brassicaceae	Fl.9-11, Fr.11-2	Leaves	Leaves aromatic and used as pot herb
41.	*Rorippa dubia* (Pers.) Hara, Brahma 166	Besor gakha	Brassicaceae	Fl.9-11, Fr.11-3	Leaves	Used as vegetables
42.	*Smilax macrophylla* (Poepp.), Brahma 133	Kumarilewa	Amerilidaceae	Fl.&Fr.2-4	Roots	Roots used in gastrointestinal disorder
43.	*Spilanthes paniculata* (Wall.), Brahma 105	Usumai	Asteraceae	Fl. & Fr. Cold season	Leaves	Stomach problems
44.	*Sphaeranthus indicus* (L.), Brahma 140	Jolanga	Asteraceae	Fl.2;Fr.4	Leaves	Urinary disorders
45.	*Vernonia anthelmintica* (L.), Brahma 196	Daumeoa	Asteraceae	Fl.3;Fr.10	Leaves	Cuts, wounds & as vegetables
46.	*Vitex negundo* (Noronha), Brahma 150	Panjati	Verbenaceae	Fl.1-4;Fr.5-8	Leaves	Toothache & eye disease
47.	*Zanthoxylum oxyphyllum* (Edgew.) Brahma 9	Mezanga	Rutaceae	Flr.4-5,Fr-8-9	Leaves	Cooked as pot herb
48.	*Zanthoxylum budrunga* (Wall.), Brahma 197	Zabrang	Rutaceae	Fl. & Fr. Mar-Nov	Fruits	Used in diarrhea, mouth disease and as spice.
49.	*Zingiber zerumbet* (L.), Brahma 90	Bura wut	Zingiberaceae	Fl.7	Rhizome	Stomache
50.	*Zingiber montanum* (J.Koenig), Brahma 68	Haijeng	Zingiberaceae	Fl.7	Rhizome	Cold & cough

Proximate analysis

Proximate nutrient analysis of selected wild edible aromatic plants (Table 2) have revealed that it contains abundant class of organic compounds in the form of carbohydrates, proteins, fats, ash and trace minerals that are primary products of photosynthesis and are essential as a source of energy to plants.

Table 2. Percentage of proximate composition and nutritive values of leaves on dry and fresh matter basis

Sl. no	Specimen Name	Crude protein	Moisture	Fats	Ash	Total solids	Carbohydrates	Nutritive value (Cal/100g)
1.	*Blumea lanceolaria*	23.66	84	0.54	32	16	40	259.5
2.	*Lippia alba*	20.28	66	1.39	20	34	7.6	124.03
3.	*Premna herbacea*	15.38	81	2.37	43	19	42	249.85
4.	*Sphaeranthus indicus*	13	87	0.68	40	13	40.6	220.52
5.	*Paederia foetida*	24.62	81	1.06	32	19	38.68	262.74
6.	*Oenanthe javanica*	11.9	84	1.33	36	16	33.23	192.49

Out of six wild aromatic plants studied, highest nutritive value was recorded in *Paederia foetida* (262.74kcal/g), with lowest in *Lippia alba* (124.03kcal/g); highest protein was recorded for *Paederia foetida* (24.62%) with lowest in *Oenanthe javanica* (11.3%); highest carbohydrate content was reported in *Premna herbacea* (42%) with lowest in *Lippia alba* (7.6 %); moisture content was found to be highest in *Sphaeranthus indicus* (87%) and lowest was found in *Lippia alba* (66%). Low fat content varying from (0.68-1.39%) indicates that it can be used as an important source of good diet and can be recommended to individuals suffering from overweight and obesity. Similarly, total solid refers to matter suspended or dissolved in water or wasteland which is related to both specific conductance and turbidity. Highest amount of total solids was recorded for *Lippia alba* (34%) and lowest in *Sphaeranthus indicus* (13%); ash content was found to be high in *Premna herbacea* (43%) and lowest in *Lippia alba* (20%).

Micronutrient analysis

Besides high nutritional components, these aromatic plants show appreciably high amounts of micronutrients. Results (Table 3) shows remarkably high amounts of iron in *Lippia alba* (27.44ppm), magnesium in *Premna herbacea* (4.364ppm), manganese in *Oenanthe javanica* (3.48ppm), zinc in *Blumea lanceolaria* (10.96ppm), copper in *Sphaeranthus indicus* (0.798ppm) and molybdenum in *Premna herbacea* (4.364ppm). Use of these wild edible plants in our diet could help in boasting in blood levels especially in anemic conditions. Similarly, phytochemical screening revealed the presence of various bioactive compounds such as saponins, tannins, alkaloids, terpenoids, flavonoids, phenolic compounds and reducing sugars that are the basis of therapeutic potential of medicinal plants useful in the treatment of diabetes, rickets (Table 4).

Table 3. Determination of various amounts of trace elements by Atomic Absorption Spectrometer (AAS).

Sl. No	**Specimen name**	**E L E M E N T S**					
		Zn	**Mg**	**Mo**	**Cu**	**Fe**	**Mn**
1.	*Blumea lanceolaria*	10.96±0.08	2.571±0.09	3.034±0.05	0.301±0.06	15.97±0.15	2.432±0.07
2.	*Lippia alba*	0.783±0.02	1.10±0.02	ND	0.551±0.02	27.44±0.07	3.348±0.26
3.	*Premna herbacea*	7.763±0.17	5.044±0.26	4.364±0.47	0.305	18.27±0.90	0.530±0.08
4.	*Sphaeranthus indicus*	0.239±0.03	1.071±0.01	ND	0.798±0.6	28.51±0.04	3.447±0.01
5.	*Paederia foetida*	6.812±0.14	2.793±0.36	1.801±0.09	0.199±0.01	21.88±0.71	0.4845±0.04
6.	*Oenanthe javanica*	0.489±0.04	1.071±0.07	ND	0.568±0.36	26.88±0.13	3.484±0.02

All concentrations in ppm (parts per million), ND = Not detectable

Table 4. Phytochemicals in the leaves of selected wild edible plants

SL. no	**Scientific name**	**PHYTOCHEMICALS**							
		Tannin	**Saponin**	**Alkaloid**	**Flavonoid**	**Phenol**	**Steroid**	**Terpenoid**	**Sugars**
1.	*Blumea lanceolaria*	+	++	+	++	++	-	++	-
2.	*Lippia alba*	++	++	-	-	++	++	+	+
3.	*Premna herbacea*	++	++	+	++	++	-	++	+
4.	*Sphaeranthus indicus*	++	++	+	++	++	-	++	-
5.	*Paederia foetida*	-	+	-		++	-	++	-
6.	*Oenanthe javanica*	++	++	++	-	++	-	++	-

++ = Present, + = Trace, - = Absent

Lippia alba showed the presence of high amounts of steroids whereas *Premna herbacea* and *Lippia alba* showed trace amounts of reducing sugars. Results of proximate nutritional analysis shows that these wild edible aromatic plants serve as an important source of non-conventional food sources for the indigenous Bodo communities of Kokrajhar district and can make a good diet for children, lactating mothers, pregnant women, adults and at the same time it can be used as food flavors. Results of phytochemical analysis showed that despite the acknowledged importance of medicinal plants to both the global economy and local household economies, their use is generally poorly organized and is poorly regulated and most are still exploited with little or no regard to the future.

Conclusion

This study highlighted the significance of wild edible species as a source of nutrients for tribals. Analysis of six wild edible aromatic plants focuses the rich nutritional composition of indigenous plants and their scope to be used as food supplement. The present work showed that wild plants occuring in Kokrajhar district constituted potential sources of primary and secondary metabolites that add healthy nutrients to the body and the mind. Hence, documentation of indigenous knowledge of wild aromatic plants can add as herbal drugs and result in innovation of new research areas in the field of pharmaceuticals. Thus from the following studies it can be specified that conservation and promotion of rich traditional knowledge systems of the tribal communities should be preserved and extensive quantitative phytochemical and pharmaceutical studies on selected nutritionally and medicinally valuable species should be done.

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