Diversity of Traditional Herbaceous Species in the Cuisine of Assam with their Nutritional and Ethno Medicinal Potential: The Quantitative Approach

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Abstract:

The people of Assam, a northeastern state of India, have unique tradition of selection and utilization of plant resource. Many food plants both from cultivation and wild are being used as ethno medicinal plants by herbal healers in Assamese society. The present study was conducted to highlight the traditional knowledge of medicinal herbs used mostly as vegetables, condiments and fruits by the people residing in different parts of Jorhat district of Assam. No ethnobotanical work including its quantitative analysis has been carried out in Jorhat district although the villagers of this area are well known for their practices of various herbal preparations as a part of tradition and culture. The collected data have been analysed employing suitable statistical tools like Informant Consensus value for Plant Part (CPP), Consensus Factor (Fic), Fidelity Level (FL%), Preference ranking exercise, Importance value (IVs) and Pearson's Correlation Coefficient (PCC). In the present study a total of 42 medicinal herb species belonging to 26 families used in 6 ethnic categories of cuisines with 32 different recipes and many ethnomedicinal preparations for curing 20 types of diseases were documented. Leaves secured the highest CPP value (0.49). Bone disease, sinusitis, Hyperuricemia and Leprosy secured the highest F_{ic} value (1). The highest FL value (100%) has been recorded for seventeen herbs which are being used for curing pain and stomach related problems. *Cucumis sativus L*. is the most frequently used plant in the cuisines in our study area by preference ranking exercise. The highest score of IVs observed in *Colocasia esculenta (L.)* Schott and *Paederia foetida L*. The PCC between IVs and FL was 0.151 showing low positive linear relationship. The current study also showed a significant difference ($p<0.05$) in the knowledge of uses of important herbaceous species for curing ailments between rural and urban respondents.

KEYWORDS: Herbaceous species; nutritional; ethno medical; North East India; Informant consensus factor; Fidelity level; Preference ranking exercise.

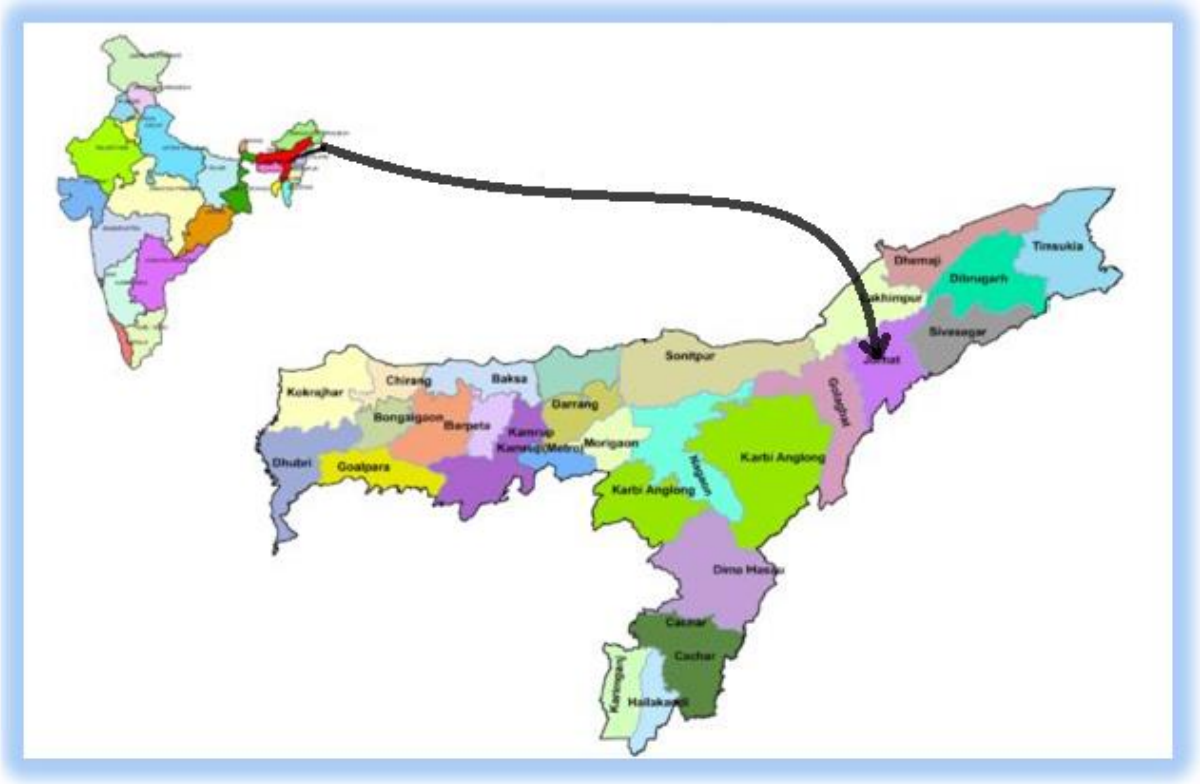

Figure1: Study Area- Jorhat, Assam, India

INTRODUCTION

Since time immemorial, ethno botany has attracted much attention in human health care and food security. Plants, being the living resources, have a long history of medicinal uses for the cure of many diseases and dietary food practices (Ahmed *et al., 200*; Bhattacharjya *et al.*, 2008). This ethno medicinal practice of health care has become a part of tradition and culture of the ethnic people which are followed by generations and continuously inherited (Arora, 1981).

India is a country inhabited by a large number of people having diverse ethnic groups. There are over 400 different tribes and other ethnic groups residing mostly in rural areas in India and most of them are still living in the remote forest areas, depending to a great extend on the indigenous system of medicines and food habits (Dutta *et al.*, 2005). More than 300 wild plant species are used in India as

subsidiary food and vegetables by different communities and out of 800 plants, at least 250 plants can be developed as a new source of food in near future (Kharkonger *et al.*, 1997).

North eastern region of India, comprising of states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim, is the centre of a diverse food culture and a paradise for ethno botanist and anthropologist. It is unique in bio resources richness being the home of a large number of tribal communities with rich culture and traditional knowledge of the environment depending on the forests, plants, and plant products for food and other purposes (Jaiswal, 2010). Food plays a very important role in defining the identity of one ethnic group from the other. The different ethnic communities use various types of plants and herbs to flavour and season their foods which reflect uniqueness of Northeast India (Asati *et al.*, 2003; Medhi *et al.*, 2013).

There is a vast variety of medicinal herbs and plants in the hills and forests of Assam. This northeastern state of India is the homeland of large number of diverse ethnic communities including 23 tribal communities (Ali *et al.*, 2003; Deka *et al.*, 2008). Some of the ethnic communities of this state are Ahom, Koch, Kachari, Moran, Motok, Chutia, Keot, Mishing, Deori, Rabha, Bodo, Sonowalkachari, Lalung, Mech, Dimasa, Brahmin, Koiborta, Kalita etc. The ethnic people mostly depend on natural resources for their food, livelihood and ailments. They are repository of indigenous knowledge system belonging to agriculture, food, medicine etc. (Srivastava *et al.*, 2009). The ethnic cuisines of Assam are very simple to cook, delicious to consume and have much nutritional values. Most of the ethnic communities take medicinal herbs as vegetables, spices, condiments with fish and meat in boiled form to increase the aroma, colour and delicacy. The ethnic communities residing in rural areas also have a deep belief in their folklore medicine for remedies and many of them rely exclusively on their own herbal cure.

The available literature reveals that few studies have been conducted on the edible plants of Assam (Kar *et al.*, 2007; Deka *et al, 2010.*), but the significant role of herbs on the traditional foods/cuisines consumed by different ethnic communities of Assam including its quantitative analysis is unavailable. Also it is observed that modernization, acculturation and urbanization among the people of Assam have brought significant changes in their lifestyles and thus affecting the indigenous knowledge of local traditional food practices. Therefore, there is an urgent need to explore the diversities of ethnic food preparations, wild edible bio-resources etc. and also to analyze and document the villagers' traditional ecological knowledge for the greater benefit of mankind.

MATERIAL AND METHODS

Data Collection:

The present study was carried out during 2017-18 in randomly selected seven villages (Atila Gaon, Titabor Thengal Gaon, Porbotia Gaon, Pohuchungi Gaon, Namdeuri Gaon, Bahfola Mishing Gaon, Sonari Gaon) of rural area and four urban localities (Naali, Suladhara, Rajamaidam, Basbari) of Jorhat district, Assam, Northeast India (26^0 82′ N to 94^0 31′ E) (Figure 1). While collecting information on plants used in Assamese cuisines, the villagers were visited and interviewed in order to gather information as well as to document their traditional knowledge in a systematic way. Data were recorded through structured open ended questionnaire on the herbs used by the respondents in different dishes, their medicinal values, parts used, patterns of use, preparation of dishes, ailments treated etc. The plants used for cuisines and medicinal purposes were first recorded using local names. An effort was also made to assess the issue of conservation of the herbs in the area of our study. Specimens were collected and herbarium sheets are prepared according to conventional herbarium technique and kept in Department of Botany, University of Science & Technology, Meghalaya, India.

A rural-urban comparative study on the use of herbs in the preparations of food in Jorhat district was also done among the respondents in order to bring light to the impact of modernization on the indigenous knowledge of medicinal herbs used in Assamese cuisines as well as for the alarming need of conservation of the regional herbs. A total of 140 people from the rural villages and 140 people residing in Jorhat City were randomly selected and interviewed.

Data analysis:

Different quantitative tools like Consensus value for Plant Part (CPP) (Monteiro *et al*., 2006), Informant Consensus Factor (F_{ic}) (Trotter *et al.*, 1986), Fidelity Level (FL%) (Friedman et al., 1986), Preference Ranking exercise (Martin, 1995), Importance Value (IVs) (Byg *et al.*, 2001) and Pearson's Correlation Coefficient (PCC) were employed to analyze the collected data.

Consensus value for plant part (CPP) measures the degree of agreement among informants concerning the plant part used and is calculated as CPP = P_x/P_t , where P_x= number of times a given plant part was cited; P_t = total number of citation of all parts. The informant consensus factor (F_{ic}) was calculated to identify the most potential medicinal plant species used by the people of study area. It is

expressed by a formula: $F_{ic} = \frac{N_{ur}-N_t}{N_{ur}-1}$, where N_{ur} is the number of use reports from informants for a particular disease category, N_t is the number of taxa that are used for that disease category. F_{ic} value ranges between 0 and 1, where a high value indicates the greater informant consensus and a lower value signifies disagreement among the informants.

The fidelity level (FL%) is used to quantify the percentage of informants claiming the use of a certain plant for the same major purpose and is calculated as : FL = $\frac{N_p}{N} \times 100$, where N_p = number of informants who cited the species for a particular disease; N = total number of informants that cited the species to treat any given disease.

Preference ranking exercise (Martin, 1995) was conducted by seven oldest informants from seven villages on five medicinal plants used to treat Kidney related problems in the study area. The informants were given the herbs and asked them to arrange plants based on their personal experience regarding efficacy of the plants. The most effective medicinal plant was given the highest rank i.e. 5 and the one with least effectiveness was given the lowest rank 1. Finally, preference ranking from informants' responses on the use of the edible herbs relating to treatment of disease was analyzed. Rank was determined based on the total score of each species following Cotton (1996).

The Importance Value (IVs) measures the proportion of informants who regard a species as most important and is calculated as follows: $\frac{n_{is}}{n}$, where n_{is}= number of informants who consider the species s as most important; n=total number of informants.

Pearson's product-moment correlation coefficient (PCC) is a good measure to numerically quantify the nature of the linear relationship between two variables, giving a value between +1 and -1 inclusive, where 1 is perfect positive correlation, 0 is no correlation, and -1 is perfect negative correlation. The strength of the relationship is indicated by the correlation coefficient (r). The significance of relationship (t-test) is expressed in probability levels p (0.05). In our case, the two variables of interest are IVs and FL. Pearson's product-moment correlation coefficient and t- tests are calculated with the help of statistical software SPSS. A rural – urban comparison on the indigenous knowledge of the medicinal herbs used in Assamese cuisine (based on Fic, FL and IVs) is done by using t-test to understand whether the modernization has any significant effect on the indigenous knowledge of urban people of Jorhat district in respect of medicinal herbs and their traditional remedial uses.

Table 1: The diversity of herbaceous species (with more than 50% FL) in Rural Area (7 villages) of Jorhat district, Assam, Northeast India

Species/Family	Local Name	Parts Used	Cuisine	Disease	FL% Rural	Ivs Rural
Acmella ciliate (Kunth) Cass./ asteraceae	Xuhoni	Leaf	as veg	Body pain	100	0.46
Allium sativum L./amaryllidaceae	Naharu	stem	as condiment to enhance the taste of veg and nonveg dishes, chutney	nerve problem	65	0.88
Amaranthus spinosus L./Amarnanthaceae	Khutora	Tender Shoot	as veg, non veg	Migraine	100	0.62
Ampheneuron opulantum (Kaulf) Holtum./thelypteridaceae	Bihlongoni	Leaf	chutney	Fever	66	0.6
Bacopa monnieri (L) Wettst./scrophulariaceae	Brahmi	leaf, Tender Shoot	as veg	Leprosy	60	0.48
Basella alba L./basellaceae	Puroi Sak	Leaf	as veg, non veg	Constipation	100	0.13
Celosia argentea L./Amarnanthaceae	Leheti Sak	Leaf	as veg	Liver	100	0.4
Centella asiatica L./apiaceae	Bor Manimuni	Whole plant	as veg	stomach upset	100	0.16
Colocasia esculenta (L.) Schott/araceae	Kochu	Tender Shoot, rhizome, leaf	as veg, non veg	blood purifier	82	0.96
Cucumis sativus L./cucurbitaceae	Tiyoh	Fruit	as veg, green salad	Diruteic kidney stone	57	0.75
Diplazium esculentum (Retz.) Sw./athyriaceae	Dhekia Sak	Tender Shoot	as veg	body pain	72	0.8
Drymaria cordata Willd./Caryophyllaceae	Lai Jabori	Leaf	as veg	Fever	100	0.4
Enhydra fluctuants Lour./asteraceae	Helonchi xak	Leaf, Tender shoot	as veg	blood pressure	71	0.56
Houttuynia cordata Thunb./saururiaceae	Mosondori	leaf	as veg, non veg	Piles	61	0.64
Hydrocotyle rotundifolia Roxb./apiaceae	Saru Manimuni	Whole plant	as veg, non veg	Fever	54	0.62
Lasta spinosa L./araceae	Sengmora	leaf	as veg	uric acid control	100	0.57
Leucas aspera/lamiaceae	Durun/drone	Leaf, Tender shoot	as veg	Piles	53	0.61
Mentha virdis (L.) L./lamiaceae	Pudina	Leaf, Tender shoot	chutney	Appetite	100	0.4
Musa balbisiana Colla./musaceae	Bhim Kal	Inflorescence, stem,	as veg	Appetite	100	0.48

Musa splendid A. chev./musaceae	Kas Kal	Fruit	as veg, non veg	Diarrhoea	100	0.39
Oldenlandia corymbosia/rubiaceae	Bonjaluk	Tender shoot	as condiment to enhance the taste of veg and nonveg dishes	Diarrhoea	100	0.22
Oxalis corniculata/oxalidaceae	Xorutengeshi	Leaf, Tender shoot	as veg, non veg	stomach problem	57	0.4
Oxalis debilis L./oxalidaceae	Bortengeshi	Leaf, Tender shoot	as veg, non veg	urinary tract infection	55	0.37
Phyllanthus niruri L./euphorbiaceae	Bon Amlokhi	leaf	as veg	Dysentery	100	0.15
Polygonum Caespifosum B. I./polygonaceae	Modhusuleng	leaf	as veg, non veg	Dysentery	100	0.22
Pomoea aquatic Forsk/convolvulaceae	Kolmou	Stem, leaf	as veg	stomach problem	100	0.39
Portulaca oleracea L./portulacaceae	Malbhog Khutura Sak	Whole plant	as veg	Liver	100	0.41
Spinacia oleracea L./Amarnanthaceae	Paleng Sak	leaf	as veg, non veg, green salad	eye sight	70	0.94
Stellaria media L./Caryophyllaceae	Morolia	Whole plant	boil	Digestion	100	0.12
Tetrastigma thomsonianm Planch./vitaceae	Noltenga	leaf, stem	as veg, non veg	Digestion	100	0.14
Zingiber cassumunar Roxb./zingiberaceae	Moran Ada	Rhizome	as condiment to enhance the taste of veg and nonveg dishes, chutney	Cough	70	0.39

RESULTS AND DISCUSSION

The diversity of herbaceous plants:

In the present study 42 herbaceous plants belonging to 26 families and 38 genera, used in 6 ethnic categories of cuisines with 32 different recipes have been documented in the seven villages under the rural area of Jorhat district [Table 1]. Assamese food epitomises the cultural diversity of the state. The Cuisines rely largely on the use of regional aromatic herbs and not spices. Thus the ethnic preparations are distinguished by the diverse flavours of exotic herbs available in Assam.

Among the recorded taxa, 32 species were stir-fried as Vegetables (Xaak Bhaji), followed by Non Vegetarian cuisines (11), Pitika (mashes/ boiled) (6), Green Chutney (5), Condiment (4) and Green salad (3) for fresh taste [Figure 2]. It is also observed during our study that the herbs used by the respondents in their daily food preparations have high medicinal values and a significant number of the villagers could provide good amount of information on the traditional ethnomedicinal knowledge of the herbaceous species.

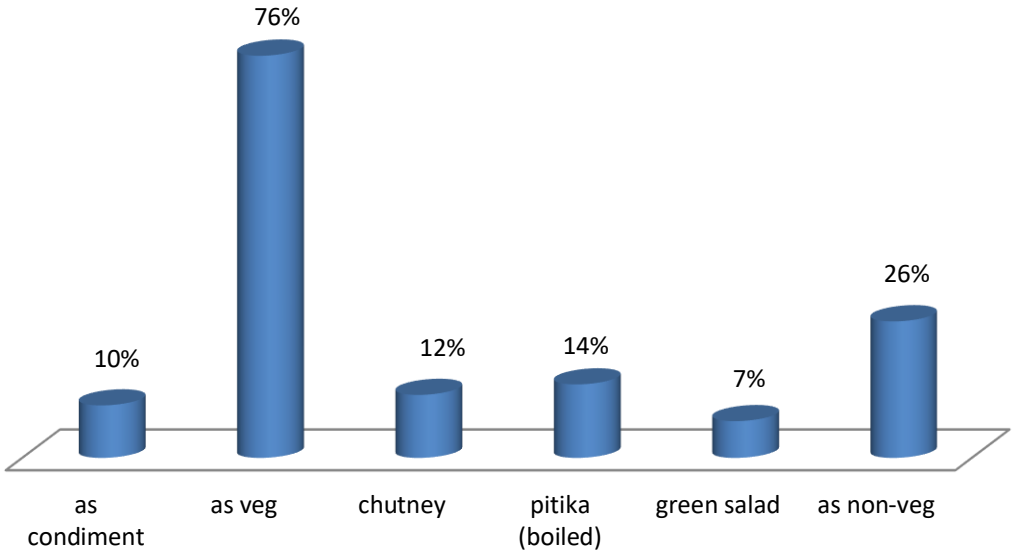

Figure 2: Percentage of herbaceous species used in different Assamese cuisines

Out of the 26 documented families, the family Amranthaceae was represented by the highest number of plants (5 species, 19%) followed by Araceae and Asteraceae (3 species each, 12%), remaining 8 families had 2 species and 15 families had single species representation [Figure 3].

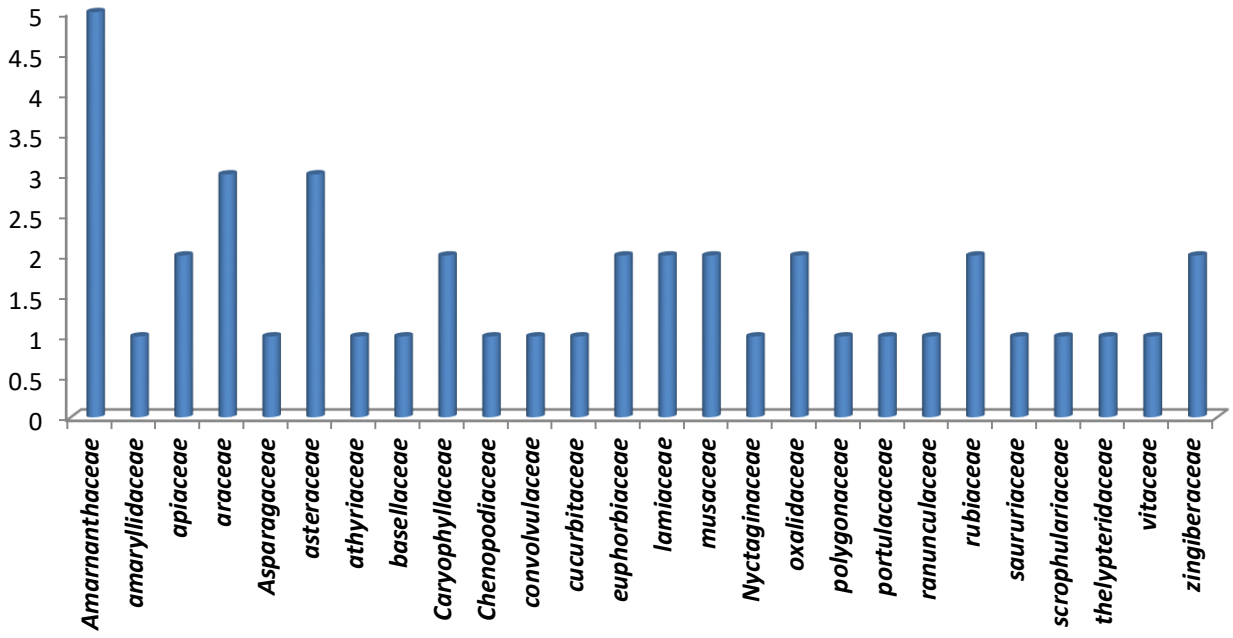

Figure 3: Number of herbaceous species in their respective family

Use of plant parts in cuisines among the informants shows variations as Leaves (CPP value 0.49) were mostly used part for the preparations of food as compared to other plant parts. Tender shoot secured the CPP value 0.25 followed by stem and whole plant (0.07), Rhizome (0.05), fruit (0.04), root and

inflarosence (0.02) [Figure 4]. Collection of plant parts specially leaves by the respondents for preparation of their cuisines would support the sustainable method of harvesting because in most of the cases at least a number of leaves are left unplucked which allows the parent plant to survive normally.

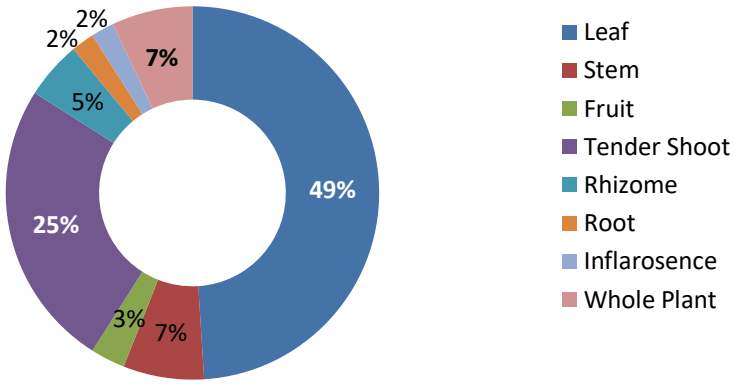

Figure 4: Percentage of plant parts used in Assamese Cuisine

The 42 herbaceous species used as food by the people from the study area were also reported to use for curing more than 40 ailments. These ailments were grouped into 20 major disease categories (Figure 4). Highest number of species (69%) was used for curing Stomach related problems, followed by Blood diseases (21%), Pain and Kidney Diseases (18%), Nervous system diseases (15%) and Hemorrhoids (10%). The respondents accordingly used the respective herbs for preparing the dishes in their meals as ethnomedicinal practice of curing a particular ailment.

Our study also revealed that there is a high level of consensus among the informants regarding disease cure and medicinal herb use through preparations of cuisines. The F_{ic} value for different categories ranges from 0.982 to 1.000 which indicates greater agreement among the informants regarding medicinal potential of the herbs used in their cuisines [Table 2]. Bone disease, sinusitis, Hyperuricemia and Leprosy secured the highest F_{ic} value (1) which indicates the remedies against these disease categories are actively practicing among the villagers in the study area. The F_{ic} results can be useful in prioritizing the herbs for further scientific validation of plants and plant products according to their medicinal values (Moshi *et al.*, 2009; Giday *et al.*, 2009). The highest number of herbs reported to use for stomach ailments in our study may be related to a high prevalence of this particular category of disease in the rural area of Jorhat district.

Stomach problem is a major concern not only in the study area but also in the whole country and result in high mortality rate if not treated promptly (Ribeiro *et al.*, 2010).

Table2: Informant Consensus Factors (ICF) value for different disease categories

Sl. No.	Disease Category	No. of species	No. of use reports Rural	Fic Rural	No. of use reports Urban	Fic Urban
1	Blood disease	8	856	0.992	100	0.929
2	Bone disease	1	75	1	10	1
3	Cough disease	3	290	0.993	105	0.981
4	Dermatological disease	2	112	0.991	42	0.976
5	Eye disease	3	150	0.987	76	0.973
6	Fever	3	215	0.991	110	0.982
7	Gynaecological disease	5	345	0.988	56	0.927
8	Hair disease	2	121	0.992	23	0.955
9	Hemorrhoids	4	321	0.991	112	0.73
10	Human brain disease	2	120	0.992	31	0.967
11	Hyperuricemia	1	80	1	20	1
12	Kidney disease	7	343	0.982	58	0.895
13	Leprosy	1	39	1	15	1
14	Liver disease	5	239	0.983	135	0.97
15	Mental illness	2	79	0.987	19	0.944
16	Nervous system disease	6	432	0.988	45	0.886
17	Pain	7	543	0.989	34	0.818
18	Sinusitis	1	34	1	9	1
19	Stomach disease	27	1125	0.977	112	0.766
20	Ulcers	3	144	0.986	11	0.8

The local people of our study area know the useful edible herbs and recipes through personal experience, ancestral practice and long utility. Our study also evidenced the use of freshly harvested plant parts from the home garden of the respondents for traditional preparation of cuisines as well as to cure various ailments. This finding is in the line with other ethnomedicinal inventories indicating the wide use of fresh plant parts for remedy preparations due to reportedly better efficacy related factors than use of dried plant materials (Yineger *et al.*, 2007; Lulekal *et al.*, 2008).

To determine culturally important herbaceous species in the society, Fidelity Level (FL%) of plants has been calculated based on use reports cited by the informants for curing a given ailment. The highest FL value (100%) has been recorded for seventeen herbs [Table 1]. The highest FL% value could be considered

as an indicator for high healing potential of those edible species used against the corresponding diseases. Plants with highest fidelity level value could also be targeted for further phytochemical investigation to identify the bioactive compounds that are responsible for their high healing potential. These seventeen species are commonly growing in natural habitats in the study area with no adverse effect of collection pressure upon them, but in future there may be a chance of declining the population of them due to their high use pressure in long term. The highest Important Value (IVs) calculated is 0.96 which has been recorded for the plants like *Colocasia esculenta (L.) Schott* against blood disease and *Paederia foetida L.* against cough [Table 1]. The highest score for Importance Value of these plants also highlights that these plants are therapeutically very important and the people of that area rely mostly upon those plants for effective treatment.

Preference Ranking:

Preference ranking exercise was conducted on seven edible medicinal herbs which are used to treat Kidney diseases reveals that *Cucumis sativus L.* is the most frequently used plant in the cuisines in our study area which highlights its highest efficacy potential among the seven plant species cited by the informants [Table 3].

Table 3: Results of Preference ranking exercise on seven edible herbs used for curing kidney diseases by villagers

Species	A	B	C	D	E	F	G	Total score	Rank
Cucumis sativus L.	5	5	4	4	5	5	5	33	1
Alocasia odora (Lindl.) K. Koch.	5	4	5	4	4	4	5	31	2
Euphorbia hirta L.	4	3	5	5	3	4	3	27	4
Boerhavia diffusa L.	4	3	2	2	2	3	3	19	7
Alternanthera Sessile (L.) R. Br.	4	3	3	3	4	3	4	24	6
Asparagus officinalis L.	5	3	4	4	3	5	4	28	3
Oxalis debilis L.	2	4	3	5	3	4	4	25	5

The Karl Pearson's Correlation coefficient has been calculated between IVs and FL% and its value is 0.151 [Table 4] which showed a low positive linear relationship between the proportion of informants who regard a species as most important and percentage of informants claiming the use of a certain plant for the same major purpose. The hypothesis test for the significance of the correlation coefficient is performed to decide whether the linear relationship in the sample data is strong enough to use to model the relationship in the population and it was observed that correlation coefficient is not significantly different from zero ($p>0.05$). Thus, there does not exist a significant linear relationship between IVs and FL%.

COMPARISON OF RURAL AND URBAN DATA ON THE INDIGENOUS KNOWLEDGE OF MEDICINAL HERBS USED IN ASSAMESE CUISINE

The current study indicated a marked difference in the knowledge of uses of important herbaceous species for curing ailments between rural and urban respondents. The result showed significant difference ($p<0.05$) when IVs of rural group has been compared with that of urban group implying that urbanization has affected the society to a great extent and as a result people are not being able to understand the importance of locally available herbs which are therapeutically very useful [Table 5]. Nowadays due to modernization people in urban area prefer modern medicines to traditional remedies. This being a cause currently people don't give attention to the remedies through traditional medicinal herbs. The findings of our study agrees with the previous reports by Maryo *et al.*, 2015 and also consistent with Ermias *et al.*, 2013 where education correlates negatively and significantly with knowledge of medicinal plant species, which in turn can affect the traditional medicinal plant knowledge and the natural healing practices in the Assamese society.

Table 4: Summary Statistics

Statistics	FL(Rural)	IVs(Rural)
Mean	**44.871**	**0.420**
Standard Deviation	**30.957**	**0.204**
Correaltion (r)	**0.151**	
t- test	**1.46**	
P value (two- tailed)	**0.15 > 0.05**	

Table 5: Summary Statistics

Statistics	IVs	
	Rural	Urban
Mean	0.435	0.086
Standard Deviation	0.084	0.2110
t- test	19.128	
P value (two- tailed)	P < 0.00001	

CONCLUSION

The information generated from the present study regarding traditional herbs use in Assamese cuisines has revealed that different ethnic groups of rural part of Jorhat, Assam have immense knowledge of use of medicinal herbs to treat a wide range of diseases. It was statistically established that the persistence of traditional knowledge is more among rural people; however, it is a matter of concern that the urban people of Jorhat are taking less interest in such knowledge.

It was also observed during our study that the uses of medicinal herbs as well as interest in traditional food are declining at an alarming rate among younger generation which may be due to modern lifestyle, high social mobility from rural areas, the habit of eating fast and fried foods. Thus there is an urgent need to raise awareness on the significance of ethno medicinal plants used in traditional Assamese cuisines for the primary health care. A database of the traditional knowledge of herbal medicine used in Assamese cuisines among the villagers of our study area should be conserved through documentation before it is lost from the society forever.

Herbs are the major growth form used in the rural region under study for curing human diseases and the people are highly dependent on these plants for medicinal uses. The trend of using more of herbaceous species could be advantageous as it is easier to cultivate. Hence the farmers need to be assisted and encouraged in cultivating commonly useful medicinal plants. In our study, it was observed that most of our documented herbs are being cultivated in home gardens in almost all the villages under study.

The wide use of the herbs based on the high values of F_{ic} and FL could validate the effectiveness and efficacy of the ethno botanical practices of the villagers. Further phytochemical analysis and pharmaceutical application are therefore recommended in order to evaluate the authenticity of ethno

medicines to scientific standards. Such research, linked to experimental trials of the effect would increase confidence of traditional users and healers.

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