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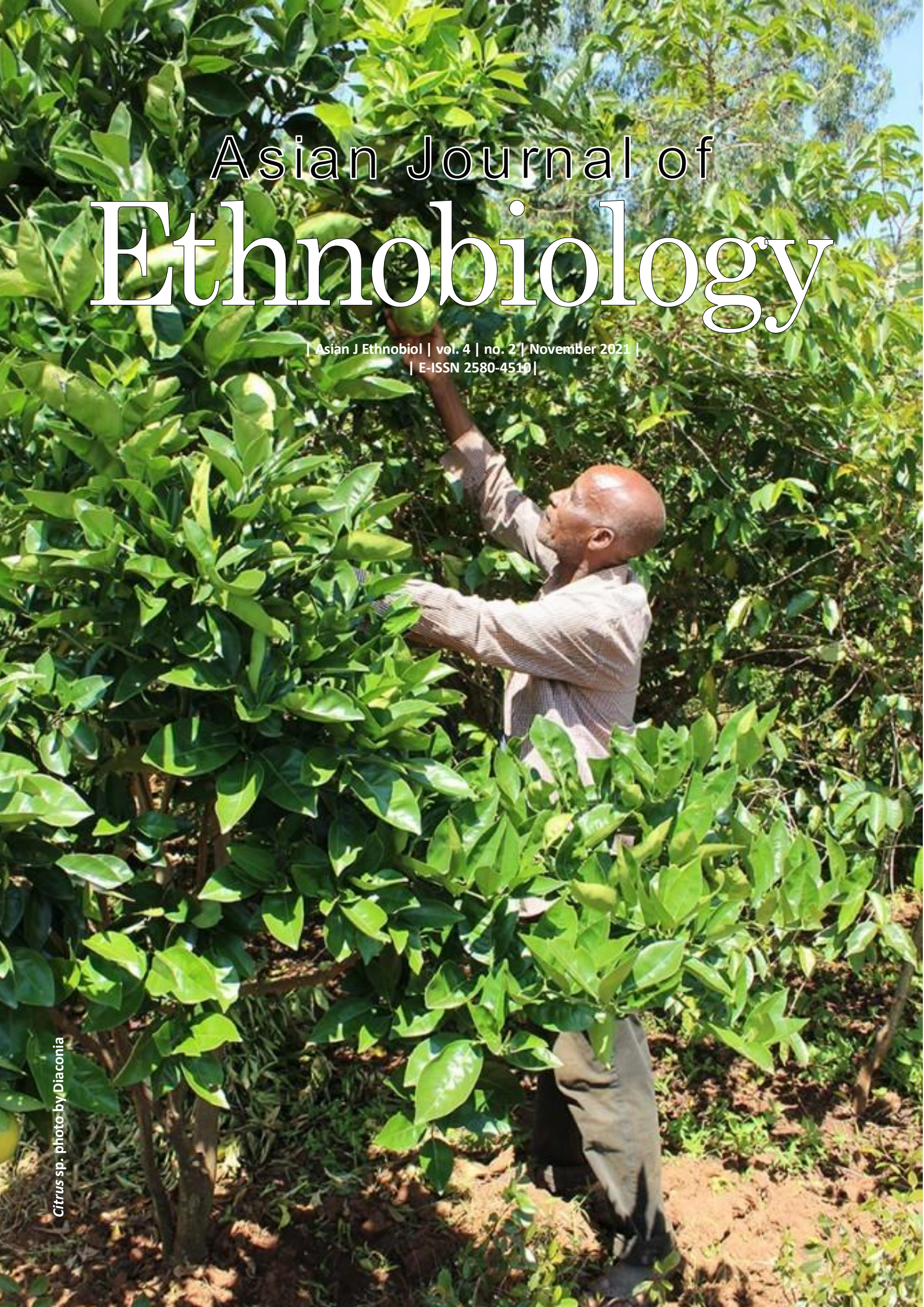

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Introduction is about 600 words, covering the aims of the research and provide an adequate background, avoiding a detailed literature survey or a summary of the results. **Materials and Methods** should emphasize on the procedures and data analysis. **Results and Discussion** should be written as a series of connecting sentences, however, for a manuscript with long discussion should be divided into subtitles. Thorough discussion represents the causal effect mainly explains why and how the results of the research were taken place, and do not only re-express the mentioned results in the form of sentences. **Concluding** sentence should be given at the end of the discussion. **Acknowledgements** are expressed in a brief; all sources of institutional, private and corporate financial support for the work must be fully acknowledged, and any potential conflicts of interest are noted.

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Journal:

Saharjo BH, Nurhayati AD. 2006. Domination and composition structure change at hemic peat natural regeneration following burning; a case study in Pelalawan, Riau Province. Biodiversitas 7: 154-158. DOI: 10.13057/biodiv/d070213.

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Smith J, Jones M Jr, Houghton L et al. 1999. Future of health insurance. N Engl J Med 965: 325-329. DOI: 10.10007/s002149800025.

Book:

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Chapter in the book:

Webb CO, Cannon CH, Davies SJ. 2008. Ecological organization, biogeography, and the phylogenetic structure of rainforest tree communities. In: Carson W, Schnitzer S (eds.). Tropical Forest Community Ecology. Wiley-Blackwell, New York.

Abstract:

Assaeed AM. 2007. Seed production and dispersal of *Rhazya stricta*. 50th annual symposium of the International Association for Vegetation Science, Swansea, UK, 23-27 July 2007.

Proceeding:

Alikodra HS. 2000. Biodiversity for development of local autonomous government. In: Setyawan AD, Sutarno (eds.). Toward Mount Lawu National Park; Proceeding of National Seminary and Workshop on Biodiversity Conservation to Protect and Save Germplasm in Java Island. Universitas Sebelas Maret, Surakarta, 17-20 July 2000. [Indonesian]

Thesis, Dissertation:

Sugiyarto. 2004. Soil Macro-invertebrates Diversity and Inter-Cropping Plants Productivity in Agroforestry System based on Sengon. [Dissertation]. Universitas Brawijaya, Malang. [Indonesian]

Information from the internet:

Balagadde FK, Song H, Ozaki J, Collins CH, Barnet M, Arnold FH, Quake SR, You L. 2008. A synthetic *Escherichia coli* predator-prey ecosystem. Mol Syst Biol 4: 187. DOI: 10.1038/msb.2008.24. www.molecularsystembiology.com.

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Plants with insecticidal potential used by ethnic groups in North-Central Nigeria for the management of hematophagous insects

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Abstract. *Adelaja OJ, Oduola AO, Abiodun OO, Adeneye AK, Obembe A. 2021. Plants with insecticidal potential used by ethnic groups in North-Central Nigeria for the management of hematophagous insects. Asian J Ethnobiol 4: 65-75.* Studies on the traditional knowledge of insecticidal plants are vital in the discovery of bioactive components for the management of hematophagous insects. This study investigated the ethnobotany and traditional knowledge of insecticidal plants among nine ethnic groups in North-Central Nigeria. Information on identifying insecticidal plants and their traditional knowledge among community leaders, elders, herb sellers, and herbalists was collected between January and December 2017, using a semi-structured questionnaire. The mentioned plants were collected and identified. A total of 388 respondents were interviewed from nine ethnic groups. All the respondents had knowledge of medicinal and insecticidal plants in their communities. The respondents mentioned 17 insecticidal plants. The most frequently mentioned plants were *Hyptis suaveolens* (19.6%, 76/388), *Ocimum gratissimum* (18.7%, 73/388), and *Citrus sinensis* (10.8%, 42/388). Hanging of plants in homes was reported among 52.9% of the respondents and smoldering for personal protection among 47.1%. The respondents also acknowledged that these plants were available (88.4%), accessible (77%), and very effective (76.3%) in controlling hematophagous insects. There was a significant relationship ($P<0.05$) between the perceived efficacy of these plants and the gender, age, educational status, and ethnicity of respondents. This study documented the knowledge and evidence of insecticidal plants among ethnic groups in North-Central Nigeria.

Keywords: Ethnobotany, ethnicity, insecticidal, insects, plants

INTRODUCTION

Traditional African communities have long relied on plants with insecticidal potential for personal protection against hematophagous insects responsible for the transmission of disease-causing parasites and pathogens (Kidane et al. 2013). This knowledge is built on close observation and long-term use of these plants in local communities and has been passed down over several generations (Karunamorthi and Hailu 2014). Such research-based documentation is required for knowledge preservation and transfer of sustained insecticidal plants cultivation and conservation and discovering the plants' insecticidal bioactive components against hematophagous insects.

Vector-borne diseases transmitted by hematophagous insects impose a massive burden on the world's populace in terms of indisposition and mortality contributing 17% of total infectious diseases affecting mankind with more than 700,000 deaths yearly (WHO 2019). West Nile Virus, Malaria, Encephalitis, Filariasis, Dengue, Zika, and Yellow Fever are the most transmitted vector-borne diseases with debilitating outcomes and the vectors are mosquitoes (Becker et al. 2003) with most of Nigeria's population at risk of mosquito-borne diseases (Oduola et al. 2016). Nigeria accounts for 24% of the 94% malaria cases in the African region, 106 million people at risk of lymphatic filariasis and 106 confirmed cases and 20 confirmed deaths from yellow fever (WHO 2019).

Since the beginning of the millennium, there has been a stimulating search for the discovery of new and active insecticidal compounds of plant origin and their traditional use (David 2010; Uperty et al. 2010). In a bid to achieve this, ethnobotanical surveys were carried out all around the world and in some countries in Africa, i.e., Ethiopia, Tanzania, Kenya, Cameroon, and South Africa to identify plants with insecticidal potential for the management of hematophagous insects (Karunamorthi et al. 2009a; Mavundza et al. 2011; Kidane et al. 2013; Karunamorthi and Hailu 2014; Youmsi et al. 2017). The survey has also been carried out in South-Eastern Nigeria where plants with insecticidal potential were identified (Edwin-Wosu et al. 2013).

Predominant plants with insecticidal potential used in the management of hematophagous insects documented in ethnobotanical surveys conducted in Africa include; *Lippia jaranica* in South Africa (Mavundza et al. 2011), *Boswellia papyrifera*, and *Ostostegia integrifolia* in Ethiopia (Karunamorthi et al. 2009a; Kidane et al. 2013), *Canarium schweinfurthii* in Cameroon (Youmsi et al. 2017), *Azadirachta indica* in Tanzania (Innocent et al. 2016), and *Ocimum americanum* in Kenya (Seyoum et al. 2002). Similarly, *Duranta repens*, *Duranta pulmeri* and *Ocimum gratissimum* were the predominant plants with insecticidal

potential against hematophagous insects documented in South-Eastern Nigeria (Edwin-Wosu et al. 2013).

A report emanating from South Africa showed that 70% of respondents traced the source of knowledge of plants having the insecticidal potential to family members (Mavundza et al. 2011). Meanwhile, ethnobotanical studies carried out in Ethiopia and Tanzania associated usage customs of insecticidal plants with sex and monthly income but not with educational status (Karunamorthi et al. 2009a; Karunamorthi and Hailu 2014). However, the only documented study of an ethnobotanical survey of plants with insecticidal potential against hematophagous insects carried out in Nigeria was done in the South-Eastern part (Edwin-Wosu et al. 2013) and ethnicity was not a factor considered hence the need to carry out this in North-Central Nigeria.

Despite ethnobotanical information on insecticidal plants from a geopolitical zone in Nigeria, we felt a need to present a first report on the ethnobotany and traditional knowledge of plants with insecticidal potential among nine ethnic groups in North-Central Nigeria. We hope that information generated from this study will go a long way in aiding the management of hematophagous insects in Nigeria.

MATERIALS AND METHODS

Study area

The study was conducted in the North-Central geopolitical region of Nigeria which is composed of six states, namely Benue, Plateau, Kogi, Nasarawa, Kwara, and Niger. A total landmass of 296,898 km^2 and a total population of 20.36 million people. Forty-eight percent of the people in the region live in rural communities. North-Central Nigeria is situated between latitudes 6^{0}30″ N and 11^{0}20″ N and longitudes 7^{0}E and 10^{0}E, the region has average annual rainfall that ranges from 1,500 mm to 1,800 mm, with average annual temperature varying between 20^{0}C and 35^{0}C (NPC 2016). These six states are found around the river Niger and Benue and some of the states are richly endowed with natural mineral resources. The major ethnic groups in this region are Tiv, Yoruba, Idoma, Igala, Ebira, Nupe, Gbayi, Berom, and Mangu. Farming is the mainstay of the rural communities' economy found in North-Central Nigeria.

Experimental design and procedure

The study was undertaken as a descriptive cross-sectional survey between January and December 2017. Communities were selected based on ethnicity in the states found in North-Central Nigeria. After which, the geographical positioning system (GPS) for the surveyed communities was captured (Figure 1). Before the survey was conducted, community leaders were consulted to gain their trust and help identify possible contact persons and respondents. People conversant with plants used for health care were the target of this survey, grouped into community leaders, elderly villagers, herb sellers, and herbalists adopting Dike et al. (2012) groupings. With the aid of a local contact person conversant with the language and culture of the locality, respondents were identified, oral interviews were carried out and data were collected using semi-structured questionnaires.

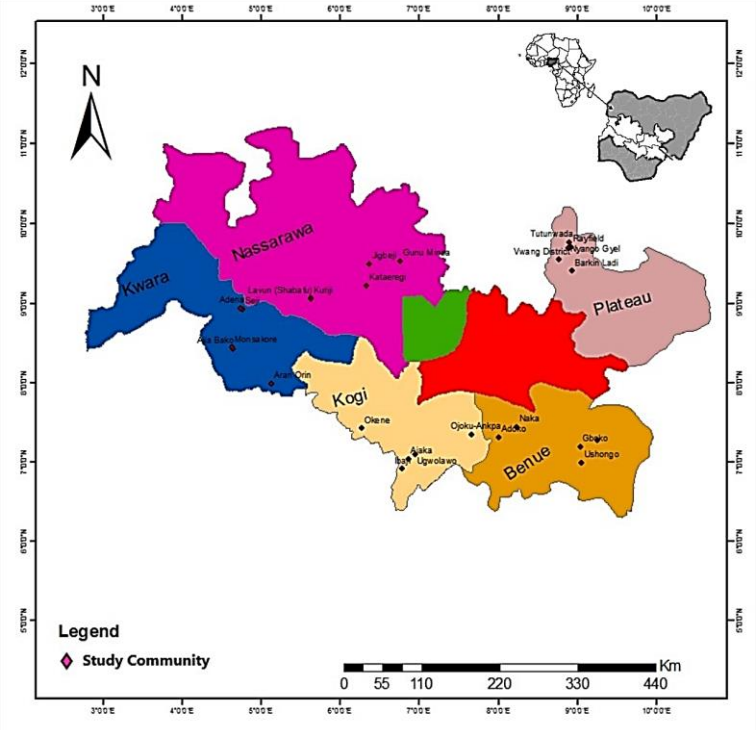

Figure 1. Map of North-Central Nigeria showing states and selected communities surveyed

Data collection and analysis

The questionnaires were filled out using oral interviews with translation done by a contact person where necessary. The questionnaire gathered information on locality, sociodemographic data, insects of public health importance, plants used for insects' control, vernacular names of the plant, plant parts used, the condition of the plant material (dried or fresh), methods and frequency of application, accessibility, availability, source of knowledge and efficacy of insecticidal plants. The local importance of each plant species was calculated based on the Relative Frequency of Citation (RFC) (Iyamah and Idu 2015; Youmsi et al. 2017).

$$\mathrm{RFC} = \frac{UR}{N}$$

Where UR: number of respondents who claim the use of plants, and N: total number of respondents interviewed.

ArcGis 10.1 was used to locate the GPS coordinate of questionnaire survey communities and generate a spatial map. Summary statistics were performed using Origin 2019, SPSS ver. 20 (IBM) and Microsoft Office Excel 2016. The range and means of the data obtained from the administered questionnaire were analyzed. Chi-square analysis was performed to test statistical significance at a 95% confidence interval (P = 0.05) using Origin 2019.

Plant identification and authentication

All plant species mentioned were collected with the help of the villagers and identified at the Herbarium of the Department of Plant Biology, University of Ilorin. The identified plants were allocated authentication numbers afterward.

Ethical statement

The ethnobotanical survey was approved by the University of Ilorin ethical review committee (UERC/ASN/2017/898). Prior to the study, the aims and objective of the study were clearly explained, and informed verbal consent was obtained from each respondent to record and publish findings from this study.

RESULTS AND DISCUSSION

Demographic information of the respondents

A total of 388 respondents were interviewed from nine ethnic groups in North-Central Nigeria. The communities were selected based on their ethnicity and the possibility of getting the required information as suggested by contact persons who are natives of the regions. The ethnic groups include Tiv (12.4%), Nupe (24.7%), Yoruba (9.8%), Berom (13.9%), Igala (11.9%), Ebira (8.2%), Gbayi (2.6%), Mangu (4.1%), and Idoma (12.4%) with the most respondents being Nupe which is found in both Kwara and Niger state followed by Berom and Tiv in Plateau state and Idoma in Benue state. The demographic data collected showed that 54.1% of the respondents were males and 45.9% were females. Religious affiliation showed that 52.6% of the respondents were Christians, 40.7% Muslims and 6.7% were Traditionalists. It was also noticed that most of the respondents had a form of education with the highest (33.5%) having secondary education followed by those who had primary education (30.9). The predominant age group was between 41 to 60 years (48.5%) with most of the respondents being between 41 to 50 years (25.8%) followed by above 70 years (24.7%). The majority of the respondents were married (85.1%) (Table 1). All the respondents had ample knowledge of plants used for health care in their communities and they were grouped into herb sellers (31.96%), traditional healers (15.98%), community heads (4.64%), and elders (47.42%) (Figure 2).

Table 1. Socio-demographic characteristics of respondents in North-Central Nigeria

Socio-demographic characteristics of variables		Frequency (n = 388)	Percentage (%)
Gender	Male	210	54.1
	Female	178	45.9
Ethnicity	Tiv	48	12.4
	Nupe	96	24.7
	Yoruba	38	9.8
	Berom	54	13.9
	Igala	46	11.9
	Ebira	32	8.2
	Gbayi	10	2.6
	Mangu	16	4.1
	Idoma	48	12.4
Educational status	None	78	20.1
	Primary	120	30.9
	Secondary	130	33.5
	Tertiary	28	7.2
	Adult education	32	8.3
Religion	Christianity	204	52.6
	Islam	158	40.7
	Traditional	26	6.7
Age	Less than 20 years	12	3.1
	21-30 years	6	1.5
	31-40 years	38	9.8
	41-50 years	100	25.8
	51-60 years	88	22.7
	61-70 years	48	12.4
	Above 70 years	96	24.7
Marital status	Single	28	7.2
	Married	330	85.1
	Widowed	30	7.7

Note: n: total number of respondents

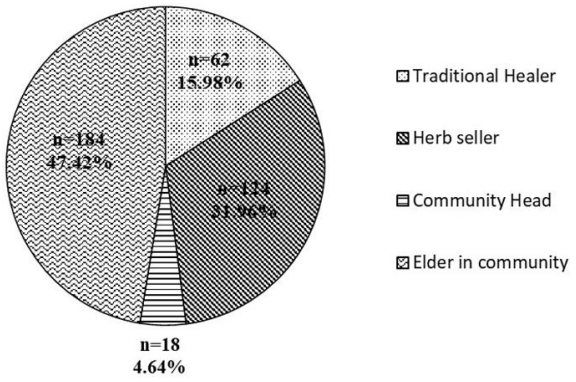

Figure 2. Category of respondents interviewed

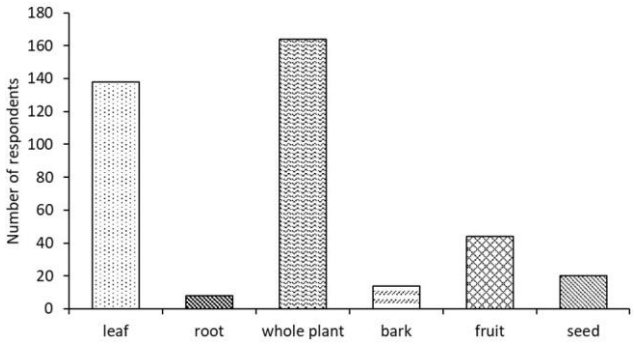

Figure 3. Insecticidal plant parts used by respondents for the management of hematophagous insects

Information on identified plants

Local inhabitants mentioned 17 plant species in the study area for personal protection against hematophagous insects. The identified and shortlisted plants belonged to 12 families among which Lamiaceae was the most represented with three species, namely *Hyptis suaveolens*, *Ocimum gratissimum*, and *Thymus vulgaris*. This was followed by Solanaceae (*Capsicum annuum* and *Nicotiana tabacum*), and Fabaceae (*Cassia mimosoides* and *Parkia biglobosa*). The most frequently mentioned plants were *Hyptis suaveolens* (19.6%, UR = 76/388, RFC = 0.196) followed by *Ocimum gratissimum* (18.7%, UR = 73/388, RFC = 0.187), *Citrus sinensis* (10.8% UR = 42/388, RFC = 0.108), *Ageratum conyzoides*, *Cymbopogon citratus* and *Thymus vulgaris* (6.2%, UR = 24/388, RFC = 0.062 each) and *Nicotiana tabacum* (5.6%, UR = 22/388, RFC = 0.057). Least mentioned plants were *Lantana camara* (1.5%, UR = 6/388, RFC = 0.015) and *Moringa oleifera* (1.0%, UR = 4/388, RFC = 0.010) (Table 2). Most of the plants identified were shrubs (58.8%) while the others were trees (35.3%). Whole plants (42.3%) were the most used plant parts followed by leaves (35.6%) (Figure 3). Fifty-three percent of the respondents reported that they used plants in their fresh states by hanging them inside their abode while the rest of the respondents reported that the plants were used dried (47.1%) by smoldering the plant materials to make smoke (Table 2).

Distribution of identified plants by ethnicity

Hyptis suaveolens and *Ocimum gratissimum* were the most represented insecticidal plant used by all of the eight ethnic groups for personal protection against hematophagous insects followed by *Citrus sinensis* which was mentioned in six ethnic groups, namely Berom, Idoma, Mangu, Nupe, Tiv, and Yoruba while *Nicotiana tabacum* mentioned in four ethnic groups (Berom, Ebira, Idoma, and Yoruba), and *Thymus vulgaris* was mentioned in three ethnic groups (Idoma, Nupe, and Tiv) (Table S1). *Hyptis suaveolens* and *Thymus vulgaries* were the only plants mentioned by all the target respondents as having insecticidal potential. The majority of the shortlisted plants were mentioned by Herb sellers and Elders in communities (Table S2).

Usage customs of identified plants

Eighty-eight percent of the respondents acknowledged that the plants were available around the community while the other respondents (8.8%) reported that they collected the plants from the forest or bought them from the market (2.8%). The majority (77%) of the respondents claimed that the insecticidal plants used for personal protection were accessible within one km radius. Information on the source of knowledge on plant use among respondents indicated that 83.8% of them obtained the information from family members while 12.6% of the respondents obtained the information from friends and neighbors (Table 3). The assessment of knowledge on how plants are applied showed that 99% of the respondents applied the plants inside their houses while 1% of the respondents applied it in sewage systems found around their houses (Table 4). The frequency of application of the plants ranged from once a week (21.7%) to once a day (71.6%). The respondents (76.3%) ascertained that the identified insecticidal plants were very effective while 23.2% of the respondents felt that the insecticidal plants were effective in controlling hematophagous insects. There was significant relationship in the perceived efficacy of these insecticidal plants for personal protection against haematophagous insects and; gender (P value = 0.000, df = 2, χ^2 = 31.396), age (P value = 0.007, df = 112, χ^2 = 64.445), educational status (P value = 0.000, df = 8, χ^2 = 102.405), and ethnicity (P-value = 0.000, df = 16, χ^2 = 116.865) of respondents (Table 5).

Discussion

An ethnobotanical survey was carried out to evaluate knowledge associated with the traditional use of plants with insecticidal potential against hematophagous insects in North-Central Nigeria. This study showed that all of the respondents interviewed from the nine ethnic tribes knew the cultural uses of plants in the control of hematophagous insects. A similar study conducted in Ethiopia showed that 97.2% of the respondents had adequate knowledge about the usage customs of traditional insecticidal plants used to repel hematophagous insects (Karunamorthi et al. 2009a). This shows that the wealth of knowledge of plant species used to control hematophagous insect dwells with the respondents surveyed in communities in North-Central Nigeria.

The observed 100% awareness of insecticidal plants' use among respondents in this study is attributable to the selection of residents (community leaders and elders, herb sellers, and traditional healers) perceived to be endowed with knowledge of plant species used for health care purposes. Iyamah and Idu (2015) acknowledged that herb sellers play a vital role in making herbs and are open to sharing their knowledge of these herbs and their uses with researchers. This might be the reason why they ranked second in the list of the most interviewed group of respondents after community elders. Also, herb sellers are helpful as sources of knowledge of plants because that is their trade making them very familiar with plant species around them and their usage customs. Iyamah and Edu (2015) also reported that herb sellers acknowledged obtaining regular feedback from their customers on the effectiveness of plants used for the treatment of malaria and personal protection against blood-sucking insects hence the authenticity of the information they present.

Table 2. Information on plants with insecticidal potential used for management of hematophagous insects in North-Central Nigeria

Family name	Scientific name	Local name	Voucher number	UR (%)	RFC (n = 388)	State of use	Habit	Application Method
Asteraceae	*Ageratum conyzoides* L.	Itanajuwe (I), Hurhur (T)	UILH/013/140	24(6.2)	0.062	Fresh	Shrub	Hanging
Amaryllidaceae	*Allium cepa* L.	Lubasakuchi (B)	UILH/008/1332	8(2.1)	0.021	Fresh	Herb	Hanging
Annonaceae	*Annona senegalensis* Pers.	Abobo (Y), Gwandar daji (N)	UILH/004/499	12(3.1)	0.031	Fresh	Tree	Hanging
Solanaceae	*Capsicum annuum* L.	Akpoko (I)	UILH/015/532	16(4.1)	0.041	Fresh	Shrub	Smoke
Fabaceae	*Cassia mimosoides* L.	Gabaruwankasa (B)	UILH/017/534	16(4.1)	0.041	Dried	Tree	Smoke
Rutaceae	*Citrus sinensis* L.	Ekpo Osan (Y)	UILH/010/159	42(10.8)	0.108	Dried	Tree	Smoke
Poaceae	*Cymbopogon citratus* L.	Ile (I), Ganyenti (B)	UILH/011/949	24(6.2)	0.062	Fresh	Shrub	Hanging
Leguminosae	*Erythrophleum suaveolens* Guill. & Perr.	Goska (B) Gwaska (N), Obo (Y)	UILH/016/221	8(2.1)	0.021	Dried	Tree	Smoke
Myrtaceae	*Eucalyptus globulus* Labill.	Turare (N) Raskata (B)	UILH/006/1073	12(3.1)	0.031	Fresh	Tree	Hanging
Malvaceae	*Hibiscus rosa-sinensis* L.	Roase mosquita (B)	UILH/007/710	9(2.3)	0.023	Dried	Shrub	Hanging
Lamiaceae	*Hyptis suaveolens* (L.) Poit.	Tamwotswagi (N), Jogbo (Y), Olufofo (I), Daddoya tadaji (B), Hurhur (T)	UILH/003/931	76(19.6)	0.196	Fresh	Shrub	Hanging
Verbenacae	*Lantana camara* L.	Latana (B)	UILH/009/509	6(1.5)	0.015	Dried	Shrub	Smoke
Moringaceae	*Moringa oleifera* Lam.	Zogole (B)	UILH/002/559	4(1.0)	0.010	Dried	Tree	Smoke
Solanaceae	*Nicotiana tabacum* L.	Taba (N)	UILH/005/504	22(5.6)	0.057	Dried	Shrub	Smoke
Lamiaceae	*Ocimum gratissimum* L.	Efirin (Y), Anyeba (I), Daidoya (T), KunguraKu-u-tamen (N)	UILH/012/984	73(18.7)	0.188	Fresh	Shrub	Hanging
Fabaceae	*Parkia biglobosa* Jacq.	Nungoro (N), Ekunigba (Y)	UILH/001/948	12(3.1)	0.031	Dried	Tree	Smoke
Lamiaceae	*Thymus vulgaris* L.	Tamwotswagi (N), Efrin wewe (Y)	UILH/012/851	24(6.2)	0.062	Fresh	Shrub	Hanging

Table 3. Perception of respondents to insecticidal plant accessibility, effectiveness, and source of information in North Central Nigeria

Scientific name	Respondents		Availability			Distance travelled to harvest the plant			Source of Knowledge		
	UR (n = 388)	%	Forest	Around community	Market	< 1Km	1-2 Km	>5 Km	Family members	Divination	Friend/ neighbour
Parkia biglobosa	12	3.0	2(16.7)	10(83.3)	NR	10(83.3)	2(16.7)	NR	10(83.3)	NR	2(16.7)
Moringa oleifera	4	1.0	NR	4(100)	NR	4(100)	NR	NR	4(100)	NR	NR
Hyptis suaveolens	76	19.6	NR	76(100)	NR	76(100)	NR	NR	72(94.7)	NR	4(5.3)
Annona senegalensis	12	3.3	NR	12(100)	NR	12(100)	NR	NR	12(100)	NR	NR
Nicotiana tabacum	22	5.6	NR	22(100)	NR	22(100)	NR	NR	10(45.5)	NR	12(54.5)
Eucalyptus globulus	12	3.3	2(16.7)	6(50)	4(33.3)	8(66.7)	4(33.3)	NR	12(100)	NR	NR
Hibiscus rosa-sinensis	9	2.3	2(22.2)	4(44.5)	3(33.3)	4(44.5)	5(55.5)	NR	9(100)	NR	NR
Allium cepa	8	2.1	8(100)	NR	NR	NR	8(100)	NR	8(100)	NR	NR
Lantana camara	6	1.5	4(66.7)	2(33.3)	NR	NR	2(33.3)	4(66.7)	4(66.7)	NR	2(33.3)
Citrus sinensis	42	10.8	2(4.8)	40(95.2)	NR	42(100)	NR	NR	20(47.6)	2(4.8)	20(47.6)
Cymbopogon citratus	24	6.1	NR	24(100)	NR	22(91.7)	2(8.3)	NR	24(100)	NR	NR
Ocimum gratissimum	73	18.7	2(2.7)	71(97.3)	NR	47(64.4)	20(27.4)	6(8.2)	69(94.5)	4(5.5)	NR
Ageratum conyzoides	24	6.2	NR	24(100)	NR	24(100)	NR	NR	24(100)	NR	NR
Thymus vulgaris	24	6.2	NR	24(100)	NR	14(58.3)	10(41.7)	NR	15(62.5)	4(16.7)	5(20.8)
Capsicum annuum	16	4.1	NR	12(75)	4(25)	14(87.5)	2(12.5)	NR	12(75)	4(25)	NR
Erythrophleum suaveolens	8	2.1	8(100)	NR	NR	NR	8(100)	NR	8(100)	NR	NR
Cassia mimosoides	16	4.1	4(25)	12(75)	NR	NR	16(100)	NR	12(75)	NR	4(25)
Total			34	343	11	299	79	10	325	14	49
Percentage			8.8	88.4	2.8	77	20.4	2.6	83.8	3.6	12.6

Note: UR: Number of respondents who claim the use of plants, the percentage in parenthesis, NR: No Record of information from respondents, %: Percentage

Table 4. Method and frequency of application of insecticidal plants used for personal protection in North-Central Nigeria

Scientific name	Respondents		Method of Application		Frequency of Application				Efficacy		
	UR	%	Inside houses	Sewage systems	Once a day	Once a week	Once a month	Once a year	Very effective	Effective	Not so effective
Parkia biglobosa	12	3.0	12(100)	NR	12(100)	NR	NR	NR	12(100)	NR	NR
Moringa oleifera	4	1.0	4(100)	NR	NR	4(100)	NR	NR	4(100)	NR	NR
Hyptis suaveolens	76	19.6	76(100)	NR	52(68.4)	16(21.1)	8(10.5)	NR	46(60.5)	30(39.5)	NR
Annona senegalensis	12	3.3	12(100)	NR	12(100)	NR	NR	NR	12(100)	NR	NR
Nicotiana tabacum	22	5.6	22(100)	NR	18(81.8)	4(18.2)	NR	NR	16(72.7)	6(27.3)	NR
Eucalyptus globulus	12	3.3	12(100)	NR	8(66.7)	NR	4(33.3)	NR	10(83.3)	2(16.7)	NR
Hibiscus rosa-sinensis	9	2.3	9(100)	NR	NR	9(100)	NR	NR	9(100)	NR	NR
Allium cepa	8	2.1	8(100)	NR	4(50)	NR	4(50)	NR	4(50)	4(50)	NR
Lantana camara	6	1.5	6(100)	NR	2(33.3)	NR	NR	4(66.7)	4(66.7)	2(33.3)	NR
Citrus sinensis	42	10.8	42(100)	NR	38(90.5)	4(9.5)	NR	NR	36(85.7)	4(9.5)	2(4.8)
Cymbopogon citratus	24	6.1	22(91.7)	2(8.3)	16(66.7)	6(25)	NR	2(8.3)	22(91.7)	2(8.3)	NR
Ocimum gratissimum	73	18.7	73(100)	NR	46(63)	25(34.3)	2(27)	NR	61(83.6)	12(16.4)	NR
Ageratum conyzoides	24	6.2	24(100)	NR	22(91.7)	2(8.3)	NR	NR	24(100)	NR	NR
Thymus vulgaris	24	6.2	24(100)	NR	20(83.3)	4(16.7)	NR	NR	24(100)	NR	NR
Capsicum annuum	16	4.1	16(100)	NR	12(75)	4(25)	NR	NR	4(25)	12(75)	NR
Erythrophleum suaveolens	8	2.1	6(75)	2(25)	NR	6(75)	NR	2(25)	8(100)	NR	NR
Cassia mimosoides	16	4.1	16(100)	NR	16(100)	NR	NR	NR	NR	16(100)	NR
Total			384	4	27.8	84	18	8	296	90	2
Percentage			99	1	71.6	21.7	4.6	2.1	76.3	23.2	0.5

Note: UR: Number of respondents who claim the use of plants, the percentage in parenthesis, NR: No Record of information from respondents

Table 5. Knowledge and effectiveness of insecticidal plants in relation to gender, age, educational status, and ethnicity

Variables		Respondents		Knowledge of plants	Efficacy of plant			P-values
		UR	%		VEF	EF	NSEF	
Gender	Male	210	54.1	210	126	78	NR	p = 0.000
	Female	178	45.9	178	152	24	2	df = 2
								χ^2 = 31.396
Age	Less than 20 years	12	3.1	12	12	NR	NR	p = 0.007
	21-30 years	6	1.5	6	4	2	NR	df = 12
	31-40 years	38	9.8	38	18	20	NR	χ^2 = 64.445
	41-50 years	100	25.8	100	80	20	NR	
	51-60 years	88	22.7	88	44	42	2	
	61-70 years	48	12.4	48	32	10	NR	
	Above 70 years	96	24.7	96	88	8	NR	
Educational status	None	78	20.1	78	70	8	NR	p = 0.000
	Primary	120	30.9	120	88	24	2	df = 8
	Secondary	130	33.5	130	106	24	NR	χ^2 = 102.405
	Tertiary	28	7.2	28	10	18	NR	
	Adult Education	32	8.2	32	4	28	NR	
Ethnicity	Tiv	48	12.4	48	48	NR	NR	p = 0.000
	Nupe	96	24.7	96	40	56	NR	df = 16
	Yoruba	38	9.8	38	26	6	NR	χ^2 = 116.865
	Berom	54	13.9	54	48	4	2	
	Igala	46	11.9	46	28	18	NR	
	Ebira	32	8.2	32	20	12	NR	
	Gbayi	10	2.6	10	10	NR	NR	
	Mangu	16	4.1	16	10	6	NR	
	Idoma	48	12.4	48	48	NR	NR	

Note: UR: Number of respondents who claim the use of plants, the percentage in parenthesis, VEF-Very Effective, EF-Effective, NSEF-Not So Effective, NEF-Not Effective, NR: No Record of information from respondents

About 84% of the respondents in this study acknowledged that the source of their knowledge of insecticidal plants was passed to them from close family members. This suggests that the knowledge of plants used for personal protection against haematophagous insects were sustained from one generation to another verbally and can be distorted or lost in the process. Documentation of this knowledge in our study is needful to conserve it for future generations. Similar observations of respondents obtaining knowledge of insecticidal plants used from family elders were also reported in South Africa (Mavundza et al. 2011).

In this present study, seventeen plant species belonging to twelve families used in controlling hematophagous insects were listed and identified. Similarly, Mavundza et al. (2011) reported 13 plant species used for personal protection against mosquitoes in South Africa belonging to nine families. Kweka et al. (2008) reported five insect repellent plant species belonging to four families in Tanzania while Karunamoorthi et al. (2009a) reported nine mosquito repellent plants belonging to eight families in Ethiopia. Pålsson and Jaenson (1999) reported eight plant species that could keep mosquitoes away from human dwellings in Guinea Bissau while Edwin-Wosu et al. (2013) reported 24 plant species with insecticidal potential in South-Eastern Nigeria. This study was able to document plants used in North-Central Nigeria for the management of haematophagous insects which can be referred to in the future.

Lamiaceae was the most represented plant family used for the management of hematophagous insects. Similarly, Karunamoorthi et al. (2009a) reported that Lamiaceae has the most represented family in an ethnobotanical study carried out in Ethiopia. The Lamiaceae family is important in the management of mosquitoes and other hematophagous insects because of the insecticidal potential of its members. In this study, members of the Lamiaceae family; *Hyptis suaveolens* and *Ocimum gratissimum* were the most frequently used plant species for personal protection purposes against hematophagous insects as mentioned by respondents from all the ethnic groups in North-Central Nigeria. These plants are tropical aromatic herbs with the ability to repel hematophagous insects (Okigbo et al. 2010). Also, Okigbo et al. (2010) reported that *Hyptis suaveolens* commonly known as mosquito plant, because of its insecticidal potential against mosquitoes, is widely used for personal protection against hematophagous insects in several communities in Nigeria.

The use of traditional medicines is rampant in regions where western medicines are inaccessible due to their unavailability and high cost (Iyamah and Idu 2015). The main reason indigenous people depend on plants that have the insecticidal potential for managing hematophagous insects is that they are accessible and available (Innocent et

al. 2016). The majority (77%) of the respondents from the study area indicated that they could easily access the insecticidal plants shortlisted and they were available. It has been speculated that most people living in rural communities in Africa rely on traditional medicine and insecticidal plants due to their availability and affordability in comparison with modern medicine and synthetic insecticides (Karunamoorthi and Hailu 2014). The distance estimated the accessibility of insecticidal plants to locals of the study area they had to travel and to harvest the plants which were less than one kilometer and majorly around the community while the availability was estimated by the source of the plants.

In this study, respondents affirmed the use of the whole plant (42.3%) and leaves (35.6%) for the control of hematophagous insects. Similarly, Karunamoorthi et al. (2009a) reported that leaves were the most used plant's parts for personal protection against mosquitoes in Ethiopia. Kweka et al. (2008) and Mavundza et al. (2011) also reported the same trend in Tanzania and South Africa respectively. Karunamoorthi and Husen (2012) emphasized the use of leaves of insecticidal plants for the control of hematophagous insects against whole plant, roots, and barks because it is a more sustainable option since the natural plant growth would not be disrupted. Hence, the use of the whole plant in North-Central Nigeria is not a sustainable option and should be discouraged. Apart from sustainability, another reason why the use of the leaves of insecticidal plants is more important than other parts is due to the availability of their active components that are more volatile (Mavundza et al. 2011).

Indeed, plants that are usually used for personal protection because of their insecticidal properties are habitually those containing volatile oils. When the leaves are crushed, it releases a strong odor that is unpleasant to biting insects (Youmsi et al. 2017). Usage of plants in their fresh state by hanging inside inhabited houses and smoldering of dried plants were frequent ways in which respondents from this study applied plants for the management of hematophagous insects. This is comparable to other reports where plants were hanged or spread inside habited houses (Kweka et al. 2008) and where the plant's parts were smoldered to manage blood-sucking insects (Karunamoorthi et al. 2008; Karunamoorthi et al. 2009b).

Observations from the present study showed that there was no significant association between the knowledge of plants with insecticidal potential and the gender, educational status, or ethnicity of respondents suggesting that all well know these plants of the elders and traditional health care practitioners notwithstanding their gender, educational status, and ethnicity. This is consistent with an earlier study that established no significant relationship between the gender, educational status or age of respondents, and knowledge and usage custom concerning insect repellent plants (Kidane et al. 2013). In contrast, a significant relationship was observed between the respondents' perceived effectiveness of insecticidal plants used for personal protection and; gender, educational status, and ethnicity. This suggests that gender, educational status, and ethnicity had a part to play in the perception of how effective these insecticidal plants are in the control of blood-sucking insects.

In conclusion, this ethnobotanical survey documented plants perceived to have insecticidal potential in different ethnic groups in North-Central Nigeria. This kind of documentation is required for traditional insecticidal plant knowledge preservation and transfer as well as the discovery of the plants' bioactive components against hematophagous insects. These plants were used because of their availability, accessibility, and perceived efficacy, and should be encouraged. The widespread use of whole plants in this study area should be discouraged to limit over-exploitation and enhance conservation. There is a need to promote the cultivation and conservation of the plants documented in this study.

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Table S1. Distribution of shortlisted plants by ethnicity in North-Central Nigeria

Plants	Berom	Ebira	Gbayi	Idoma	Igala	Mangu	Nupe	Tiv	Yoruba	Total
Ageratum conyzoides	NR	NR	NR	11	NR	NR	NR	13	NR	24
Allium cepa	NR	NR	NR	NR	NR	NR	8	NR	NR	8
Annona senegalensis	8	NR	NR	NR	NR	4	NR	NR	NR	12
Capsicum annuum	NR	4	NR	NR	12	NR	NR	NR	NR	16
Cassia mimosoides	NR	NR	NR	NR	NR	NR	16	NR	NR	16
Citrus sinensis	6	NR	NR	8	NR	2	14	8	4	42
Cymbpogon citratus	16	NR	NR	NR	NR	NR	NR	8	NR	24
Ertyphleum suaveolens	8	NR	NR	NR	NR	NR	NR	NR	NR	8
Eucalyptus globulus	8	NR	NR	NR	NR	4	NR	NR	NR	12
Hibiscus rosa sinensis	6	NR	NR	NR	NR	NR	NR	3	NR	9
Hyptis suaveolens	3	24	4	8	4	4	2	9	18	76
Latanna camara	6	NR	NR	NR	NR	NR	NR	NR	NR	6
Moringa oleifera	4	NR	NR	NR	NR	NR	NR	NR	NR	4
Nicotiana tabacum	4	4	NR	8	NR	NR	NR	NR	6	22
Ocimum gratissimum	3	23	2	8	4	4	2	9	18	73
Parkia biglobosa	NR	NR	NR	NR	NR	NR	5	NR	7	12
Thymus vulgaries	NR	NR	NR	6	NR	NR	12	6	NR	24
Total	72	55	6	49	20	18	59	56	53	388

Note: NR: No Record of information from respondents

Table S2. Distribution of shortlisted plants by target respondents in North-Central Nigeria

Plants	Community head	Elder in community	Herb seller	Traditional healer	Total
Ageratum conyzoides	NR	15	3	6	24
Allium cepa	NR	8	NR	NR	8
Annona senegalensis	NR	3	3	6	12
Capsicum annuum	2	6	8	NR	16
Cassia mimosoides	4	12	NR	NR	16
Citrus sinensis	NR	23	5	14	42
Cymbpogon citratus	NR	12	11	1	24
Ertyphleum suaveolens	NR	2	NR	6	8
Eucalyptus globulus	4	4	4	NR	12
Hibiscus rosa sinensis	NR	5	4	NR	9
Hyptis suaveolens	5	37	21	13	76
Latanna camara	NR	NR	4	2	6
Moringa oleifera	NR	NR	4	NR	4
Nicotiana tabacum	NR	6	8	8	22
Ocimum gratissimum	NR	38	31	4	73
Parkia biglobosa	NR	NR	12	NR	12
Thymus vulgaries	4	12	4	4	24
Total	19	183	122	64	388

Note: NR: No Record of information from respondents

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Ethnomedicinal survey of plants used in the treatment of skin-related ailments in the Northern Delta State of Nigeria

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Abstract. *Enebeli-ekwutoziam KC, Aruah CB, Ogbonna BO, Eze UJ, Egedeye-fubura FS, Nwankwo CF, Oliseyenum IN, Udoha NW, Afuye TN, Asogwa GN, Chinweokwu KA, Anenih FO, Iyamu JE, Oboti ID, Nwaizu N, Ajabor JI, Ozadibe OY, Otunla RA, Francis OB, Orji CM. 2021. Ethnomedicinal survey of plants used to treat skin-related ailments in the Northern Delta State of Nigeria. Asian J Ethnobiol 4: 76-85.* An ethnomedicinal survey of plants used to treat skin-related ailments was conducted to document information on the common plant resources employed in the ethnomedicinal practices of the indigenous people of the Northern Delta State of Nigeria. A total number of 100 respondents were selected from the Northern Delta State of Nigeria. The herbalists were mostly males (61%). The respondents comprised two age groups, i.e. <40 (30%), and >40 (70%). The respondents were 30 herbal drug dealers, 46 herbalists, and 24 community elders. Semi-structured questionnaires were used to obtain data through personal interviews with the respondents. 51 plant species belonging to 29 families of flowering plants were revealed as useful in the treatment and management of Skin diseases/parasites, boils, wounds, cuts, sores, pimples, inflammation, aftershave bumps, abscess, and bleeding. Asteraceae (8.75) and Fabaceae (8.2) showed the best consensus among respondents on reported species and families. The highest values of relative citation frequencies were reported for *Citrus limon* and *Ricinus communis* with 0.24 each. On the other hand, the highest value of fidelity level was reported for *Elaeis guineensis* (99). Herbs were the most dominant life form found in the study (45%). Females (52%) have higher knowledge of medicinal plants and their application than males (48%). Leaf was the most commonly used plant part (44%) in preparing herbal remedies. A decoction was the most common method of herbal drug preparation (33.96%). Herbal recipes used by the locals to treat skin-related ailments contain some active ingredients, some of which have been scientifically proven and others still undergoing clinical validation. This justifies their ethnomedicinal uses as a remedy for skin ailments. High levels of medicinal plant diversity and ethnomedicinal knowledge exist in the area. Therefore conservation studies should be carried out on the plants reported in this survey for sustainability.

Keywords: Ethnobotany, ethnomedicine, herbal drugs, Northern Delta State, Nigeria

Abbreviations: AB: Abscess and Boils, BDU: Bioresources Development Centre Herbarium, FL: Fidelity Level, FV: Familial Use Value, PIAB: Pimples, Inflammations, and Aftershave Bumps, RC: Consensus between respondents, RFC: Relative Frequency of Citation, RU: Reported Use Value, SDP: Skin Disease and Parasite, UV: Use Value, WCS: Wounds, Cuts, and Sores

INTRODUCTION

Tropical regions have over 400,000 species of flowering plants which possess medicinal properties (Akpulu et al. 1994). The diversity of these plants, and their affordability and easier accessibility, led to the increased practice of ethnomedicine compared to orthodox medicine (WHO 2002; Ariwaodo et al. 2012). This has led to investigations for their possible use as a drug for adequate provision and affordable health care to humankind. Medicinal plants are widely known for historical and cultural reasons (Alade and Ajibesin, 2017). Studies have been conducted on medicinal plants for their potentials in alleviating health problems. Several intensive studies are currently being undertaken on plant-origin drugs because plants are sources of newer alternatives with lesser side effects (Alade et al., 2018).

As d WHO (1978) defines traditional medicine as the knowledge and practical application of plants inexplicably to prevent and cure physical, mental, or social diseases. It exclusively depends on practices, experience, and observations handed down from generation to generation, either verbally or written.

People across the continents, including Africa and most notably West Africa, since ancient times, have relied on plants as sources of remedies for the treatment of many

diseases (Abd El-Ghani 2016). Hostellmann and Marston (2002) reported conventional drugs are expensive in developing countries, especially in West Africa, and more than 80% of the populace rely on ethnomedicinal plants as remedies. Medicinal plants have been employed in therapeutic practices for hundreds of years before the evolution of modern scientific medicine and scarcely have adequately documented evidence of adverse effects (Iyamah and Idu 2015, Okigbo and Mmeka 2006).

Orthodox medicine is not widespread in developing countries, and the provision of healthcare has been made possible by these indigenous alternatives (Okujagu 2005, pers. Com. (personal communication). Herbal drugs have become popular because they have fewer side effects, are higher tolerant, cheap, and are widely accepted. Herbal drugs have successfully treated many diseases that defy treatments using orthodox medicines. Studies have been conducted on several plants' ability to treat various ailments (Malik et al. 2019).

Since historical times, plant resources of Nigeria have been alternative sources of drugs though there have been challenges of poor documentation (Gbile and Adesina 1986). Significant challenges experienced with sustainable management of these plant resources include over-exploitation of plant species growing in the wild, anthropogenic activities, and poor conservation programs (Wambebe 1998).

The skin is the largest sense organ and is crucial in ensuring health and well-being (Mowobi et al., 2016). It is the first defense layer of the human body and is structured in three layers- epidermis, dermis, and hypodermis, with each layer interfacing with the environment and performing a specialized function towards its well-being (Tabassum and Hamdani 2014; Malik et al. 2019). General functions of the skin are a defense against pathogenic organisms, prevention of excess loss of water, thermoregulation, irritability, storage of fats and lipids, vitamin D synthesis from ultraviolet rays, preservation of folic acids, insulation, protection of delicate internal organs, excretion, absorption of oxygen and drug. Plants which possess dermatological properties and serve as antidotes to various skin troubles such as wounds, cuts, sores, abscesses, bleeding, acne, and inflammation are essential to humans (Malik et al. 2019). Diseases associated with the skin are a common universal occurrence but most notably in tropical regions of the world. All age groups experience their harmful effects and gender, whether newly born or elderly (Grice et al. 2009; Pappas 2009). Despite their universal occurrence, skin diseases are a significant concern in rural areas of developing countries in tropical regions of the world (Mowobi et al., 2016). Skin diseases are classified as non-contagious and contagious diseases, and their causal organisms are bacteria, fungi, viruses, and parasites (Malik et al., 2019). This study aims at documenting information on the typical plant resources used to treat skin diseases by the indigenous people of Northern Delta State of Nigeria as they have not been previously reported.

MATERIALS AND METHODS

Study area

North Delta is one of the districts in the Northern Delta State of Nigeria. It comprises nine councils, i.e., Aniocha North, Aniocha South, Ika North East, Ika South, Ndokwa East, Ndokwa West, Oshimilli South, Oshimilli North, and Ukwuani (Figure 1). The area is popularly called Anioma, meaning "good land." It is located west of Niger-Delta of southern Nigeria, the third-largest wetland globally (Umoh 2008), with Africa's largest river delta and mangrove ecosystem (Ajonina et al. 2008). It lies at 6º11′40″N and 6º25′41″E with an elevation of 154 meters above sea level (Anioma Delta State Nigeria 2012). The climatic type is humid sub-equatorial with tropical lowland rainforest, freshwater swamp, estuarine and marine mangrove swamps, and aquatic ecosystems (Izah 2018). The mean annual rainfall ranges from 3000 mm to 4000 mm, and the average monthly temperature of 27ºC. A wet season extends from July to September and a dry season from December to February (Olalekan and Gordon 2011). The spoken languages are various dialects of the Ibo language.

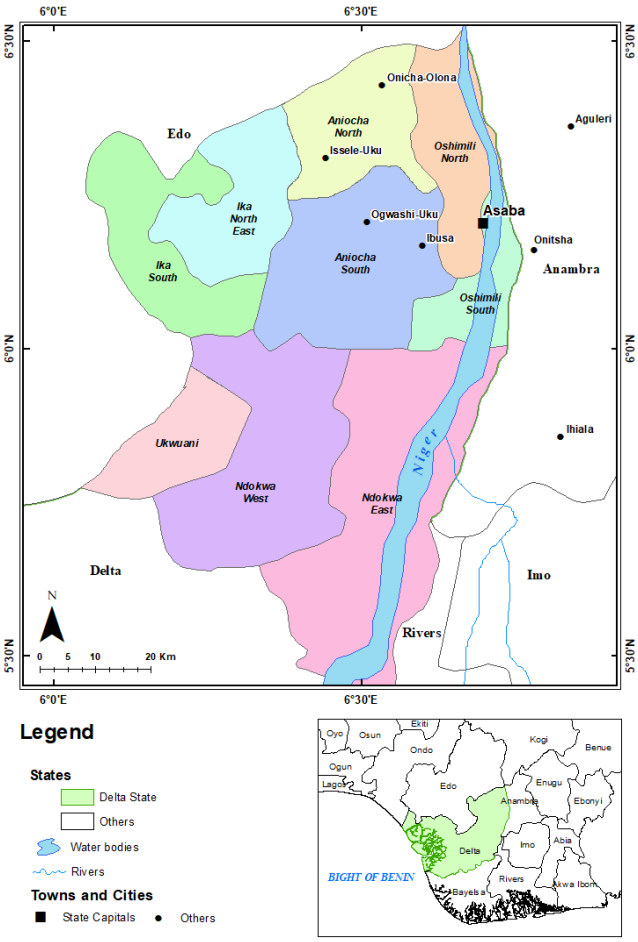

Figure 1. Map of North Delta District, Delta State, Nigeria

Table 1. Demographic data of informants on ethnomedicinal plant species

Respondents	Herbal drug dealers	Herbalist	Community elders	Total interviewed persons
Male (<40)	5	11	-	16
Male (>40)	6	17	9	32
Female (<40)	8	6	-	14
Female (>40)	11	12	15	38
Total interviews	30	46	24	100
Percentage (%) males	36	61	38	48
Percentage (%) females	63	39	63	52

Field survey

Visits were made to the study area between September and December 2019. An ethnomedicinal survey was carried out with the aim of documentation plants used in the treatment of skin-related ailments. Free prior informed consent of the informants was obtained before the study commenced. Informants were 46 renowned herbalists, 30 herbal drug dealers, and 24 elders. Interviews were conducted with the informants using a semi-structured questionnaire and a local-language interpreter. Information such as local names, therapeutic use, plant part used, mode of preparation was collected (Huntington 2000). Medicinal plants reported in the survey were collected, identified using Trees of Nigeria (Keay 1989), Flora of Nigeria, and West Africa (Hutchinson and Dalziel 1954, 1958, 1968). The identified plants were pressed and deposited at the Bioresources Development Centre Herbarium (BDU), Ubulu-Uku, Delta State.

Data analysis

Data obtained from the study were analyzed using Statistical Package for Social Science (SPSS) Version 23 and Microsoft Office Excel 2016. Ethnomedicinal data were analyzed using the Relative Citation Frequency (RFC), Fidelity Level (FL), Familia Use Value (FV), and Use Value (UV). Socio-demographic data of the respondents were analyzed using a simple descriptive statistical method and reported in a summary of frequency and percentages.

Relative frequency of citation (RFC)

Calculations were made for the local importance of each plant species based on the relative frequency of citation (Tardio et al. 2006). The RFC was calculated as follows: the number of those mentioned using the species (Fc) divided by the total number of respondents (N).

$$RFC = Fc/N$$

Fidelity level (FL)

Fidelity level was calculated following Alexiades and Sheldon (1996) for the most frequently reported diseases as:

$$FL\ (\%) = N_p / N$$

Where:

N_p: number of informants that claim a plant used to treat a particular disease.

N: number of informants that use the plant as medicine in treating any disease.

Familial use-value (FV)

The importance of a family is measured by its familial use-value (Letsela et al., 2003). This was determined by summation the number of species mentioned under each family across all the uses categories.

Use value per plant part (UV)

Use value per plant part was calculated following Hoffman and Gallaher (2007):

$$\text{Use value (UV)} = \sum RU_{(\text{plant part})//ns}$$

Where:

RU: total number of use categories for each plant part

NS: total number of informants interviewed

Consensus between authors on cited species and families

Consensus between authors on cited species was calculated following Molares and Ladio (2009):

Number of species ×100/Number of respondents

A lower value gives a better consensus than a higher value.

RESULTS AND DISCUSSION

Socio-demographic information of respondents

A total number of 100 respondents were selected from the Northern Delta State of Nigeria. The respondents comprised two age groups, i.e. <40 (30%), and >40 (70%). The respondents were 30 herbal drug dealers, 46 herbalists, and 24 community elders. The herbalists were mostly males (61%) than females (39%). In contrast, the herbal drug dealers and community elders comprised mostly females (63% each, respectively), while males comprised 36% herbal dealers and 38% community elders (Table 1).

Skin treatment plants

The survey revealed the indigenous knowledge of plants used to treat skin-related ailments and various skin diseases in the Northern Delta State of Nigeria. 51 plant species distributed among 29 families were reported as plants used to manage skin-related ailments (Table 2). Herbs (45%) were the main growth habit, followed by shrubs and trees (27.5% each), respectively (Figure 2).

Categorization of skin diseases

Relative frequency of citation (RFC)

The highest RFC values for species were reported for *C. limon* and *R. communis* (0.24 each), *A. precatorius*, *C. Papaya*, and *C. aurantifolia* (0.22 each), *A. melegueta*, *A. cordifolia*, and *M. indica* (0.21 each), and *A. montanus*, and *E. guineensis* (0.20 each) respectively (Table 2).

Fidelity Level (FL)

The highest FL values were reported for *E. guineensis* (99), *E. hirta* (97), *C. limon, C. nucifera,* and *T. superba* (96 each), *D. arborea* (95), *T. fructicosum* (93), and *B. nitida* (92) respectively (Table 2).

Frequency of family occurrence

A total of 29 families were reported in this study. Fabaceae and Asteraceae had the highest number of species (8 each), Euphorbiaceae (5) and Araceae (4) (see Figure 3).

Familia use value

Fabaceae and Asteraceae were the essential families having the highest domestic use value of 7 and a consensus between respondents of 8.2 and 8.75 (Figure 3).

Frequency of plant preparation

In the study area, decoction (33.96%) was the most common method of plant preparation used in herbal remedies, followed by infusion (16.03%), poultice (15%), juice extracts (13.2%), mastication, and macerations (4.71% each), baths and remedies (3.7%), aromatherapy (3.7%), tinctures (1.8%), powdered, compresses and syrups each having 0.94% (Figure 4).

Reported use value per plant part

Leaf (44%) was the most commonly used plant part in the preparation of herbal remedies for skin-related ailments; this was followed by stem/stem-bark and root (16.29% each), seed (7.4%), fruit (5.92%), and whole plant (3.7%). Others were scarcely used (Table 3).

Discussion

The study was carried out to document the ethnomedicinal plant species used to cure skin diseases among the indigenous people of the Northern Delta State of Nigeria. It was observed that the rural parts of the study area were mainly dependent on medicinal plants for the treatment of skin diseases and other diseases. This agrees with earlier reports of Malik et al. (2019) on the dependence of 84% of the rural population on herbal medicines. In the present study, 51 medicinal plant species distributed across 29 families were reported to treat skin-related ailments by herbal drug dealers, herbalists, and community elders. Asteraceae (8.75) and Fabaceae (8.2) showed the best consensus between respondents on reported species and families (Figure 2.). Other value families were Euphorbiaceae (10) and Araceae (16). Asteraceae and Fabaceae have been earlier reported as the most commonly used family in ethnomedicinal practices in southern Nigeria (Alade et al. 2018; Iyama and Idu 2015).

Data from 100 randomly selected male and female respondents in the study area consisted of 30 herbal drug dealers, 46 herbalists, and 24 community elders. Herbalists (46%) were the most consulted on the herbal drugs for skin diseases and ailments. However, the results showed females (52%) have higher knowledge of medicinal plants and their application than males (48%). This agrees with earlier reports by Iyamah and Idu (2015). The respondents above 40 years (70%) were more than those below 40 years (30%). This indicates that the older generations are more knowledgeable on ethnomedicinal plants species. Oladunmoye and Kehinde (2011) have reported similar findings on elders having a higher knowledge of the use of plants as medicines.

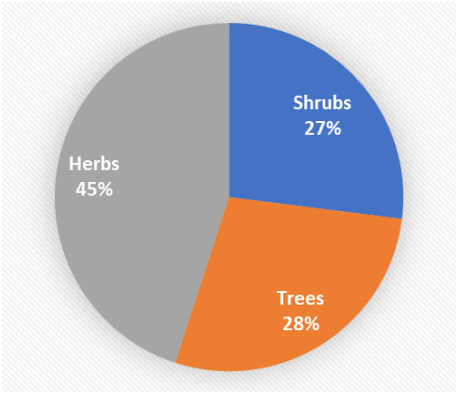

Figure 2. Growth habit of reported ethnomedicinal species

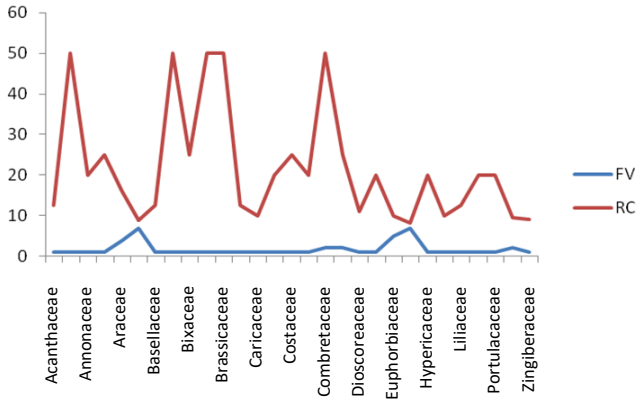

Figure 3. Familial use-value and consensus among respondents on reported species and family

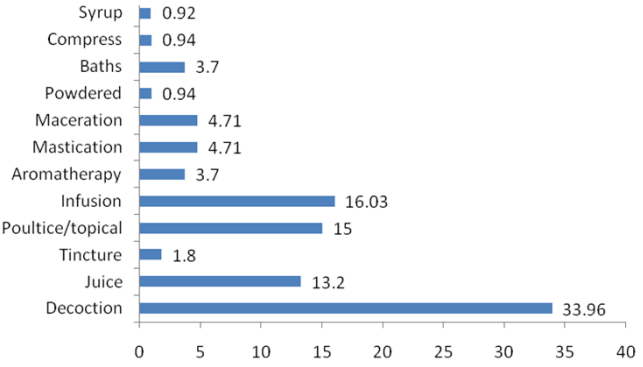

Figure 4. Method of preparation of plants used in the treatment of Skin related ailments

Table 2. Ethnomedicinal plants used in the treatment of Skin related ailments in Northern Delta State, Nigeria

Plant name	Voucher numbers	Family	Local name	Common name	Habit	Therapeutic usage	Parts used	Method of preparation	Relative frequency of citation (RFC). RFC = FC/*N* (*N* = 100)	Fidelity level (FL)
Abrus precatorius L.	BDU 106	Fabaceae	Anyannun	Crab's eye, Bead tree	Herb	Skin disease	Leaves	Decoction	0.22	73
Acalypha fimbriata (Schum &Thonn) Forsk	BDU 91	Euphorbiaceae	Agukwu	Copper leaves	Herb	Skin disease, boils	Leaves, twig	Juice, decoction	0.08	68
Acanthus montanus (Nees)T.Anders	BDU 10	Acanthaceae	Inyinyi ogwu	False thistle	Herb	Boils, wounds	Leaves, roots	Decoction, tincture, poultice	0.20	70
Adenostemma mauritianum DC.	BDU 03	Asteraceae	Oshosho	-	Herb	Measles	Leaves	Infusion	0.03	60
Afromomum melegueta Roscoe K. Schum	BDU 31	Zingiberaceae	Ose-oji	Alligator pepper, grains of paradise, guinea grains	Herb	Smallpox, chickenpox, measles	Leaves, seeds, stem-bark	Decoction, aromatherapy, mastication, macerations in *Momordica charantia* and *Sorghum arundinaceum*	0.21	78
Ageratum conyzoides L.	BDU 184	Asteraceae	Ula njula, urata njele	Goat weed	Herb	Wounds, skin diseases	Leaves	Infusion, juice extract	0.16	84
Alchornea cordifolia (Schum &Thonn.) Mull.-Arg.	BDU 53	Euphorbiaceae	Ubebe	Christmas bush	Shrub	Wounds, ringworm	Leaves, stem-bark, root epidermis	Decoction, juice, mastication, maceration,	0.21	76
Aloe vera (L.) Burm. f	BDU 16	Liliaceae		Barbados Aloe	Shrub	Wounds, skin infections	Leaves	Decoction	0.05	71
Anthonotha macrophylla P. Beauv	BDU 79	Fabaceae	Ububa-ikpa	-	Tree	Skin infections	Leaves, stem-bark, roots, gum exudates	Decoction, infusions, poultices	0.04	75
Artemisia dracunculus L.	BDU 25	Asteraceae	Nshegbuawom	Tarragon	Herb	Skin disease, cuts	Leaves	Decoction, infusion	0.13	50
Aspilia Africana (Pers.) C.D Adams	BDU 66	Asteraceae	Oranjila	Hemorrhage plant	Herb	Wound clotting	Leaves	Juice extract	0.11	90
Baphia nitida Lodd.	BDU 95	Fabaceae	Ufie	African sandalwood, camwood	Tree	Boil	Leaves, twig, stem-bark, roots	Mastication, poultice	0.09	92
Baphia pubescens Hook.F	BDU 45	Fabaceae	Obenetete	Benin - camwood	Shrub	Wounds, ringworm,	Leaves, stem-bark, roots	Decoction, infusion	0.02	50
Basella alba L.	BDU 33	Basellaceae	Ukasi Kongo	Ceylon spinach	Herb	Boils	Whole plant	Infusion	0.05	71
Bixa orellana L.	BDU 12	Bixaceae	Ufie, Uhie	Annatto	Shrub	Scrapes, burns	Leaves, fruits, seeds	Decoction	0.04	75

Brassica oleracea L.	BDU34	Brassicaceae	Ogbeagu	Wild cabbage	Herb	Wound	Leaves	Juice, Poultices	0.03	75
Caladium bicolor (Aiton) Vent.	BDU 20	Araceae	Honya	Heart of Jesus	Herb	Skin diseases, wound	Corm	Poultice	0.03	50
Carica papaya L.	BDU 146	Caricaceae	Okpurukwa	Papaya, papaw	Tree	Eczema, after-shave bumps	Leaves, fruit (ripe and unripe), seeds	Decoction, infusion, macerations in *Ocimum gratissimum*, *Garcinia kola* seed	0.22	76
Carpolobia lutea G. Don	BDU 28	Polygonaceae	Agba, Angalagala	Cattle stick	Shrub	Wounds	Leaves, root bark, roots	Decoction	0.01	50
Citrullus colocynthis (L.) Schrad	BDU 31	Cucurbitaceae	Eliliegusi/ogili, Egusi	Bitter apple	Herb	Skin disease	Leaves, fruits, seed	Decoction, powder mixed with palm oil	0.16	84
Citrus aurantifolia (Christm) Swing.	BDU 11	Rutaceae	Oroma nkirisi	Lime	Tree	Ringworm, eczema,	Fruit juice	Aromatherapy, baths, decoction, infusion,	0.22	78
Citrus limon (L.) Burm. f.	BDU 60	Rutaceae	Lemonu	Lemon	Tree	Spots, scabs, wounds scars, insect bites	Fruit juice	Decoction, tincture, infusion	0.24	96
Cocos nucifera	BDU 76	Araceae	Aku oyinbo	Coconut	Tree	Skin diseases	Stem-bark, roots, fruits	Decoction	0.13	90
Colocasia esculenta (L.) Schott	BDU 131	Araceae	Ede	Cocoyam, taro	Herb	Insects bites, sore	Whole plant	Decoction, juice extract	0.02	50
Combretum racemosum P.Beauv.	BDU 87	Combretaceae	Alagame	Christmas rose	Shrub	Skin disease	Leaves	Juice extract	0.03	50
Costus lucanusianus Braun &Schum	BDU 19	Costaceae	Opete, Okpete	Bush cane	Herb	Measles,	Stem-bark	Baths, compresses, decoction	0.16	80
Cucurbita maxima Duch.	BDU 198	Cucurbitaceae	Ugboghoro	Pumpkin	Herb	Skin disease	Leaves	Juice extract	0.10	60
Dacryoides edulis (D.Don) Lam.	BDU129	Burseraceae	Ube	Native pear	Tree	Skin parasites/disease	Leaves, stem resins, fruit	Decoction	0.18	95
Dioscorea rotundata Poir	BDU 98	Dioscoreaceae	Ji	White yam, West African yam	Herb	Burns, skin disease	Leaves	Infusion	0.01	75
Distemonanthus benthamianus Baill.	BDU 62	Fabaceae	Oguafo	African satinwood	Tree	Skin disease, boils,	Stem-bark	Decoction with *Pterocarpus Erinaceus*, mastication poultice	0.03	66
Dracaena arborea (Wild.)	BDU 30	Dracaenaceae	Odo	African dragon tree	Tree	Boils	Leaves, Stem-bark	Infusion, poultice	0.09	95
Elaeis guineensis Jacq.	BDU 01	Araceae	Nkwu, Akwu	Oil palm	Tree	Skin troubles	Oil, unripe kernel, leaves	Aromatherapy, decoction, mastication, syrups	0.20	99
Emilia coccinea (Sims) G. Don.	BDU 247	Asteraceae	Ntiene	Tassel flower	Herb	Measles, skin diseases, sores	Leaves	Juice extract	0.06	88
Euphorbia hirta Linn.	BDU 189	Euphorbiaceae	Ogwu asma, Ahihia ugwa	Garden spurge, spurge weed	Herb	Eczema	Leaves	Decoction, topical application, aromatherapy	0.10	97
Harungana madagascariensis Lam *ex* Poir	BDU 116	Hypericaceae	Otori	Dragon's blood tree	Tree	Skin diseases- itches and leprous spots	Plant sap, leaves, stem-bark	Decoction, topical application	0.12	80

Heliotropium Indicum L	BDU110	Boraginaceae	Azu	Heliotrope, cock's comb	Herb	Sting, insect bites, boils	Leaves, whole plant	Decoction, Infusion	0.01	50
Irvingia gabonensis (Aubry-LeComte ex O′Rorke) Bail.	BDU 189	Irvingaceae	Agbono	West African bush mango	Tree	Skin disease	Leaves, stem-bark, seeds	Decoction, infusion, Poultice	0.09	86
Kalanchoe pinnata (Lam.) Pers. (syn. *Bryophyllum pinnatum*)	BDU 169	Crassulaceae	Oda opue	Resurrection plant	Herb	Boils	Leaves, roots	Decoction, juice extract	0.11	80
Mangifera indica Linn.	BDU 170	Anacardiaceae	Mangoro	Mango	Tree	Skin disease	Leaves, stem, bark, and fruit	Baths, decoction, maceration	0.21	60
Manihot esculenta Crantz	BDU 172	Euphorbiaceae	Akpu, Ugboro, Jiaphu	Cassava	Shrub	Wound healing	Leaves, premature roots	Leaf juice extract, root decoction	0.08	75
Newbouldia laevis (Beauv.) Seeman ex Bureau	BDU 399	Bignoniaceae	Oke-ogirishi	Smooth Newbouldia, Tree of life, Fertility tree	Shrub	Septic wounds, bleeding, skin disease	Leaves, stembark, roots	Decoction, infusion, topical application of leaf juice, poultices	0.16	71
Palisota hirsuta (Thumb.)K. Schum.	BDU 350	Commelinaceae	Ikpere aturu	Palisota	Herb	Boils	Leaves, stem	Decoction, infusion, poultices	0.06	77
Ricinus communis L.	BDU 386	Euphorbiaceae	Ogiri	Castor bean	Shrub	Skin disease	Leaves, seeds	Decoction, juice, syrup, topical application	0.24	80
Rauvolfia vomitoria Afzel	BDU 262	Apocynaceae	Akanta	Serpent wood, Swizzle stick	Shrub	Skin disease, smallpox,	Leaves, roots	Decoction, infusion	0.16	80
Senna alata (L.) Roxb.	BDU 377	Fabaceae	Ogala	Candle bush, ringworm bush	Shrub	Eczema, ringworm, abscess, skin disease, bleeding	Leaves, roots	Infusion, juice extract poultices	0.11	50
Senna occidentalis (L.) Link.	BDU 101	Fabaceae	Akidi agbara	Negro coffee, coffee senna	Shrub	Abscess, skin diseases, inflammation, bleeding	Leaves, roots	Infusion, poultices	0.05	88
Talinum fruticosum (L.) Juss.	BDU 79	Talinaceae	Mgbolodi	Waterleaf, Ceylon spinach	Herb	Boils, measles	Leaves	Juice extract, decoction	0.12	93
Terminalia superba Engl.& Diels	BDU 308	Combretaceae	Edo ocha	Shingle wood, Yellow pine	Tree	Skin diseases	Leaves, stem, roots	Decoction, baths, and remedies	0.13	96
Tridax procumbens L.	BDU 347	Asteraceae	Mbuli	Tridax	Herb	Skin diseases	Leaves	Decoction, infusion	0.11	82
Uvaria chamae P. Beauv	BDU 316	Annonaceae	Mmimi-ohia	Cluster pear	Shrub	Boils, wound	Leaves, stem-bark, roots	Decoction	0.04	85
Vernonia amygdalina L.	BDU 265	Asteraceae	Onugbu	Bitter leaf	Shrub	Measles, smallpox, chickenpox	Leaves, leaf sap, root epidermis	Leaf juice is used as decoction, tincture, maceration, and as poultices made with crude chalk	0.22	80

Table 3. Use value (per plant part) of reported plants used in the treatment of skin-related ailments

Organs	Skin diseases/ parasites	Boils	Wounds, cuts & sores	Scrapes & burns	Pimples, inflammation, aftershave bumps	Abscess & bleeding	Total usage (SDP+WCS+SB+ PIAB+AB)	Reported use-value (∑RU/ns)	Categorized reported use-value infraction
Leaf	28	8	16	2	3	3	60 (44%)	6	1.00
Twig	1	1	-	-	-	-	2 (1.48%)	2	0.33
Root	10	2	7	-	1	2	22 (16.29%)	5	0.83
Seed	6	1	-	1	2	-	10 (7.4%)	4	0.66
Fruit	6	-	-	1	1	-	8 (5.92%)	3	0.5
Stem/Stem-bark	12	4	4	-	1	1	22 (16.29%)	5	0.83
Gum exudates	1	-	-	-	-	-	1 (0.74%)	1	0.16
Whole plant	1	1	3	-	-	-	5 (3.7%)	3	0.5
Corm	1	-	1	-	-	-	2 (1.48%)	2	0.33
Stem resins	1	-	-	-	-	-	1 (0.74%)	1	0.16
Oil	-	1	-	-	-	-	1 (0.74%)	1	0.16
Sap	1	-	-	-	-	-	1 (0.74 %)	1	0.16

Herbs were the most dominant life form used in the study (45%), while shrubs and trees were 27.5% each, respectively (Figure 2). Medicinal plants were readily sourced from the wild, forest, roads, side bushes, and farmlands. This agrees with earlier reports of Malik et al. (2019). It has been reported that the efficacy of herbal medicine and the wide varieties of medicinal preparations employed by herbal doctors and herbal users is dependent on the flora diversity of a given geographical area (Adjanohoun et al., 1991). Rural dwellers have shown a high dependence on natural vegetation for timber, food, fuel-wood, medicine, etc., mainly harvested from the wild without replacement practices (Adjanohoun et al. 1991; Malik et al. 2019).

Earlier researches have reported some of the listed plants in this study for other ethnomedicinal uses such as *Abrus precatorius* L. (Iyama and Idu 2015), *Acanthus montanus* (Nees) T.Anders (Akwaji et al. 2017; Alade et al. 2018), *Afromomum melegueta* Roscoe K. Schum (Iyama and Idu 2015; Alade et al. 2018), *Ageratum conyzoides* L. (Iyama and Idu 2015), *Alchornea cordifolia* (Ariwaodo et al. 2012; Akwaji et al. 2017), *Baphia nitida* Lodd. (Ajibesin et al. 2008, 2012; Ariwaodo et al. 2012; Alade et al. 2018), *Carica papaya* L. (Alade and Ajibesin 2017).

The study revealed plant parts like a leaf, twig, root/root epidermis, seed, fruit, stem/stem-bark, gum exudates, whole plant, and corm were used in herbal preparations in the study area (Table 3). However, the everyday use of leaf in the practice of herbal remedies has been reported by earlier studies of Asase et al. (2010), Nguta et al. (2010), Ighere et al. (2011), Olorunnisola et al. (2013), Traore et al. (2013), Iyama and Idu (2015), Alade et al. (2016), Treasure et al. (2020). The use of leaves may arise from accessible collection and ensuring the continued existence of plant species used in herbal medicine.

New plant parts were preferred in herbal preparations for treating skin diseases and ailments. The reasons given by the respondents were the higher efficacies in treating skin diseases and ailments in contrast with dried plant parts. Iyama and Idu (2015) opined herbal remedies would have a reduced potency or completely lose their potency in dried plant materials if active compounds in the plants are volatile.

Herbal drugs were usually prepared crudely without quality control and standard dosage and were drunk or topically applied three times daily until the patient was healed. Mowobi et al. (2016) reported herbal recipes were made from different parts of two or more plants species, including leaves, seeds, and stem-bark. A single plant may be used to treat one disease, and a single disease could be treated by combining more than one plant (Assefor et al., 2021). The decoction was the most common method of herbal drug preparation (Figure 4), and this agrees with earlier reports of Ogunmefun and Gbile (2012) and Treasure et al. (2020). It was made by boiling woody, rugged, and fibrous plant parts that have active water-soluble components in water for long periods of steeping overnight before use. Other commonly used methods of herbal drug preparation in the study area include infusion and poultice/topical application. Infusion is made by pouring boiling water over an herbal combination in a cup used for delicate herbs, leaves, and fresh, tender plants. The poultice was made from plant materials crushed or made into a paste mixed with crude chalk and applied directly on the affected part, usually rashes, sting, wounds, and fungal infections, or by pouring hot water over dried or fresh herbs to revive it. The wet plant was directly placed on the affected area of the skin or on a light napkin that was bound to the skin. Other less commonly used methods of herbal drug preparation in the study area include compress, tincture, herbal baths, aromatherapy, maceration, and juice extract. On the other hand, compresses were made by soaking a highly absorbent napkin in an already prepared decoction, infusion, or tincture, then placed on the infected area. The medicine was made by soaking plant materials whose active components could only be extracted using alcohol. The respondents reported tinctures having a higher shelf life, which varied with the concentration of the alcohol used in the herbal preparation. Herbal baths were usually prepared by placing herbs in water and bringing them to a boil. The herbs were strained, and the water was used for bathing the skin. Aromatherapy was prepared like

baths; the mixture was poured into a bucket rather than straining off the herbs. The patient is made to sit on a stool with a thick bucket thrown over the patient, allowing the skin to absorb the steam from the herbal preparation. Macerations of fresh or tender plant parts were prepared by soaking overnight, then straining the herb out and drinking the liquids. Interviewed respondents stated the medicinal components of these macerated tender plants might be degraded due to heating or alcoholic extraction. Juice extract was obtained by crushing the plant material, usually leaf, among the fingers and then squeezing it to get fresh juice directly applied to the patient's skin.

Medicinal plant species showing high potency are usually selected for further research and drug discovery using relative citation frequency. This is vital for assessing their phytochemical composition and proving their active components for subsequent application in the discovery of drugs (Malik et al., 2019). In this study, plant species with RFC values of 0.24-0.20 were accorded a high level of relative citation.

Plant species with high fidelity level values indicate the choice of respondents for their use in treating a specific disease. Plant species with 92% and above FL values were treated as highly significant ethnomedicinal plant species. The study reported the highest FL values for E. guineensis (99).

The use-value index quantifies the relative importance of plant parts used in herbal drug preparation. For this reason, use-value indices per plant amount above 40% were considered significant in this study. For reported use value per plant part in the treatment of skin diseases, leaf showed the highest total usage (60%), said use-value (6), and categorized use-value infraction (1.00). Respondents in the study revealed that the leaf was either crushed manually by hands to obtain leaf juice, which was applied directly to the infected area, pounded using a wooden mortar, and the crushed material applied directly on the skin as a poultice the chewed/masticated. These findings likely suggest the active components responsible for ameliorating skin diseases and ailments reside in the leaves of the studied plant.

In conclusion, this research is novel for the Northern Delta State of Nigeria. This study reveals a high level of biodiversity of medicinal plants and ethnomedicinal knowledge of the plants in the area. Most respondents indicated the source of their ability on ethnomedicinal plants as from the past generation usually handed through informal methods of communication. Nonetheless, the elders had a higher knowledge of herbal drug use, suggesting a lack of interest in ethnomedicine by the younger generation, potentially threatening the extinction of ethnomedicinal expertise in the future. Based on interviews conducted, 51 plant species belonging to 29 families have been potent in treating various skin-related ailments. Herbs were reported as the most dominant life forms, leaves were the most used plant part, and decoction was the most used method of herbal drug preparation. Many herbal recipes used by the locals to treat skin-related ailments contain some active ingredients, some of which have been scientifically proven and others still undergoing clinical validation. This justifies their ethnomedicinal uses as a remedy for skin ailments and diseases. Conservation studies on the plants reported in this survey for sustainability should be carried out.

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Utilization of mangrove plants as a source of Malaria medicine in North Maluku Province, Indonesia

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Abstract. *Tamalene MN, Sen UK, Bhakat RK, Vianti E, Bahtiar, Suparman. 2021. Utilization of mangrove plant species as medicine against malaria in North Maluku Province, Indonesia. Asian J Ethnobiol 4: 86-92.* Local communities have still used plants as a source of medicine since immemorial time. Most local communities mix the plants to treat various diseases, including malaria. Almost half of 250 million of Indonesia's population lives in malaria-endemic areas, and about 15 million people look for clinical malaria treatment every year. This research aims to survey mangrove plants as a source of Malaria medicine utilized by six ethnic groups of North Maluku Province, Indonesia. Data were collected from 98 informants on the local names of the used species, the parts, and the "modes of preparation." The Fidelity Level serves to find out various outcomes. Six mangrove plant species, *Lumnitzera littorea*, *Rhizophora mucronata*, *Scyphiphora hydrophyllacea*, *Sonneratia alba*, *Xylocarpus granatum*, and *Xylocarpus moluccensis*, are used as malaria medicine. The traditional treatment that used mangrove rinds, barks, fruits, and flowers was a popular method practiced in the community social life. The mangrove plants have cultural, ecological, and economic values; Authors suggest that further investigations be undertaken on the pharmacological properties and level of toxicity of potion made using mangrove plant species. This will lead to stating scientific information related to the safety of consuming traditional medicines.

Keywords: Indonesia, local knowledge, malaria, mangrove, medicinal plants

INTRODUCTION

The use of plants as medicinal raw materials has been conducted since formulating process is known to local communities. Traditional medication is a way used by local communities to treat diseases. Raw materials, including plant parts containing active components, serve as medicine. Most local communities mix more than one plant to treat various diseases, including malaria (Husain et al. 2019; Kasmawati et al. 2019; Sen and Bhakat 2020).

The Asia continent contributes almost 40% of malaria disease globally (Gething et al., 2012). The disease is generally found in Southeast Asia areas, including Brunei Darussalam, Cambodia, China, Indonesia, Laos, Malaysia Peninsula, Myanmar, Philippines, Singapore, Thailand, Timor, and Vietnam. Most areas are at risk of vector-borne diseases, especially malaria, transmitted by mosquitoes from the *Anopheles* genus (Suwonkerd et al., 2013). Almost half of the population of 250 million in Indonesia live in malaria-endemic areas, and about 15 million people look for clinical malaria treatment every year (Elyazar et al. 2012; Herdiana et al. 2016).

Malaria is one of the life-threatening diseases in developing countries with high mortality risk (del Prado et al., 2014). In Southeast Asia, Indonesia is reported as the third-highest rank for malaria cases, 229819 cases with the number of deaths of 432 people (Dale et al. 2005; WHO 2012). Based on the data from the Health Research and Development Agency of the Republic of Indonesia, malaria prevalence in Indonesia is 6 percent, and 15 provinces that have malaria prevalence above the national rate are primarily located in East Indonesia. Of the 15 provinces, five provinces with the highest malaria incidence include Papua 29.57%, West Papua 20.85%, East Nusa Tenggara (NTT) 12.81%, Maluku 6.0% and North Maluku 3.32% (Elyazar et al. 2012). In Indonesia, malaria caused by *Plasmodium* parasites includes *Plasmodium falciparum*, *Plasmodium malariae*, *Plasmodium ovale*, *Plasmodium vivax*, and a mix (Manning et al. 2011).

In addition to chemical drugs obtained from a drug store, local communities use various medicinal plant species to prevent, recover, and treat malaria disease (Asase and Asafo-Agyei 2011). Local knowledge is key-from community traditions in formulation plant species to be made as traditional medicines to treat malaria disease (Belayneh et al., 2012). Plant species in coastal areas have a high potential for medicine, such as mangrove plants with a utility as a local community medicine source (Dossou-Yovo et al., 2021). The plants grow on small islands in North Maluku Province, such as Bacan, Buton, Gorap, Maba, Makian, Ternate, and Tidore ethnic groups. These islanders have traditional knowledge of mangrove plants to treat malaria disease. The composition of malaria potion in each ethnic is not standardized. The concoction of medicinal herb composition still uses knowledge inherited from generations. Various mangrove plant species are used

by ethnic groups in the North Maluku islands area as a source of malaria medicine (Sukardjo 2016).

The research aims to describe the local wisdom of communities on the islands of North Maluku Indonesia in the formulation and to utilize mangrove plants as a source of medicine to treat malaria disease. The data would provide important information to the researchers in the health and medicinal, pharmaceutical, and medical field and biology and chemistry to test the efficacy and toxicity of malaria potion using mangrove plants as the primary ingredient.

MATERIALS AND METHODS

Study area

The research was conducted at Tuada and Baneigo villages in West Halmahera District; Dodaga and Gotowasi villages in East Halmahera District; Anggai and Wayaua villages in South Halmahera District; and Loleo and Gita Raja villages in Tidore Island City of North Maluku District, Indonesia (Figure 1).

The research data sources included Bacan, Maba, Buton, Tidore, Makian, and Ternate ethnics. The research locations were tropical regions of the islands. Participants were selected based on their ethnomedicinal knowledge. The interviews were carried out on plants used in ethnomedicine among the villagers. Individuals who were locally recognized as knowledgeable on plant use were identified with the assistance of the village elders. The selection in the questionnaire was described systematically and through the participatory rural appraisal (PRA) method. Plants were collected from the forest with the help of the locals. Plant specimen vouchers were collected using the standard method (Martin 2014).

Ethics statement

Before the survey, a meeting was held with the head of the village, traditional figures as traditional leaders, public figures, and members of environmental associations to clearly explain the purposes of the survey. Since all selected informants were adults, an agreement was made with each informant before the interview through agreed voluntary consent forms. Each informant was convinced to be interviewed in each stage of research. However, all informants actively participated, and no one refused to be interviewed. The informant code number was used to replace the informant's name, and the information collected was concealed. The research result feedback was conducted through discussion meetings and dissemination upon completing the survey for data verification.

Field survey and data collection

An in-depth interview with primary informants had been chosen using purposeful sampling (A'Yunin Al-Isyrofi et al., 2021). The authors collected data from March 2018 to August 2020. The in-depth interview, participant assessment, group discussion, and field visit collected data on mangrove plants' communities (McClatchey and Gollin 2005). An open questionnaire was asked to uncover key informants' knowledge maps (Qu and Dumay 2011). The interview was conducted in the local language through the individual visit of each informant. Before ethnobotanical data collection, the informants obtained an agreement (Medinaceli 2018; Dossou-Yovo et al. 2021). The research informants consisted of 98 key informants are presented in Table 1. The informants were selected for an interview and collect information related to name, age, gender, and level of education (Table 2). A semi-structured questionnaire served to collect data on the local names, plant parts, modes of preparation, routes of administration, and doses of various medicines. Data on the informant's occupation were also collected. Before the data collection, group discussion was conducted with the key informants to explain the research purposes.

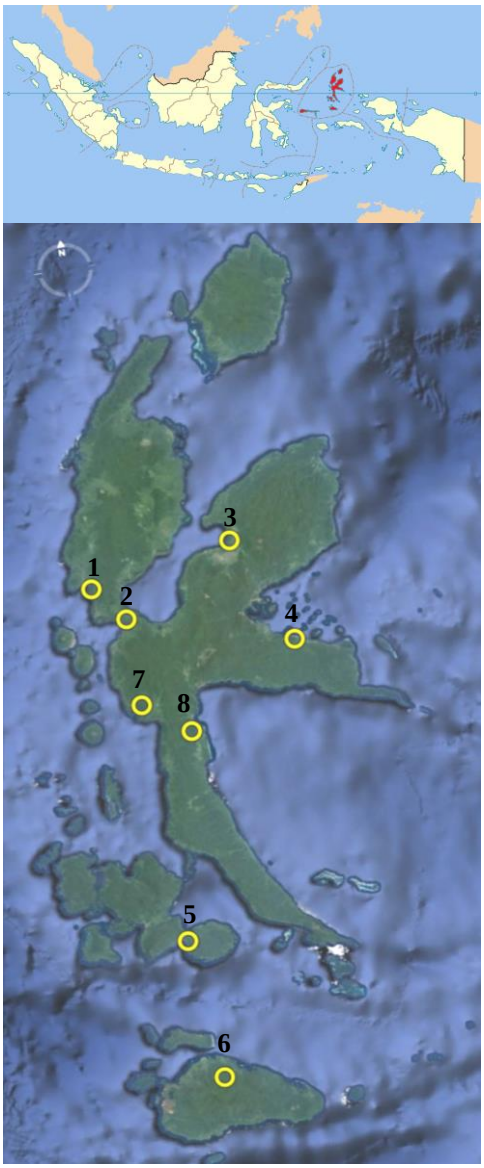

Figure 1. Research location in North Maluku, Indonesia, namely Tuada (1) and Baneigo (2) in West Halmahera; Dodaga (3) and Gotowasi (4) in East Halmahera; Anggai (5) and Wayaua (6) in South Halmahera; Loleo (7) and Gita Raja (8) in Tidore Island City

Plant collection, identification, and preservation

Uses of medicinal plants were interviewed in a structured manner. Of care was taken during the recording of information to record the local name of the plant, parts used, methods of preparation, and the uses of medicinal plants. For each specimen, photos were taken to confirm the identification of the taxonomy and the documenting of specimens. After knowing the specific use of medicinal plants, informers were taken to the fields to identify the plants based on local names. Photographs of the plant habit and reproductive structures were taken, and plants were collected for voucher sheet preparation. Voucher sheets were verified in the herbarium section, Bogoriense Botanical Laboratory of the Indonesian Institute of Science Biological Research Centre (LIPI), Cibinong, Indonesia. The certified plant specimens were housed at the Biology Laboratory, Khairun University. The plant's scientific name was checked with the World Checklist of Vascular Plant [WCVP] (WCVP 2021) website and confirmed only the accepted name.

Data analysis

Data on informant background and plants used were schematically recorded using Excel 2019 software. Data collected consisted of the local name, botanical name, and parts utilized. Data on plant utilization were calculated using the Fidelity level formula (FL %) = $Ip/Iu \times 100$ (Hoffman and Gallaher 2007). FL is a percentage of informants claiming a specific plant for the same purpose. Ip is the number of informants who independently recommended plant species for malaria, and Iu is the total. They mentioned the same plant for malaria disease.

RESULTS AND DISCUSSION

Demographic characteristics and knowledge of informants on medicinal plants

Among the informants, 40 (40.82%) respondents were male, and 58 (59.18%) were female. This repartition was not unusual in ethnobotanical investigations in Indonesia due to the importance of women in the domestic context, where most plant resources, especially dietary and medicinal plants, were managed. The current investigation also meant that women proved to be the main upholders of traditions linked to domestic life. The age of the informants was from 40 to above 89 years. Age-wise, 32 (32.65%) informants were in the age group of 60-69 years, which is much higher than the informants in the other age groups—31 (31.63%, 50-59 years), 15 (15.30%, both 40-49 and 70-79 years) and 5 (5.10%, ≥80 years), respectively (Table 1). As for educational qualifications, only 2 (2.04%) were illiterate; 5 (5.10%) had only primary school education; 23 (23.46%) had middle school education; 51 (52.04%) had secondary school education, and only 17 (17.34%) had a university degree (Table 2).

The 6 plant hats traditional healers use among the village people were interviewed, identified, and documented. Most of the medicinal plants identified belong to 5 families (Table 3).

Anti-malaria mangrove species

The local communities of North Maluku-Indonesia, especially Bacan, Buton, Gorap, Maba Makian, Ternate, and Tidore ethnic groups, used *Rorano* as their cultural identity to name medicinal herbs. The research result used the term to call potions made by the locals since it is community local knowledge preserved until now. The research data provided important information that the local ethnics utilized mangrove plants of *Lumnitzera littorea*, *Rhizophora mucronata*, *Scyphiphora hydrophyllacea*, *Sonneratia alba*, *Xylocarpus granatum*, and *Xylocarpus moluccensis* as a source of malaria medicine (Figure 2).

For the islanders, the six species were beneficial. Plant parts, including flowers, bark, rind, and fruit, had high values in combating malaria (Dossou-Yovo et al., 2017; 2021). Mangrove plants from *X. granatum* and *X. moluccensis* species were generally known by the communities as buangkirakira (a local name). Aside from being a malaria medicine, mangroves had benefits as a cosmetic ingredient and natural dye in traditional drinks. Specifically, the utilization of fruits and flowers compromises the species of mangrove plants from *L. littorea*, *R. mucronata*, *S. hydrophyllacea*, and *S. alba* species known as Soki in the local language were used as a source of malaria medicine (Figure 3). The local ethnics lived in small islands with long coastlines and mangrove vegetation. *L. littorea* and *S. hydrophyllacea* plants were taken during the flowering season in May-August 2018 and May-September 2019. In addition to its use for malaria treatment, red *L. littorea* flowers (Figure 3) were used as a sleeping therapy with additional ingredients of sweet liquid from enau [*Arenga pinnata* (Wurmb) Merr., Family: Arecaceae] plants.

The benefit of mangrove species

Data of fidelity level utilization analysis value based on ethnic groups indicated that Bacan, Buton, Gorap, Maba, Ternate, and Tidore had utilized mangrove plants of *X. granatum* as the raw material of malaria medicines with an FL value of 74.48%, followed by *X. moluccensis* of 60.20%, *S. alba* of 51.02%, *R. mucronata* of 43.88%, *S. hydrophyllacea* of 28.57% and *L. littorea* of 27.55% (Table 3; Figure 4). Maba and Buton ethnic groups mostly used *X. granatum* and *X. moluccensis* as essential malaria medicines. Bacan and Maba ethnic groups were the highest in utilizing mangrove species of *S. alba*, whereas Buton ethnic group preferred *R. mucronata* to cure malaria. Mangrove with the lowest fidelity level included *L. littorea* and *S. hydrophyllacea*.

The traditional use by the communities of the six ethnic groups was a pearl of local wisdom original from communities' oral tradition, spoken for generations. Local knowledge of mangrove plants as a medicine was the characteristic of the community's ability to adapt to their living environment. The environment adaptation was closely related to a social and cultural transformation in the community. The consumption pattern of traditional medicine continued to evolve from herbal medicines to chemical drugs. If it continued, the community's local knowledge of medicinal plant utilization would vanish in

the future. One of the efforts to eliminate the loss of the community's local knowledge was through ethnic-based education.

The use of rinds and barks of mangrove from *X. granatum* and *X. moluccensis* species by the local ethnic groups were in the high category since these species were the main ingredients in malaria treatment (Figure 4). *S. alba* flowers and *R. mucronata* fruits were the second options for medicines when the first options were not found. Parts of the plant, such as flowers from *L. littorea* and *S. hydrophyllacea* fruits, were the alternative ingredients if the main ingredients were not found.

Informants from all age groups explained that children, teenagers, and adults often experienced malaria symptoms such as high fever and chills, fatigue, sweating, headache, nausea and vomiting, diarrhea, and muscular pain. Actions conducted by Gorap, Makian, Ternate, and Tidore ethnics to treat malaria was by making *Rarano* by taking the rinds and barks of *X. granatum* and *X. moluccensis* and boiling them, and taking the potion twice a day after meals. Bacan and Maba ethnics preferred to use *S. alba* by taking its flower and adding *L. littorea* flowers and *R. mucronata* fruits. These three plant parts were mixed and soaked in hot water and allowed to cool and taken twice a day after meals.

Table 1. Distribution of informants' gender and age

Ethnic groups	Age Groups	Gender		No. of persons	Percentage
		Male	Female		
Bacan	40-49	1	1	2	14.28
	50-59	2	2	4	28.57
	60-69	1	4	5	35.71
	70-79	1	1	2	14.28
	80-89+	0	1	1	7.14
Buton	40-49	1	1	2	14.28
	50-59	0	3	3	21.42
	60-69	4	1	5	35.71
	70-79	1	3	4	28.57
	80-89+	0	0	0	0
Gorap	40-49	0	1	1	7.14
	50-59	1	3	4	28.57
	60-69	2	5	7	50
	70-79	0	2	2	14.28
	80-89+	0	0	0	0
Maba	40-49	1	1	2	28.57
	50-59	2	4	6	28.57
	60-69	1	1	2	14.28
	70-79	1	1	2	14.28
	80-89+	1	1	2	14.28
Makian	40-49	2	1	3	21.42
	50-59	2	3	5	35.71
	60-69	2	2	4	28.57
	70-79	0	2	2	14.28
	80-89+	0	0	0	0
Ternate	40-49	1	0	1	7.14
	50-59	3	2	5	35.71
	60-69	3	4	7	50
	70-79	1	0	1	7.14
	80-89+	0	0	0	0
Tidore	40-49	1	3	4	28.57
	50-59	2	2	4	28.57
	60-69	1	1	2	14.28
	70-79	1	1	2	14.28
	80-89+	1	1	2	14.28
	Total	40	58	98	

Table 2. Level of education of the informants

Ethnic groups	Level of education	No. of individuals	Percentage
Bacan	Illiterate	0	0
	Primary	1	7.14
	Middle	5	35.71
	Secondary	6	42.86
	University	2	14.29
Buton	Illiterate	1	7.14
	Primary	1	7.14
	Middle	3	21.43
	Secondary	7	50
	University	2	14.29
Gorap	Illiterate	1	7.14
	Primary	1	7.14
	Middle	4	28.57
	Secondary	7	50
	University	1	7.14
Maba	Illiterate	0	0
	Primary	0	0
	Middle	1	7.14
	Secondary	11	78.57
	University	2	14.29
Makian	Illiterate	0	0
	Primary	0	0
	Middle	6	42.86
	Secondary	4	28.57
	University	4	28.57
Ternate	Illiterate	0	0
	Primary	2	14.29
	Middle	2	14.29
	Secondary	9	64.29
	University	1	7.14
Tidore	Illiterate	0	0
	Primary	0	0
	Middle	2	14.29
	Secondary	7	50
	University	5	35.71

Table 3. Fidelity level values of mangrove species utilization based on ethnic groups

Mangrove plant species	Family	Voucher no.	Ethnic groups						
			Bacan	Buton	Gorap	Maba	Makian	Tidore	Ternate
Lumnitzera littorea (Jack) Voigt	Combretaceae	TACO1	42.86	42.86	14.29	35.71	14.29	28.57	14.29
Rhizophora mucronata Poir.	Rhizophoraceae	TARH1	50	78.57	35.71	50	42.86	21.43	28.57
Scyphiphora hydrophyllacea C.F.Gaertn.	Rubiaceae	TARU1	28.57	28.57	14.29	50	14.29	50	14.29
Sonneratia alba Sm.	Lythraceae	TALY1	64.29	64.29	57.14	85.71	42.86	14.29	28.57
Xylocarpus granatum J.Koenig	Meliaceae	TAME1	78.57	92.86	50	92.86	35.71	85.71	85.71
Xylocarpus moluccensis (Lam.) M.Roem.	Meliaceae	TAME2	78.57	92.86	35.71	85.71	28.57	85.71	14.29

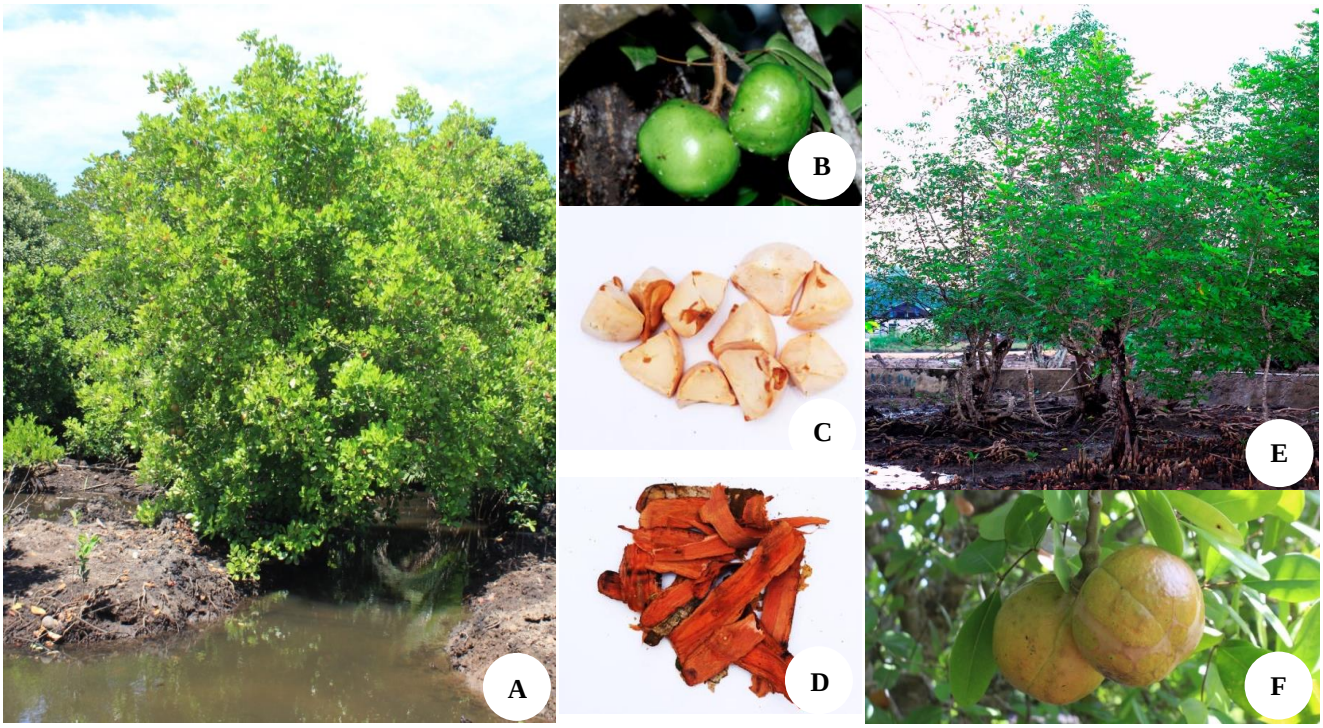

Figure 2. *Xylocarpus granatum*: A, Tree habit, B. Fruits, C. Flesh fruits, D. Barks; *Xylocarpus moluccensis*: E. Tree habit, F. Fruits

Figure 3. A. *Lumnitzera littorea* (Jack) Voigh. Flowers, B. *Scyphiphora hydrophyllacea* Gaertn. F. Fruits, C. *Sonneratia alba* J. Sm., D. *Rhizophora mucronata* Lam. propagules

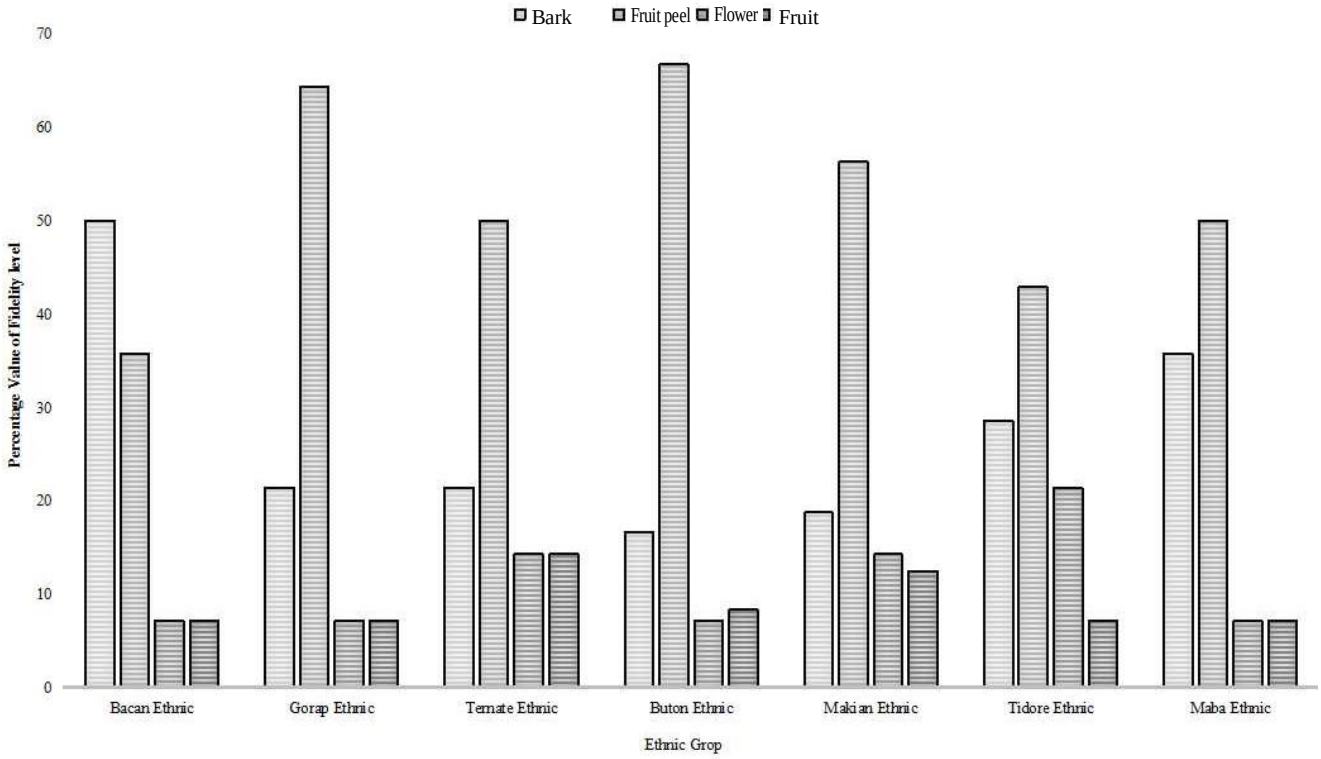

Figure 4. Fidelity level values (%) of plant parts utilization based on ethnic groups

Discussions

The formulation method of mangrove plants into *Rorano* of malaria was boiling. The communities in the five ethnic groups collected the medicinal plants and dried them to produce simplicia. It was conducted to maintain the medicine availability to be available when they got sick. The medicinal plant simplicia was dried for 1-3 weeks to remove water content in the plant organs to prevent mold fungi from growing. Only the traditional healers in the villages owned the simplicia. People who had access to chemical drug stores no longer used mangrove plants as malaria medicines. Traditional treatment was one of the best ways practiced in the community social life (Elyazar et al., 2012). The mangrove plants had cultural, ecological, and economic values (Datta et al., 2012). Traditional health treatment systems were developed from generations and practiced using mangrove plants in various disease treatment activities. People in remote villages performed therapy to cure malaria utilizing the plant's vegetative and generative parts (Bandaranayake 1998). From the locals ' perspective, the utilization of mangrove plants from generations proved that mangroves had the property to cure malaria (Lalitha et al., 2019). In X. granatum J.Koenig, four compounds were found: gedunin, photogedunin, xyloccensin-I, and palmitic acid. Gedunin and xyloccensin-I compounds found indicated suitable activities as antimalaria (Lakshmi et al., 2012).

The locals in the island areas of North Maluku used rinds, barks, fruits, and flowers of mangrove plants to make *Rorano* of malaria (Tamalene et al., 2019). Those parts of the plant were taken freshly and dried to make a potion. The locals utilized fresh leaves, seeds, bark, and fruits for malaria treatment preparation (Ngarivhume et al., 2015). Mangrove from *R. mucronata* Poir. species had potential as a safe and effective source of mosquitoes control agent to cure malaria. The community's need for medicine sources from plants is important as an agent of malaria cure (da Silva and Ricci-Júnior 2020). The use of *Jamu* (herbs) for generations has shown safety; however, further testing is required to determine the safety of potions consumed by the communities. This research only reports community knowledge on mangrove utilization as an agent to cure malaria for communities in the coastal areas of North Maluku Province in Indonesia. Mangrove has drug value since it has derivative compounds such as stigmasterol, triterpenoids, tretinoin, pyrethrins, and rubrolide-N) that could become new inhibitors for dihydrofolate reductase. The in-silico docking study also found that mangrove derivative compounds could block dihydrofolate reductase that, in turn, it could cause the inhibition of malaria parasites growth (Senthilraja et al., 2012).

At present, six mangrove species are being used by local communities of North Maluku Province Indonesia, especially ethnic peoples, as a source of malaria medicines. Traditional health treatment systems developed from generations and practiced in treatment activity and therapy to cure malaria disease used mangrove plants species from *L. littorea*, *R. mucronata*, *S. hydrophyllacea*, *S. alba*, *X. granatum*, and *X. moluccensis*. The traditional treatment that used mangrove rinds, barks, fruits, and flowers was one of the best methods practiced in the community social life. The mangrove plants have cultural, ecological, and economic values; hence, the local communities utilized and protected the plant through the socio-cultural approach.

The information forms the basis of further research to test the toxicity of potions made from the mangrove plant as the primary ingredient; therefore, the local communities would obtain scientific information related to safety in consuming traditional medicine.

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Floristic and ethnic perspective on wild forest plant species of Nongkhyllem Reserve Forest, Nongpoh, Meghalaya, India

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Abstract. *Parkash V. 2021. Floristic and ethnic perspective on wild forest plant species of Nongkhyllem Reserve Forest, Nongpoh, Meghalaya, India. Asian J Ethnobiol 4: 93-105.* This paper elucidates the indigenous traditional knowledge of wild plants usage by *Khasi* people (ethnic group) of Nongkhyllem Reserve Forest, Nongpoh, Meghalaya, India. About 117 different wild forest plant species belonging to 63 families were collected and enumerated for their traditional usage. Most of the plant parts utilized were of herbs (44) followed by trees (32) and shrubs (28). The climbers (7) and scrubs (6) have been utilized least in traditional usage by *Khasi* people in Nongkhyllem Reserve Forest. It is interesting to mention that due to overexploitation, some plant species, i.e., *Abroma augusta* L., *Phlogacanthus thyrsiflorus* (Roxb.), *Puereria tuberosa* L., *Eryngium foetidum* L., Nees, *Smilax aspera* L. and *Houttuynia cordata* Thunb. were utilized in colossal quantity, and these plant species are nearing their threshold and hence, are under threat. Only two plants of *A. augusta* L. were found around forest edge areas of reserve forest, so there is a need of the hour to conserve this plant species in situ and ex-situ conditions. This study emphasizes research potentials and the need to document traditional knowledge about wild forest plant species utilization to benefit society and humankind through scientific intervention.

Keywords: Indigenous traditional knowledge, *Khasi* ethnic group, Nonghkyllem Reserve Forest, wild plants

INTRODUCTION

The northeast Himalayan region in India has vibrant forest flora. It has tremendous potential for cultivating and utilizing plant resources in its diverse agro-climatic zones. Meghalaya is one of the smallest states in this North-eastern part of India, (25°5′-26°10′ N latitude, 89°47′-92°47′ E longitude), covering an area of 22,429 km^2 and occupies the plateau and rolling hills between Assam state (India) and Bangladesh (Myer et al. 2000.). The word `*Meghalaya*` means the abode of clouds, and it is the home of ethnic groups (tribals) influenced by the Hindu culture. The ethnic groups who inhabited Meghalaya are the *Khasis, Jaintias, Garo, Mikirs,* and the *Kacharis*. Meghalaya is a hilly strip in the eastern part of the country and is covered with lush forest areas and rich orchid plantations. Meghalaya has a forest cover of 9,496 km^2 square, which is 42.34 % of the total geographical location of the state (Samati 2004; 2007). The Meghalayan subtropical forests have been considered among the richest botanical habitats of Asia (Nayar 1996). These forests receive abundant rainfall and support a wide variety of floral and faunal biodiversity. A small portion of the forest area in Meghalaya is under what is known as "sacred groves." These are small pockets of an ancient forest that have been preserved by the communities for hundreds of years due to religious, cultural, and spiritual beliefs and held in great reverence. These forests represent the ancient ecosystem of the world—these 'sacred groves' harbor many rare floral and faunal species. Meghalaya has three Wildlife Sanctuaries,*i.e.,* the Nongkhyllem Wildlife Sanctuary, the Siju Sanctuary, and the Bhagmara Sanctuary, which is also the home of the insectivorous 'pitcher plant,' *Nepenthes khasiana*.

Nongkhyllem Reserve Forest (NRF) is located near Nongpoh, the district- headquarters of the Ri-Bhoi District of Meghalaya, situated on Gauhati-Shillong National Highway (NH-40). Nongkhyllem Reserve Forest, Nongpoh, has an area of 96 km^2, excluding the 29 km^2 area of Nongkhyllem Wildlife Sanctuary (Figures 1 and 2). Due to the diverse climatic and topographic conditions, Nongkhyllem Reserve Forest supports a vast floral diversity, including many epiphytes, succulent plants, and shrubs. The various trees like *Terminalia bellirica, T. chebula, Albizia lebeck, Adina cordiafolia, Schima wallichii, Shorea robusta, Shorea assamica, Tectona grandis, Aesculus assamica, Aporusa wallichii, Bridelia retusa, Cryptocarya andersonii, Talauma hodgsonii, Lagerstroemia parviflora, Gmelina arborea,* etc. are some of the most important trees of economic importance. The main components of shrubby species are *Capparis zeylanica, Garcinia lancifolia, Bauhinia acuminata, Mimosa himalayayana, Acacia concinna, Mussaenda roxburghii, Eupatorium modiflorum, Solanum kurzii,* and *Phlogacanthus tubiflorus,* etc. Numerous lianas intertwine the trees in a few areas, e.g., *Dysolobium grande, Mucuna bracteata, Fissistigma wallichii, Paederia scanders, Solena heterophylla,* and *Aristolochia saccate,* are prominent (Kumar et al. 1987).

Natural resources are being exploited on a large scale by the human race. So due to the over-exploitation of natural forest wealth, some forest plant species are on the verge of extinction. Therefore, it is a need of the hours to collect the primary data on botanical knowledge of the

ethnic groups and biodiversity conservation. It is also possible to discover new plants not documented earlier to cure diseases and other ailments. Ethnic perspective on wild forest plant species will help evaluate the natural forest wealth for traditional medicinal plants for further phytochemical studies and economic upliftment of the folk, conservation of biodiversity, and eventually for the welfare of society. So this study was taken in the form of a project on "Utilization of Vesicular Arbuscular Mycorrhizal diversity for conservation of some useful wild forest plant species of Nongkhyllem Reserve Forest Nongpoh, Meghalaya" during 2009-13 funded by ICFRE (Indian Council of Forestry Research and Education), Dehradun. Some notes on wild medicinal plants of Umtasoar Range under Nongkhyllem Reserve Forest, Nongpoh, Meghalaya, India, and their traditional usage by the Khasi tribe. Its have already been published (Parkash et al. 2013). The rest of the beneficial wild forest plant species with the traditional use of this reserve forest, including the forest ranges,i.e., the Nongpoh forest range and Umtasoar forest range, have been discussed in this paper.

MATERIALS AND METHODS

An extensive survey was conducted with the help of the Global Positioning System (GPS) (see Table 1 and Figure 1) and forest area map during (2009-2013) in Umtasoar and Nongpoh Range (Figure 2) and collected the wild functional plant species samples and data for enumeration. About 117 valuable and medicinal plants were collected from 11 compartments during the field survey. According to Forest Department, Meghalaya of Umtsar Forest Range classification, i.e., Umsaw, Khakuoi, Benpoint, Khirdemkulai, Satroh-Khadnio. From the Nongpoh Forest Range, i.e., Diphu-Sydang, Leprosy Colony, Morok, Umsiling, and Tower Point. These plants were preserved in herbarium sheets and then deposited at the regional herbarium of Rain Forest Research Institute (Indian Council of Forest Research and Education) at Jorhat, Assam, India. The unidentified collected plants were identified to B. S. I. (Botanical Survey of India) Northeast Circle, Shillong, Meghalaya, India, and also by consulting the available literature and flora (Kanjilal et al. 1934-40; Joseph 1982; Haridasan and Rao 1985, 1987) available in the Institute. The botanical names were neutralized, verified, and updated with the help of 'The Plant List' (www. theplantlist.org).

During different seasons, frequent visits were carried out to Nongkhyllem Reserve Forest, Nongpoh, and Meghalaya. The plants were collected from various sites of the area as cited above, identified by their local names recorded with the help of villagers/tribals/local village man. The data on ethnobotanical/medicinal usage of wild plants were collected through general conversation and questionnaires provided to the people of the fringe area of the reserve forest. The photographs of these wild forest plant species were taken during the field visits. Accurate datum regarding each plant species was collected by assigning botanical and local names along with habit, habitat, general description, and distribution of each plant species in the area. Collected plant specimens were maintained through herbarium preparation, as described earlier. The standard methods of ethnobotanical studies and identification of the collected plant specimens were done by using traditional methods and floral documentation written by different researcher's (Martin 1995; Gupta 1995; Jain 1995; Joshi 1995; Mudgil 1995; Rao and Hajra 1995; Parkash and Aggarwal 2010; Verma et al. 2012; Parkash et al. 2013) and available at the laboratory and library of Rain Forest Research Institute, at Jorhat, Assam.

In addition to this methodology, two broad approaches of ethnobotanical studies were considered. The indirect method, the extensive and intensive fieldwork in the rustic villages, was made. This is usually carried out by direct contacts with ethnic groups/ villagers, and first-hand information was collected from all the study sites. In an indirect approach, information was obtained in different ways, i.e., through ancient literature, personal diaries of foresters, traditional local doctors/hermits, plant collectors, etc.

Table 1. GPS data with different compartments of Umtasoar and Nongpoh Range under Nongkhyllem Reserve Forest, Meghalaya, India

Forest range	Compartments	GPS location		Elevation (m) (asl.*)
		Latitude	Longitude	
Umtasor (UM)	Ben Point (BP)	25° 49' 05.1" N	91° 46' 17.9" E	567
	Kyrdemkulia (KK)	25° 48' 30.1" N	91° 46' 12.5" E	434
	Mowdkhar (MK)	25° 49' 40.6" N	91° 50' 07.9" E	628
	Pen-Point (PP)	25° 49' 09.9" N	91° 46' 19.9" E	570
	Umsaw (US)	25° 49' 50.8" N	91° 48' 21.0" E	576
	Zero-Point (ZP)	25° 49' 36.0" N	91° 50' 17.8" E	616
Nongpoh (NP)	Diphu-Sydang (DS)	25°48' 28.1"N	91°46' 10.5" E	432
	Leprosy Colony (LC)	25°55' 22.1"N	91°52' 15.9" E	536
	Morok (MO)	25°49' 23.8"N	91°51' 26.9"E	540
	Umsiling (UMSL)	25°48' 45.0"N	91°46' 10.6"E	418
	Tower point (TP)	25°55' 6.9"N	91°51' 47.9"E	569

Note: asl.: above sea level

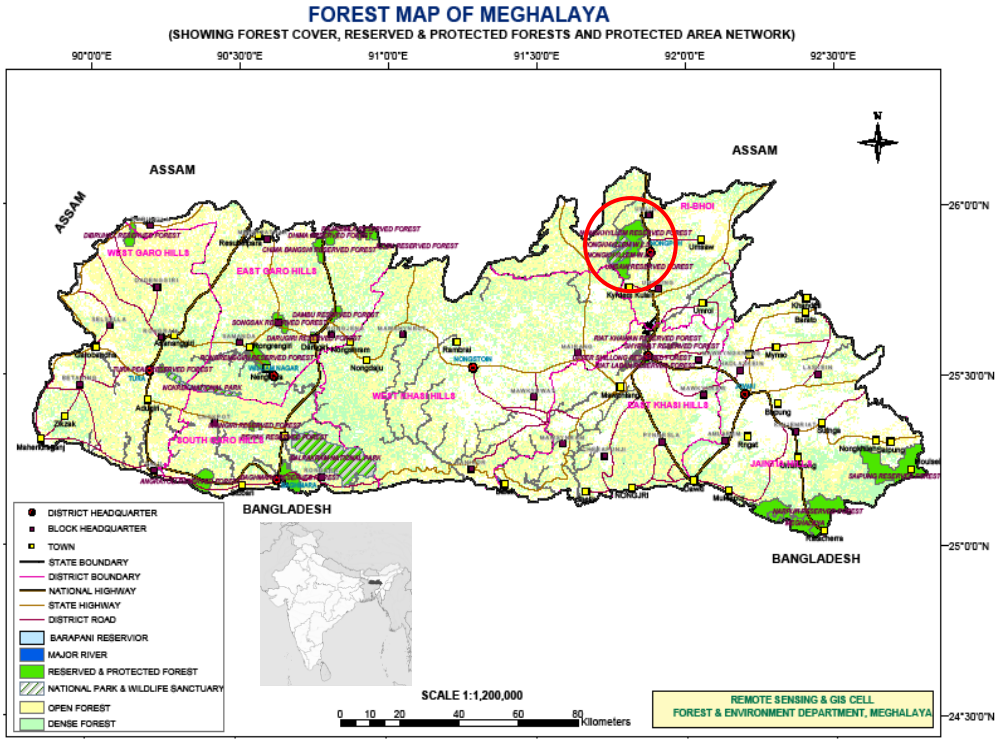

Figure 1. The study site of Nongkhyllem Reserve Forest (red circle), Nongpoh, Meghalaya, India

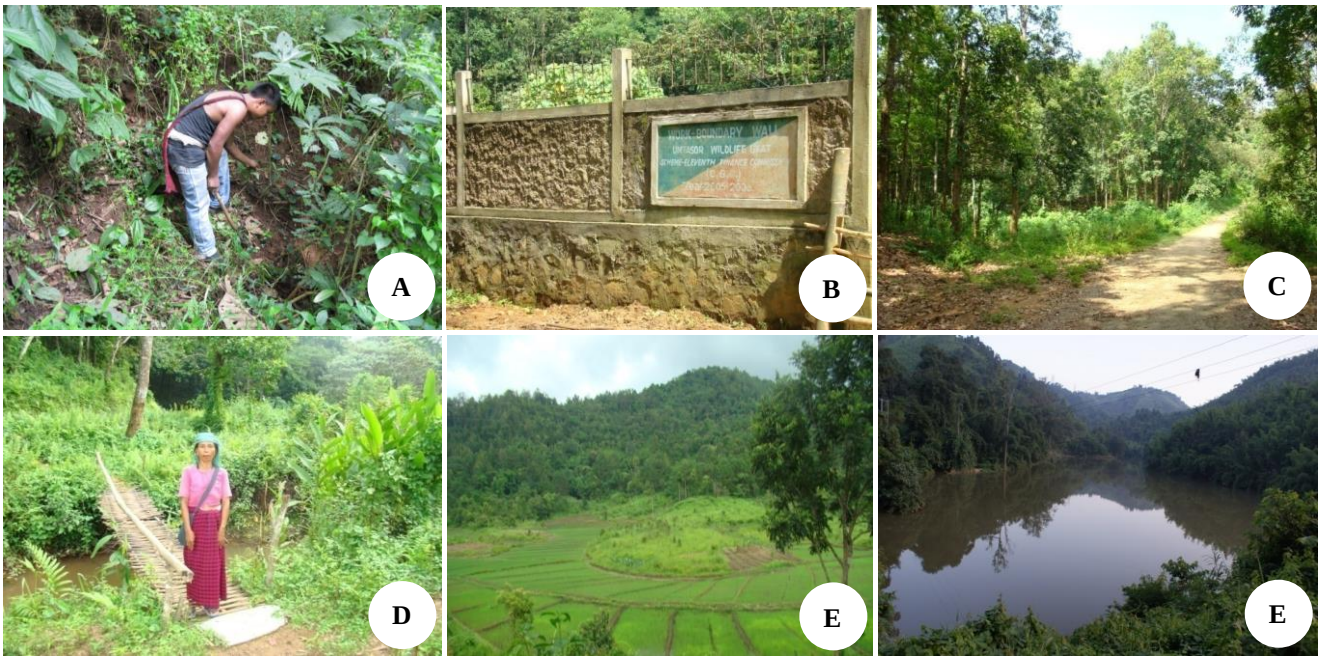

Figure 2. A-F: Different study places/locations along with *Khasi* people at Nongkhyllem Reserve Forest, Nongpoh, Meghalaya

In the present investigation, both direct and indirect approaches were employed to understand the traditional uses of plants properly. Information about the plants was recorded regarding their vernacular names, plant part used, the preparation of medicine either individually or in combination with other plant parts, and mode of application and dosage for the treatment.

RESULTS AND DISCUSSION

Nine survey tours were conducted to visit two forest ranges, *i.e.*, Umtasor (Ben-point, Kyrdemkulia, Mawdkhar, Pen-point, Umsaw, Zero-point) and Nongpoh (Leprosy Colony, Morok, Dipu-Sydang, Tower point, and Umsling) for the collection of useful wild plants (see above Figures of the study site (Figure 1) and of study locations (Figure 2)).

A total of 117 plant samples of these two ranges, namely Umtasor and Nongpoh, were collected. Some of the valuable plant species of the Nongkhyllem Reserve Forest (NRF) are shown in Table 2. Enormous plant diversity exists in the Nongkhyllem Reserve forest, but only those plants specimens/samples were collected, which are being utilized by the local people directly from the wild. The locals utilize all the plants being used managed in their day-to-day life. Some of the essential plants are quoted along with their various usages (Table 2). The flowers of the *Trevesia* species of family Araliaceae found in the Mokdhor (MK) compartment are eaten by Khasi people in the Khasi hills and used to lower fever. The Juice of the root of *Holmskioldia sanguinea* Retz., a shrub in nature that belongs to the family Verbenaceae found in the compartment; the local people use Umsaw to get relief from fever. The shrub, *Solanum khasianum* of Solanaceae family, copiously found in compartment Mokdhor, is used as a vegetable, and mainly, the fruits and roots are cooked. *Costus speciosus* of family Costaceae, a shrub found in compartment Pen Point, is beneficial in urinary and earache problems. *Schima wallichii*, a common tree found in compartment Umsaw of family Theaceae, is used by the native people to cure cuts and wounds, kill intestinal worms in cattle, and kill leeches for which mainly the leaf and bark parts are used. During the survey, it was observed that as per the status of different plant parts used, stem and leaves form integral parts of most formulations while plant fibers are used in lesser quantities by local inhabitants.

The dominant top ten plant families of Nongkhyllem Reserve Forest have been shown in Figure 3. 63 families have been reported with 116 genera and 117 species. The studied families are clustered into six groups. The famiraceae and Euphorbiaceae are in the Ist group, represented by 6 genera and 6 species each. Rubiaceae are placed in the IInd group and are characterized by 5 genera and 5 species. In group IIIrd, Acanthaceae, Fagaceae, Lauraceae, Verbenaceae, and Labiatae (Lami,aceae) are represented by 4 genera and 4 species except for 1 family,*i.e.,* Acanthaceae is represented by 3 genera only. Five families, namely Ceasalpineaceae, Moraceae, Poaceae, Smilaceae, and Urticaceae, are placed in group IV, eachesenting 3 genera and 3 species each. The rest 52 families are placed in Vth and VIth groups. 2 genera and 2 species represent the Vth group families except for the Magnoliaceae family with 1 genus only; all the families in the VIth group are represented by 1genus and 1 species each, respectively (see Table 3 and Figure 3).

The distribution of some collected wild useful plants of Nongkhyllem Reserve Forest is shown in Figure 4. Dicots are represented by 54 families, 101 genera, and 102 species. Monocots are represented by 5 families, 10 genera, 9 species, and the Pteridophytes with 4 families, 5 genera, and 5 species (Figure 4). Habit-wise distribution of wild valuable plant species of Nongkhyllem Reserve Forest is also shown in Figure 5. Trees are represented by 22 families, 31 genera, 32 species. Scrubs belong to 5 families, 6 genera, and 6 species, and the climbers with 5 families, 5 genera, and 7 species. Shrubs are represented by 21 families, 26 genera, and 28 species. Herbs are represented by 27 families, 43 genera, and 44 species (Figure 5).

Enormous plant diversity exists in the Nongkhyllem Reserve forest. Still, only those plants specimens were collected, which are being utilized by the local people (*Khasi* ethnic group) directly from the wild (not domesticated) (Figures 6). Interestingly, some wild plant species like *Houttuynia cordata* Thunb., *Abroma augusta* L., *Eryngium foetidum* L., *Phlogacanthus thyrsiflorus* (Roxb.) Nees, *Pueraria tuberose* L., and *Stachyterpheta jamaicensis* L. were utilized by the local *Khasi* ethnic group people inhabiting this range for their day-to-day remedies. In the course of the survey work, *H. cordata* is reported to be used by the *Khasi* community in measles, dysentery, gonorrhea, eye troubles, skin diseases, hemorrhoids, certain gynecological disorders (Parkash and Dhungana 2011). This plant is a well-known, traditionally used medicinal material in China and Japan and is listed in the Chinese Pharmacopoeia. Recently, during the SARS outbreak, *H. cordata* was one of the ingredients in the SARS prevention formulae recognized by the Ministry of Public Health and the State Administrative Bureau of Traditional Chinese Medicine [TCM-2003] (Parkash and Dhungana 2011). Similarly, *Stachytarpheta jamaicensis*, which is cidered a weed in some other places, is used to prepare tea by the local Khasi community and *Thea Chinensis. A. augusta* L. is only found in fewer numbers around forest edge areas, so there is an urgent need to conserve this plant species in *in-situ* and *ex-situ* conditions.

It has been shown through numerous examples that the ethnic groups of Meghalaya make wide use of a large variety of wild medicinal plants available to them. The demand in the local market has increased, causing a threat to these wild plant species. Also, the genetic diversity in medicinal plants has diminished due to shifting cultivation and large-scale destruction of their natural location. The overexploitation of medicinal resources in an unscientific manner by unskilled laborers and poor natural or artificial regeneration has resulted in the virtual extinction of certain vital plant species (Kayang et al., 2005).

The data on wild medicinal plants will serve as a valuable tool to prepare development and action plan for the herbal drug industry for improving and uplifting the life and economy of the state. *In situ* and *ex-situ* conservation of endangered or likely to be endangered (rare) plant species should immediately be started in the appropriate districts of the state. Spontaneous and wild-collected plants must be limited as far as possible and should be replaced by sustainable cultivation. Rural people should be encouraged to raise their ethnomedicinal gardens or herbal gardens in their vicinity to conserve the depleting biodiversity in wild medicinal plants. Local people should be trained how to propagate, preserve and collect the medicinal plants as a part of extension and sustenance. They should be educated and provided with the proper guidelines so that there is a continuous regeneration of wild flora. Again, it is noteworthy that we should not disturb the local forest flora, which is generally susceptible to environmental changes that may lead to the extinction of natural and essential plant species.

Table 2. Some valuable wild forest plant species of Nongkhyllem Reserve Forest, Nongpoh, Meghalaya, India

Accession/ Collection No.	Botanical names	Family	Habit	Local name	Ethnic and r usage (if any)
NRF/UM/MK/01	*Castanopsis indica* (Roxb.) DC.	Fagaceae	Tree	*Khasi badam*	Fruits are edible and eaten raw by the *Khasi* people
NRF/UM/MK/02	*Sterculia villosa* Roxb.	Sterculiaceae	Tree	*Dieng-star*	Fiber and timber yielding plant species, Seeds are edible
NRF/UM/AM/03	*Melastoma malabathricum* Linn.	Melastomaceae	Shrub	*Dieng-soh-khing*	Fruits are edible, and it is speculated if this plant species are growing in any place that place is suitable for tea cultivation
NRF/UM/MK/04	*Curcuma pseudomontana* Graham	Zingiberaceae	Herb	*	Porcupines and boar eat tubers. The small almond-shaped tubers are boiled and eaten by the locals
NRF/UM/MK/05	*Aquilaria agallocha* Roxb.	Thymelaeaceae	Tree	*Makhi sal*	Used for production of agarwood
NRF/UM/MK/06	*Artocarpus chaplasha* Roxb.	Artocarpaceae	Tree	*Dieng-soh-ram*	Yields good logs and wood; seeds are edible; fruits are used as a vegetable
NRF/UM/MK/07	*Mussaenda frondosa* Sensu G. Forst., non L.	Rubiaceae	Shrub	*	Local medicinal formulations of leaves in stomach pains
NRF/UM/MK/08	*Garcinia Cova* Linn.	Clusiaceae	Tree	*Dieng-soh-longkor*	The acidic fruits are locally used to cure dysentery and stomach trouble, usually dried and preserved. Wild elephants also relish the fruits.
NRF/UM/MK/09	*Shorea asamica* C.F. Gaertn.	Dipterocarpaceae	Tree	*Dieng-blei (K), Bolsal, Borsal (G)*	Timber-yielding and resin yielding plant species
NRF/UM/MK/10	*Smilax hispida* Muhl.	Smilacaceae	Shrub	*	Shoot pounded, fermented, extracted, and sun-dried for off-season use by *Khasi* and *Jaintia* ethnic group
NRF/UM/MK/11	*Emblica officinalis* Gaertn.	Euphorbiaceae	Tree	*Dieng-sohmylleng (K)*	Fruits are edible, medicinal uses in the powder used in stomach pain and constipation.
NRF/UM/MK/12	*Lagerstroemia parviflora* Roxb.	Lythraceae	Tree	*Dieng-lang-sing (K)*	Timber yielding, used by locals as gum and fiber yielding plant species
NRF/UM/MK/13	*Solanum khasianum* C.B. Clarke	Solanaceae	Shrub	*	Fruits/berries are used as vegetables. Roots are also used for curing fungal infections on the skin.
NRF/UM/MK/14	*Sida cordifolia* Linn.	Malvaceae	Shrub	*	The plant is used in curing asthma by applying a paste made with the whole plant, pepper, and garlic over the body
NRF/UM/MK/15	*Solanum torvum* Sw.	Solanaceae	Shrub	*Katahi Bengelrgetable*	Fruits are edible raw, green fruits as a local vegetable; dried fruits yield powder (*churana*) used for digestion
NRF/UM/MK/16	*Asplenium nidus* Linn.	Aspleniaceae	Herb	*	The sprouts are eaten as a vegetable. Used as food plants by the larvae of some insect /butterfly species
NRF/UM/MK/17	*Mesua ferrea* Linn.	Clusiaceae	Tree	*Dieng-ngai (K), Khimdi (G)*	Fresh flowers are used medically mainly in itching, nausea, piles, excessive thirst, and sweating by the locals
NRF/UM/MK/18	*Spilanthes paniculata* Linn.	Asteraceae	Herb	*	Flowers and seeds are used in the toothache of children.
NRF/UM/MK/19	*Eryngium foetidum* Linn.	Apiaceae	Herb	*Dhania-khlaw*	Leaves used as a spice, it is also known as wild coriander and utilized in local vegetable preparation
NRF/UM/MK/20	*Polystichium braunii* Spenner	Dryopteridaceae	Herb	*	Young shoots are used as a v by the *Khasi* people
NRF/UM/MK/21	*Polypodium vulgare* Linn.	Polypodiaceae	Herb	*	Young shoots are used as a vegetable by the *Khasi* people
NRF/UM/MK/22	*Pteridium aquilinum* (L.) Kuhn.	Dennstaedtiaceae	Herb	*	Tender fronds are cooked in oil, sold in the local market by the *Khasi* people
NRF/UM/MK/23	*Alpinia allughas* (Retz.) Rose	Zingiberaceae	Shrub	*Tara*	The inner portion of the aerial parts (pith) is cooked as a vegetable and curry for flavoring. The rhizome is used and cooked, has been traditionally acclaimed as a remedy for intestinal infections

NRF/UM/US/24	*Callicarpa arborea* Roxb.	Verbenaceae	Tree	*Lakhiat*	Leaf, stem, and bark medicinal; leaf juice in fever, gastric diseases, giddiness, headache; bark in skin diseases and scorpion sting, carminative and used in cutaneous diseases
NRF/UM/US/25	*Thysanoleana maxima* (Roxb.) O. Ktze	Poaceae	Shrub	*Jhadu*	Inflorescence/Terminal twig is used in local broom-making /purpose
NRF/UM/US/26	*Manihot esculanta* Herm.	Euphorbiaceae	Scrub	*	The tapioca plant, extensively cultivated in in *Jhum* lands in *Khasi* hills for root tuber harvesting for local vegetable and staple food
NRF/UM/US/27	*Ficus glomerata* Linn.	Moraceae	Tree	*Tejmuri (Assamese)*	Fruits are edible and are eaten raw
NRF/UM/US/28	*Pueraria tuberosa* (Roxb. ex Willd.) DC.	Papilionaceae	Climber	*	Root/tubers are of medicinal value and used against bodily debility; root paste is applied on joint pains
NRF/UM/US/29	*Pteris cretica* Linn.	Adiantaceae	Herb	*	The leaves are used in skin inflammation and irritation. Also, in Phytoremediation and as an ornamental plant
NRF/UM/US/30	*Cocculus hirsutus* Linn.	Menispermaceae	Climber	*	An infusion of the leaves is used to treat stomachache. Root and stem are used in the treatment of fever
NRF/UM/US/31	*Nephrodium hirsutum* C.Presl.	Dryopteridaceae	Herb	*	Extract of leaves is used for the treatment of fungal infections
NRF/UM/US/32	*Adiantum tenerum* Sw.	Pteridaceae	Herb	*	The fronds are used as a garnish on dishes and dried fronds in local tea preparation
NRF/UM/ZP/33	*Bridelia retusa* Spreng.	Euphorbiaceae	Scrub	*Jati*	Used as biological control of pests by attracting predators in *Jhum* lands
NRF/UM/ZP/34	*Mimosa himalayensis* Gamble	Mimosaceae	Shrub	*Sohshih*	The bark is used for fish poisoning by the local people during fishing
NRF/UM/ZP/35	*Crotolaria alata* Buch.-Ham. ex D.Don	Fabaceae	Herb	*Turin*	Fodder plant for grazing animals and milk yielding
NRF/UM/ZP/36	*Castonopsis concinna* (Champ. ex Benth.) A.DC.	Fagaceae	Tree	*Sohot*	Timber yielding plant species, the fruits/nuts are edible and eaten raw by the local people
NRF/UM/ZP/37	*Boechmeria macrophylla* Hornem	Urticaceae	Shrub	*Sohbyrthid*	Fiber yielding plant species and leaves extract used in skin allergy and irritation
NRF/UM/ZP/38	*Uncaria rhynchophylla* Schreb.	Rubiaceae	Climber	*Jermi*	The dried roots are used in local remedies of epilepsy, head pain, and dizziness. Used as a herbal medicine
NRF/UM/ZP/39	*Festuca pratensis* Huds.	Poaceae	Herb	*	Used as fodder grass species in more milk yield and also as an avenue grass species along riversides
NRF/UM/ZP/40	*Leea indica* (Burm.) Merr.	Lauraceae	Shrub	*Pharun-barne*	Fiber-yielding plant species. The plant is used as a remedy for ailments such as diarrhea, dysentery, diabetes, body ache, and wound treatment by the local people
NRF/UM/ZP/41	*Duabanga grandiflora* Roxb. ex DC.	Sonneratiaceae	Tree	*Dieng-bai*	Timber yielding plant species, especially for plywood manufacturing
NRF/UM/ZP/42	*Boechmeria nivea* Hk. Et Arn.	Urticaceae	Shrub	*	Fiber yielding plant species and leaves extract used in skin allergy and irritation
NRF/UM/ZP/43	*Begonia crenata* Linn.	Begoniaceaea	Herb	*Jajew*	Wholeegetable plant is used in urination problems/disorders
NRF/UM/KK/44	*Dioscorea bulbefera* Linn.	Dioscoreaceae	Climber	*Sohksiew*	Species of Dioscorea are used as local vegetable preparation
NRF/UM/PP/45	*Costos speciosa* (Koenig) Smith	Costaceae	Shrub	*	Used in urinary problem and ear-ache by the local/ ethnic group people
NRF/UM/MK/46	*Crotolaria juncia* Linn.	Leguminosae	Shrub	*	Fodder plant for grazing animals for yielding more milk
NRF/UM/US/47	*Elephantopus scaber* Linn.	Asteraceae	Herb	*	The aqueous extract is consumed orally to induce abortion and treat urinary disorders. Used as a contraceptive by the ethnic group women
NRF/UM/US/48	*Richardia scabra* Linn.	Rubiaceae	Herb	*	Roots are used in lowering body temperature and amoebic dysentery
NRF/UM/US/49	*Zanthoxylum armatum* DC	Rutaceae	Scrub	*Dieng-sohkhlam (K), Dieng-jaiur (J)*	Young branches used as tooth-brush, stomach pains, young twig sprouts are used in making local *chutney*

NRF/UM/US/50	*Abrus fruticulasus* W.& A.	Fabaceae	Shrub	*	The seeds are used in the treatment of bodily infirmity. Used in piles also, the seed powder is used with milk early in the morning for the more vibrant condition of the body
NRF/UM/US/51	*Holmskioldia sanguinea* Retz	Verbenaceae	Shrub	*	Juice of roots is taken to relieve fever and bodily ebb
NRF/UM/US/52	*Semecarpus anacardium* Linn. f.	Anacardiaceae	Tree	*	Pseudocarp eaten raw or roasted, nut used medicinally as a source of Vitamin K, the nuts are used as body vitalizer
NRF/UM/US/53	*Hyptis suaveolens* (Linn.) Poit.	Lamiaceae	Herb	*Bontulsi*	Young twigs and leaves are used against skin diseases
NRF/UM/US/54	*Schima wallichii* (DC.) Korth.	Theaceae	Tree	*Dieng-nganbuit*	Bark, leaf medicinal; leaf paste on cuts and wounds; leaf decoction to cure flatulence; powdered bark to cattle to kill intestinal worms and leaches
NRF/UM/BP/55	*Leucas cephalotes* (Roth) Spreng.	Lamiaceae	Herb	*	The whole plant is used as an edible vegetable and herbal remedy for skin eruption
NRF/UM/BP/56	*Bidens pilosa* Linn.	Asteraceae	Herb	*	The whole plant is applied to a fresh wound and cut for healing
NRF/UM/BP/57	*Phyllanthus glaucus* Wall. Ex Mull.Arg.	Phyllanthaceae	Shrub	*	Plant extract is used to relieve stomach indigestion
NRF/UM/BP/58	*Dicliptera paniculata* Forssk.	Acanthaceae	Herb	*	The plant is used as a good forage for cattle for yielding more milk; the whole plant is used as a green manure
NRF/UM/BP/59	*Lepidagathis hyaline* Nees	Acanthaceae	Herb	*	The leaves decoction are used for reducing fever, and the flowering ash mixed with coconut oil is used for external application for inflammation, wound healing by *Khasi* people
NRF/UM/BP/60	*Achyranthes aspera* Linn.	Amaranthaceae	Herb	*	Leaves are used for curing cuts and wounds by sickles and axes
NRF/UM/BP/61	*Urena picta* Linn.	Malvaceae	Herb	*	Paste of fresh leaves is applied for swelling, bone fracture, and joint pains
NRF/UM/BP/62	*Selaginella exalta* (Kunze) Spring.	Selaginellaceae	Herb	*	The whole plant is used in the treatment of seasonal sneezing, colds, and coughs
NRF/UM/US/63	*Carissa spinarum* Linn.	Apocynaceae	Shrub	*	Fruits are either eaten raw or prepared of pickle and jam
NRF/UM/US/64	*Pteris umbrosa* R.Br.	Adiantaceae	Herb	*	Local people use the plants in their household yards for soil stabilization and also as ornamental plant species
NRF/UM/US/65	*Crepis japonica* (L.) Benth.	Asteraceae	Herb	*	Extract of fresh leaves is used as traditional ear drop (2-3 drops 3 to 4 times a day as per local hermit).
NRF/UM/US/66	*Hypoestes aristata* (Vahl) Sol. ex R.Br.	Labiatae	Herb	*	Leaf juice is orally administered in Jaundice by the ethnic group people
NRF/UM/US/67	*Salix psilostigma* Andersson	Salicaceae	Tree	*	Timber yielding plant and used for firewood. The decoction of the leaves or bark has also been used as an antihelminthic and vermifuge traditional remedy
NRF/UM/US/68	*Uncaria sessilifructus* Wall. ex Roxb.	Rubiaceae	Climber	*	The leaves extract is used as an emetic tonic if consumed overdosed
NRF/UM/US/69	*Macaranga denticulata* Muell.Arg.	Euphorbiaceae	Tree	*Dieng-lakhor*	Stem juice is helpful in skin diseases, cuts, and wounds. Also considered a religious/venerated tree and planted in temple yards
NRF/UM/US/70	*Phlogacanthus thyrsiflorus* (Roxb.) Nees	Acanthaceae	Shrub	*Tadang-kakseu, Dieng-soh-kajut*	Local people use leaves and flowers. The flowers are used in the treatment of diabetes.
NRF/UM/US/71	*Ficus elastica* Roxb. ex Hornem	Moraceae	Tree	*Dieng-jri (K), Phrap-ramkhet (G)*	The bark of the tree is used in the treatment of muscle and joint pain administered by village medicine-man
NRF/NP/LC/72	*Salix daphnoides* Vill.	Salicaceae	Tree	*Padem-dieng*	Timber yielding plant and used for firewood
NRF/NP/LC/73	*Elaecarpus floribundus* Bl.	Elaeocarpaceae	Shrub	*Lamsuvegetable*	Fruits are edible, usually pickled and cooked. The seeds are used in the preparation of beaded necklaces/jewelry/rosary
NRF/NP/LC/74	*Alangium platanifolium* Linn.	Alangiaceae	Scrub	*Lobong-kakseu*	The leaves and the bark of the root are used as an insecticide in seed keeping in containers

NRF/NP/LC/75	*Toona ciliata* Roem.	Meliacaea	Tree	*Dieng-Sali*	Timber yielding plant and the bark is used for tanning leather and has been traditionally used in joint pains
NRF/NP/LC/76	*Litsea glutinosa* C.B. Roxb.	Lauraceae	Scrub	*	Used as firewood, fruits are edible for their pulp, the bark is wrapped on bone fractures with the help of a bandage for healing
NRF/NP/LC/77	*Paspalidium flavidum* Stapf.	Poaceae	Herb	*Tuilaasu bon*	The grass species is planted alongside ravines for controlling erosion; seeds are eaten raw.
NRF/NP/LC/78	*Dendrocalamus hamiltonii* Nees & Arn. ex Murno	Poaceae	Herb	*Dieng-Seij-lai*	The shoot is used for making soup by the locals
NRF/NP/LC/79	*Cinnamomum tamala* (Buch.-Ham.) Nees & Nees	Lauraceae	Tree	*Dieng-syiem*	Leaves are used as a local spice; the leave is put in local tea in the making of .local tea *Kadah*
NRF/NP/LC/80	*Eheretia laevis* Roxb.	Boraginaceae	Shrub	*	Yield good timber for construction. Leaves provide fodder for yielding more milk
NRF/NP/LC/81	*Cyperus involculatus* Linn.	Cyperaceae	Herb	*	Used for making house plants, beds, and borders, containers, pools and ponds, flower arrangements, roots are used in high fever and poor digestion
NRF/NP/LC/82	*Terminalia bellirica* (Gaertn.) Roxb.	Combretaceae	Tree	*Dieng-sohkhoru (K)*	Local people eat seeds to cure gastric problems and stomach disorders. The fruits are used in piles, dropsy, leprosy, and headache
NRF/NP/LC/83	*Terminalia arjuna* (Roxb.) Wight & Arn.	Combretaceae	Tree	*	The bark is used medicinally for curing gastric problems and stomach disorders; the bark for blood pressure.
NRF/NP/LC/84	*Smilax aspera* Linn.	Smilacaceae	Climber	*	Planted in front of the house to protect from evil sight. The twig is used as a vegetable
NRF/NP/LC/85	*Michelia champaca* Linn.	Magnoliaceae	Tree	*Shap (K)*	Wood is durable, used in furniture and building works, the flowers are used in temples and for fragrance
NRF/NP/LC/86	*Tectona grandis* Linn.	Verbenaceae	Tree	*Dieng-rang*	Timber yielding plant species, flowers are acrid, bitter, and valuable in bronchitis, biliousness, urinary discharges
NRF/NP/LC/87	*Chlorophytum comosum* Thunb.	Liliaceae	Herb	*	Twigs cooked as a vegetable, the tuberous roots are used in bodily debility
NRF/NP/LC/88	*Amorphophallus* species Blume ex Decne.	Araceae	Herb	*	Corms are cooked as local vegetable/ preparation
NRF/NP/LC/89	*Impatiens balsamina* Linn.	Balsaminaceae	Herb	*	Leaves are used for yielding dye and are pasted on hands during the rainy season for hand and feet inflammation
NRF/NP/LC/90	*Boechmeria platyphylla* Buch.-Ham. ex D.Don	Urticaceae	Herb	*	Fiber yielding plant species and used in skin allergy and irritation
NRF/NP/LC/91	*Peperomia pellucida* (Linn.) Kunth	Piperaceae	Herb	*	Leaves used in stomach pain and as a local vegetable/preparation
NRF/NP/LC/92	*Centella asiatica* (Linn.) Urban	Apiaceae	Herb	*Badmaina*	Useful in stomach disorder, used as a brain tonic and act against conjunctivitis and eye irritation
NRF/UM/US/93	*Abroma augusta* (Linn.) Linn. f.	Sterculiaceae	Scrub	*Dieng-tyrkhum*	The root bark is used as an emmenagogue and uterine tonic. The powdered root is an abortifacient and anti-fertility agent. Used in intra-uterine diseases and other gynecological disorders
NRF/UM/US/ 94	*Houttuynia cordata* Thunb.	Saururaceae	Herb	*Ja-myrdoh*	Leaves are used as spice and roots, and leaves are used for *chutney* preparation.
NRF/NP/TP/95	*Bauhinia purpurea* Linn.	Ceasalpineaceae	Shrub	*Dieng-long (K) Bol –Megong(G)*	Stem warts are edible; Leaves are used as fodder for milk yield
NRF/NP/TP/96	*Ficus palmata* Linn.	Moraceae	Tree	*	Fruits are edible raw, the closed flowers/fruits are dried and moistened with water and taken for stomach pain early in the morning
NRF/NP/TP/97	*Phyllanthus fatraenus* Linn.	Phyllantheceae	Herb	*	Plant extract is used to relieve stomach indigestion

NRF/NP/TP/98	*Clerodendrum serratum* Linn.	Verbenaceae	Shrub	*	Flowers are of medicinal value and taken during fever and as a local vegetable/preparation
NRF/NP/TP/99	*Cassia obtusifolia* (L.) Irwin & Barneby	Caesalpiniaceae	Shrub	*Amoora*	Leaves used as fodder; pulp as purgative and is much relished by deer and goats
NRF/NP/TP/100	*Roylea cineria* (D. Don) Baillon	Labiatae	Shrub	*	Medicinally used for the treatment of jaundice, skin diseases, malaria, diabetes, febrifuge, and contusions
NRF/NP/TP/101	*Grewia abutifolia* Linn.	Tiliaceae	Shrub	*	Fruits and roots are used in diarrhea, dysentery, wounds. The bark is astringent, expectorant, and used in cough, skin diseases, clearing hair by local women
NRF/NP/TP/102	*Cassia occidentalis* Linn.	Caesalpiniaceae	Shrub	*	Used in local remedies for skin and hand eruption/disease
NRF/NP/TP/103	*Selaginella velutina* Ces.	Selaginellaceae	Herb	*	Plants were placed on the head as a headache remedy, or were boiled in water and then strained, cooled liquid used as a medicinal eyewash
NRF/NP/MO/104	*Trevesia palmata* Roxb.	Araliaceae	Tree	*Phunlut*, Dieng-Soh-khyntur	The flowers are eaten in Garo hills and are used for fever
NRF/NP/MO/105	*Phoebe attenuata* Nees	Lauraceae	Tree	*Bonsum*	Yields straight boiled, good quality timber, which is a substitute for Teak wood in the local area
NRF/NP/MO/106	*Celtis orientalis* Linn.	Ulmaceae	Tree	*	Fodder plant and used for more milk yield by cattle, the fruits are fermented to get local vinegar (*Sirka*)
NRF/NP/MO/107	*Caryota urens* Linn.	Arecaceae	Tree	*Dieng-klai*	Stem pith boiled, mixed with rice, and cooked for getting a local drink (liquor)
NRF/NP/MO/108	*Smilax zeylanica* Linn.	Smilacaceae	Climber	*	Leaves are used during labor pain and fever in children
NRF/NP/MO/109	*Dicliptera cuneata* Juss.	Acanthaceae	Herb	*	The plant species is a good forage and used to have more milk
NRF/NP/MO/110	*Celastrus paniculatus* Willd.	Celastraceae	Herb	*	The seeds are crushed to get oil which issued in joint pains and leg and temple pain
NRF/NP/MO/111	*Albizia chinensis* (Osb) Merr.	Leguminosae	Tree	*	Wood is used for house construction purposes, furniture, and firewood; a gum of low quality is extracted from the bark mixed with other gums and used as an extender and termite repellent
NRF/NP/MO/112	*Rubia cordifolia* Linn.	Rubiaceae	Shrub	*	Extract from plant roots are used in skin disease, irritation, and also in high fever
NRF/NP/MO/113	*Commelina erecta* Linn.	Commelinaceae	Herb	*	Leaves cooked as a v by local people for stomach pains
NRF/NP/MO/114	*Michelia excelsa* Wall.	Magnoliaceae	Tree	*	Wood is durable, used in furniture and building works, plant species are used in shifting cultivation
NRF/NP/MO/115	*Indigofera hebepetala* (Benth)	Fabaceae	Shrub	*	Flowers are used for yielding dye by local people
NRF/NP/DS/116	*Rubus indicus* Thunb.	Rosaceae	Shrub	*Soh-piro*	Ripe fruits are eaten raw
NRF/NP/DS/117	*Crassocephalum crepidioides* (Benth.) S. Moore	Asteraceae	Herb	*	Leaf paste is applied on cuts and wounds for healing

Table 3. List of dominant Plant families of Nongkhyllem Reserve Forest, Nongpoh, Meghalaya, India

Family	Genera	Species	Group
Asteraceae	6	6	I
Euphorbiaceae	6	6	
Rubiaceae	5	5	II
Acanthaceae	3	4	
Fagaceae	4	4	III
Lauraceae	4	4	
Verbenaceae	4	4	
Labiatae (Lamiaceae)	4	4	
Ceasalpineaceae	3	3	
Moraceae	3	3	IV
Poaceae	3	3	
Smilacaceae	3	3	
Urticaceae	3	3	
Adiantaceae	2	2	V
Apiaceae	2	2	
Araceae	2	2	
Clusiaceae	2	2	
Combretaceae	2	2	
Cyperaceae	2	2	
Dryopteridaceae	2	2	
Leguminosae	2	2	
Magnoliaceae	1	2	
Malvaceae	2	2	
Polygonaceae	2	2	
Salicaceae	2	2	
Selaginellaceae	2	2	
Solanaceae	2	2	
Sterculiaceae	2	2	
Zingiberaceae	2	2	
Alangiaceae	1	1	
Amaranthaceae	1	1	
Anacardiaceae	1	1	
Apocynaceae	1	1	
Araliaceae	1	1	VI
Artocarpaceae	1	1	
Aspleniaceae	1	1	
Balsaminaceae	1	1	
Boraginaceae	1	1	
Celastraceae	1	1	
Commelinaceae	1	1	
Costaceae	1	1	
Dennstaedtiaceae	1	1	
Dioscoriaceaeegetable	1	1	
Dipterocarpaceae	1	1	
Elaecarpaceae	1	1	
Liliaceae	1	1	
Lythraceae	1	1	
Melastomaceae	1	1	
Meliacaea	1	1	
Menispermaceae	1	1	
Mimosaceae	1	1	
Papilionaceae	1	1	
Piperaceae	1	1	
Polypodiaceae	1	1	
Pteridaceae	1	1	
Rosaceae	1	1	
Rutaceae	1	1	
Saururaceae	1	1	
Sonneratiaceae	1	1	
Theaceae	1	1	
Thymelaeaceae	1	1	
Tiliaceae	1	1	
Ulmaceae	1	1	
Total	116	117	6

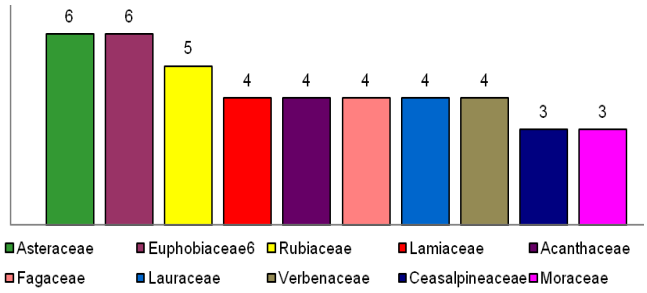

Figure 3. Top ten dominating plant families in Nongkhyllem Reserve Forest, Nongpoh, Meghalaya, India

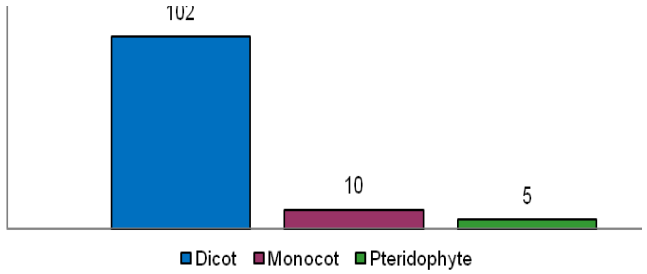

Figure 4. Distribution of some valuable wild plant species in Nongkhyllem Reserve Forest, Nongpoh, Meghalaya, India

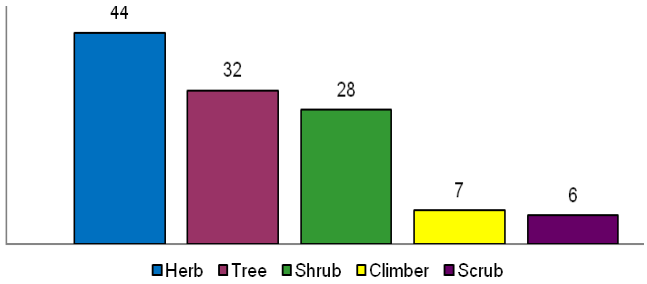

Figure 5. Habit wise distribution of some beneficial wild plant species in Nongkhyllem Reserve Forest, Nongpoh, Meghalaya, India

Considering the importance of natural forest plant species, the present investigation was carried out to see the endomycorrhizal association and diversity from the rhizospheres of the wild forest plant species and exploit them for better quality stock production *vis-a-vis* their conservation. The endomycorrhizal association and diversity from the rhizospheres of the wild forest plant species have been published (Parkash 2020). Hence, only the ethnic perspective on wild forest plant species of Nongkhyllem Reserve has been published, and also Forest, Nongpoh, has been discussed in this manuscript.

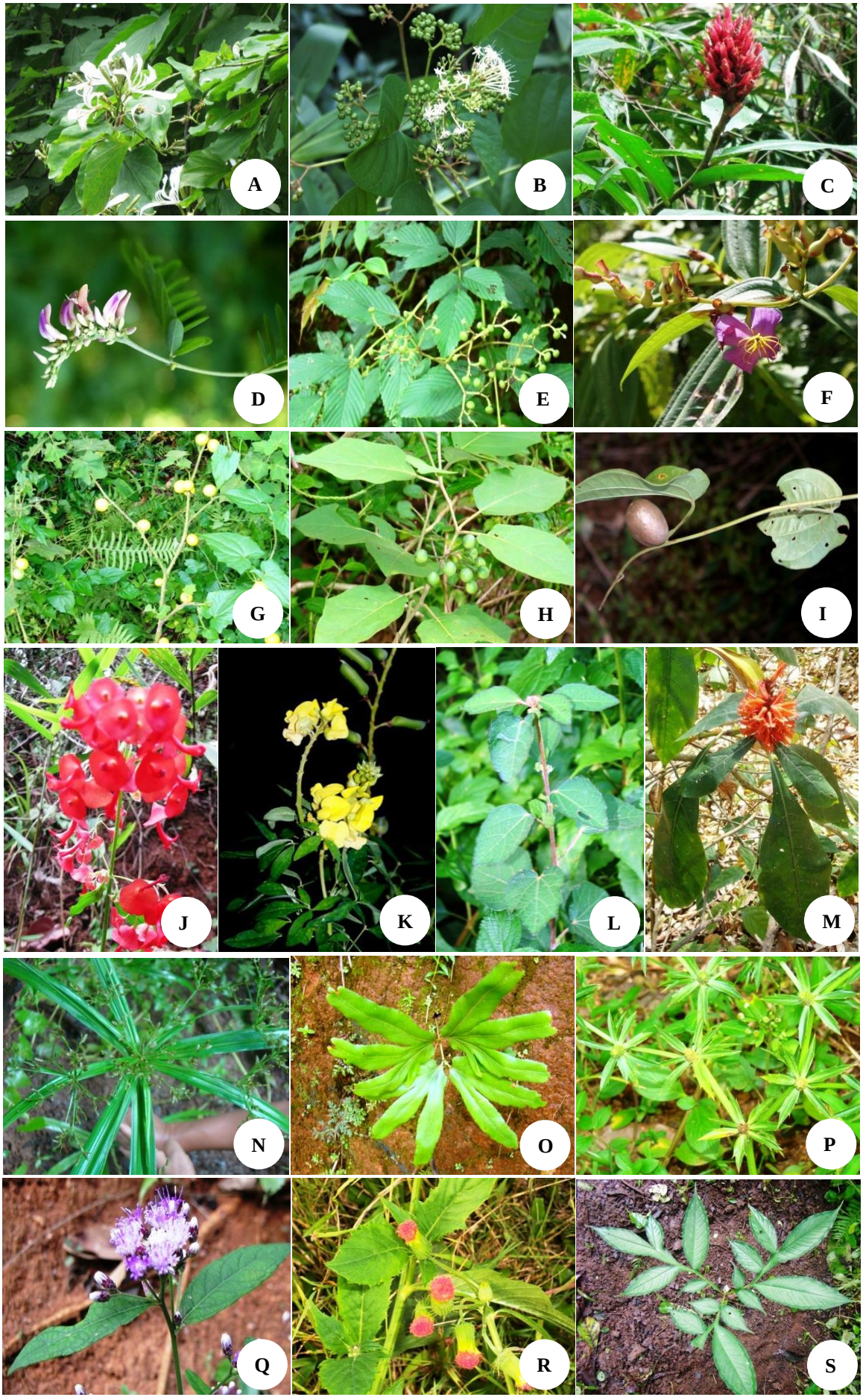
A
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Figure 6. A. *Bauhinia purpurea*, B. *Clerodendrum coolebrokianum*, C. *Costos speciosa*, D. *Indigofera hebepetala*, E. *Leea sambuciana*, F. *Melastoma malabathricum*, G. *Solanum khasianum*, H. *Solanum turbum* I. *Dioscorea bulbefera*, J. *Holmskioldia sanguinea*, K. *Crotolaria juncea*, L. *Sida cordifolia*, M. *Phlogacanthus thyrsiflorus*, N. *Cyperus involcuratus*, dwarf umbrella sedge, O. *Pteris cretica* (Ribbon fern), P. *Eryngium foetidum*, Q. *Hypoestis* species, R. *Crassocephalus crepidioides*, S. *Amorphophallus Blume* ex Decne, T. *Impatiens balsamina*, U. *Leucas cephalotus*, V. *Peperomia pellucida*, W. *Nephrodium* species, X. *Polypodium* sp., Y. *Selaginella exalta*, Z. *Adiantum tenerum*, AA. *Elephantopus scaber*, AB. *Polystichium* species

In conclusion, the baseline information generated from this study on wild forest plant species usage by the *Khasi* ethnic group needs a thorough scientific and additional phytochemical investigation. The ethnic groups have good knowledge of medicinal plants and their traditional conservation of plant species. Therefore, the knowledge on depleting wild and natural plant resources could help create mass awareness regarding the need to preserve plants and promote ethno-medico-botany expertise within the region. Traditional knowledge contributes to protecting and conserving those wild economically important plant species that are nearing their threshold. We must conserve our floral and faunal diversity before they are lost irrevocably.

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Diversity of plants used for non-medicinal purposes by the traditional communities of Coastal Karnataka, India

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Abstract. *Bhandary JM. 2021. Diversity of plants used for non-medicinal purposes by the traditional communities of Coastal Karnataka, India. Asian J Ethnobiol 4: 106-114.* The Coastal Karnataka region of India, comprising of two districts called Dakshina Kannada and Udupi, is ethnobotanically prosperous owing to its floristic and cultural diversity. This is justified because many ethnobotanical studies have been reported from this area. However, all these studies are concerned only with documentation of traditional knowledge and medicinal plant diversity; the various non-medicinal uses of plants have not received any scientific attention so far. Therefore, this study was undertaken to document the diversity of plants used for edible, piscicidal, and fodder purposes and make different household materials. Plant specimens and associated traditional information were gathered from the knowledgeable elders from other areas' different indigenous tribal and non-tribal communities. Prior-informed, open-ended interviews, and discussions were conducted with 32 purposively chosen informants in the field during different seasons of the study period. The botanical identity of the plants mentioned as applicable by informants was confirmed with the help of local flora, and enumeration of plant species was done based on the user category. A total of 125 species of angiosperm plants used for non-medicinal purposes by different traditional and tribal communities were documented during the present study. Among them, 116 species were used for any of the above four studied purposes, and only nine species were used for two different purposes. As many as 76 species were used for edible purposes, 18 species as piscicides, 21 species as fodder plants, and 19 species used to make baskets, mats, and other traditional artifacts used in daily lives. This study confirmed that the traditional communities of the study locality have considerable traditional knowledge about non-medicinal uses of local plants. However, the practical use of wild plants for the studied traditional purposes has gradually decreased due to a lack of interest in the newer generation and the availability of modern alternatives.

Keywords: Coastal Karnataka, edible plants, fodder plants, material culture, piscicidal plants, traditional plant uses

INTRODUCTION

The indigenous people's understanding of local plants has manifested itself in several ways, including using them as sources of medicine, food, fiber, fodder, and various other essential artifacts that form part of their material culture. This traditional knowledge, gained by the indigenous communities as a result of their continued interactions with nature, is an integral part of human cultural heritage, much of which is currently threatened and on the verge of disappearing due to environmental changes, livelihood diversification, and the influence of cultural conflicts (Cao et al. 2020). Loss of such precious traditional wisdom is permanent and irreversible as it is only orally transmitted over generations of traditional communities without any written accounts. Thus, the exploration and documentation of the local traditional knowledge are of utmost importance in any part of the world.

The documentation of ethnobotanical knowledge about the medicinal uses of plants has received considerable scientific attention in India (Pushpangadan and George 2010, Pathak and Bharati 2020). On the contrary, only a few studies have been undertaken to record the non-medicinal uses of plants (Choudhary et al. 2008; Sasi and Mohan 2018; Saini and Sood 2018; Lokhande 2020). This is true also for the Coastal regions of Karnataka, a southern state of India. Several ethnic-medico-botanical reports are available from this area (Bhandary 2020; Bhandary and Chandrashekar 2001, 2003, 2011; Bhandary et al. 1995, 1996; Harsha et al. 2003, 2006). As many as 342 species of plants have been reported to be used for various ethnomedicinal purposes by the different indigenous communities of this region (Bhandary and Chandrashekar 2014). However, the non-medicinal aspects of the ethnobotany of this area have not received any scientific attention so far. They remain entirely unknown. Therefore, this study was undertaken to catalog the diversity of plants used for non-medicinal purposes such as edible, piscicidal, fodder, and making different household artifacts by the traditional communities of Coastal Karnataka, India.

MATERIALS AND METHODS

Study area and its traditional people

Dakshina Kannada and Udupi are the two coastal districts of Karnataka State, India, constituting 8441 km^2. They are located between 12°29'36'' and 13°49'22'' N latitudes, and 74°37'24'' and 75°41'00'' E longitudes (Figure 1). The 136 km long stretch of coastline facing the Arabian Sea forms the western edge of these districts,

while the towering heights of the unbroken sweep of the Western Ghats mark their eastern boundary.

Together with the northern part of the adjoining Kasaragod district of Kerala State, these two districts constitute a historical and cultural landscape called the *Tulunadu* (land of Tulu) because of the dominance of traditional communities speaking a language called *Tulu*. These districts are the home for several tribal and other indigenous communities such as the *Billavas, Bunts, Idigas, Mogaveers, Gowdas, Koragas, Malekudiyas, Kunabis, Maratis*, and others who have maintained a close association with the components of nature in their surroundings.

The total population of these two districts was 32,67,010 (Census of India 2011). The area is still predominantly rural and agricultural, with about 80 % of the workforce employed in agriculture and allied activities, including coconut cultivation, areca nut, and other horticultural products. More than 70 % of cropland is under cereals, with rice as the principal crop. Fishing is the other significant traditional livelihood activity, with about 1,00,000 people directly engaged in fishing. This region receives rain in the range of 2,500-3,0,00 mm; heavy rainfall harbors different vegetation types such as littoral,

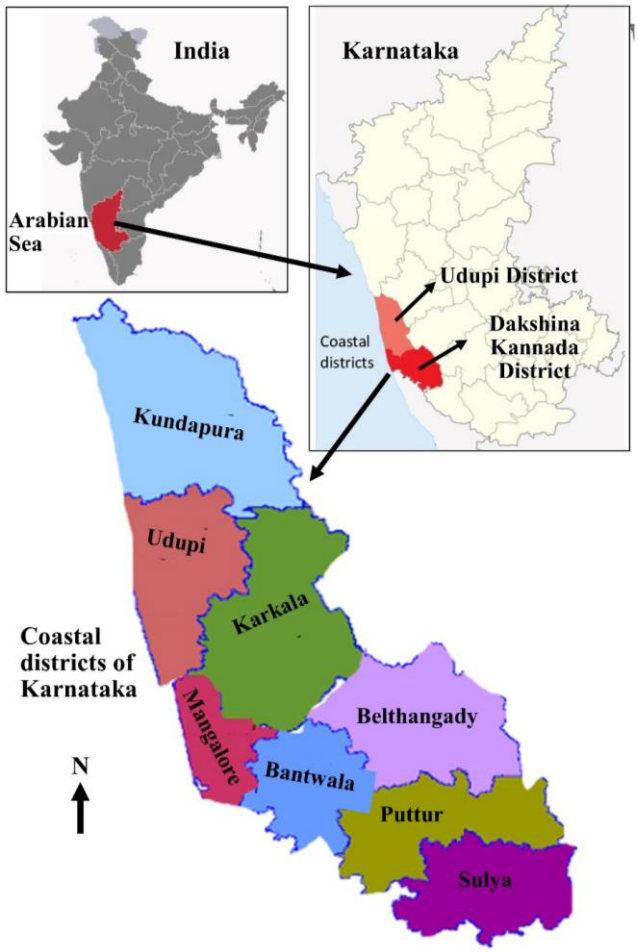

Figure 1. Map of the coastal district of Karnataka State, India

Scrub, moist deciduous, and typical evergreen. The littoral and the scrub forests are found along the coastal belt, the moist deciduous forests mainly in the inland plateaus extending to the foot of the ghats, and the evergreen forests localized only in the ghats. The floristic diversity of this region has been sufficiently studied and documented (Gamble 1967; Bhat 2003).

Data collection and analysis

Information regarding the plants used for edible, piscicidal, fodder, and making household artifacts was gathered from the knowledgeable elders belonging to the different indigenous communities, including two tribes, namely the *Koraga* and the *Malekudiya*, residing in the study area. This study was an extended part of an ongoing comprehensive ethnobotanical documentation project started in the study area in 1995, resulting in many publications (Bhandary et al. 1995, 1996; Bhandary and Chandrashekar 2001, 2003, 2011, 2014; Bhandary 2020). Data collection was made through prior-informed interviews and discussions with informants in the field during different seasons of the study period. A total of 32 people, including 27 males and 5 females, were selected as informants to represent other study area locations. These informants were chosen based on the opinion and recommendations of the community and village heads. The mean age of all informants was 63 years.

The selected informants were contacted and convinced about the objectives of the study. Prior oral consents were also obtained from them. Later, they were repeatedly taken to the nearby forest patches and other locations where useful plants were available, and open-ended discussions and interviews gathered data. Simultaneous to recording information on uses, additional related information such as common names, parts used, and methods of use of the plants were also recorded. Herbarium materials of the plants were gathered for botanical identification. They were identified with the help of local floras (Gamble 1967; Bhat 2003; Bhat 2014) and deposited in the Herbarium of the Department of Applied Botany, Mangalore University. Information gathered in the field was analyzed for enumeration and comparison of plant uses for different non-medicinal purposes, and the list of plants was presented in tabular form.

RESULTS AND DISCUSSION

A total of 125 species of angiosperm plants used for edible, piscicidal, fodder, and artifact-making purposes by different traditional and tribal communities of the study area were documented during the present study. Several plant species, genera, and families used for each of these other purposes are summarized in Table 1.

As many as 116 of the 125 species were used for only one of the four purposes, whereas nine species were used for two different purposes. *Bambusa bambos* (L.) Voss (Poaceae), *Borassus flabellifer* L. (Arecaceae), *Pandanus odorifer* (Forssk.) Kuntze (Pandanaceae) and *Smilax zeylanica* L. (Smilacaceae) were used for their edible parts

and also for making artifacts like baskets, containers, and mats. However, the components used for each of the purposes were generally different. Fresh fruits of *Borassus flabellifer* and *Pandanus odorifer* were edible while their dried leaves were employed for making baskets and mats.

Similarly, *Asparagus racemosus* Willd. (Asparagaceae), *Ficus racemosa* L. (Moraceae), *Maranta arundinacea* L. (Marantaceae) and *Xylia xylocarpa* (Roxb.) Taub. (Fabaceae) were used both for edible and fodder purposes. *Merremia umbellata* (L.) Hall. f. (Convolvulaceae) was used as fodder and as raw material for weaving baskets.

Plants used for edible purpose

As shown in Table 2, people of Coastal Karnataka used different parts of 65 species of plants for edible purposes. This list excludes popularly cultivated vegetable and fruit plants.

Fruits, leaves, tubers, and rhizomes were the commonly used edible parts. Fruits were generally eaten fresh in raw form while other factors like leaves and tubers were consumed, usually after cooking. Analysis indicated that fruits/seeds were the most widely used edible part (54%), followed by leaves (16%), stems/rhizomes (6%), and tubers (6%). In 18% of plants, more than one part of the same plant was used for edible purposes.

A total of 71 plant species belonging to 63 genera and 39 families have been recorded as wild edibles in a study conducted with the Gond tribe of Maharashtra, India (Lokhande 2020). Fruits were the widely used edible part (43.2%), followed by leaves (22%). Communities of Udhampur district, Jammu & Kashmir, India, used 90 plant species belonging to 45 families and 78 genera for edible purposes (Bhatia et al. 2018). However, in this study, the maximum number of species were used as vegetables (46 species), followed by fruits (37 species).

A notable feature of the traditional use of wild edible plants in Coastal Karnataka was that some plants have to be customarily consumed during specific seasons or some specific cultural occasions. For example, a tender stem of *Bambusa bambos* (L.) Voss, locally called *kanile*, and leaves of *Colocasia esculenta* (L.) Schott. (*kesu* or *thevu*), *Senna tora* (L.) Roxb. (*tajank*) and *Remusatia vivipara* (Roxb.) Schott. (*mara kesu* or *mara thevu*) They were invariably consumed during *aati*, the fourth month in the Tulu calendar coinciding with the July/August months of the English calendar. These plants generally considered good for health were collected from the wild for personal use by families and were also sold in the local markets of the study area during this season (Figure 2). Aati month is generally considered an inauspicious month in Coastal Karnataka with some prohibitions and restrictions. It is also associated with other local traditional practices like mass drinking of a decoction prepared from the stem bark of *Alstonia scholaris* (L.) R. Br. (Apocynaceae) are believed to be improving immunity (Bhandary 2020).

The leaves of *Senna tora* were used to treat leprosy, ringworm, flatulence, colic, dyspepsia, constipation, cough, bronchitis, and cardiac disorders in the Ayurvedic systems medicine (Mazumder 2005). Phyto-pharmacological studies of *Colocasia esculenta* have proved its antimicrobial, antihepatotoxic, anti-cancer, antioxidant, antibacterial, antifungal, anthelmintic, antidiabetic, hypolipidemic, anti-melanogenic, estrogenic, and neuropharmacological effects (Pawar et al. 2018, Sudhakar et al. 2020). Leaves of *Remusatia vivipara* have a high anti-oxidant activity (Asha et al., 2013). Many of the other plants used for edible purposes are also reported to be having various ethnomedicinal uses in coastal Karnataka (Bhandary and Chandrashekar 2014). All this scientific evidence indirectly endorse using many of the above plants as seasonal foods to promote health.

Table 1. Number of plant species, genera, and families used for different non-medicinal purposes by traditional communities of Coastal Karnataka, India

Use purpose	Number of species used	Number of genera	Number of families
Edible	76	62	41
Piscicidal	18	18	15
Fodder	21	18	13
Making of household artifacts	19	19	16

Table 2. List of plants used by traditional communities of Coastal Karnataka, India for edible parts

Name of the species and Family	Local name(s)	Part(s) used	Method of use
Aglaia elaegnoidea (A. Juss.) Benth. (Meliaceae)	Pucche parndu	Fruit	Raw
Alangium salvifolium (L.f.) Wangerin (Alangiaceae)	Ankole hannu, mullankole	Fruit	Raw
Alocasia macrorrhizos (L.) G. Don (Araceae)	Mundi kesu	Tuber	Cooked
Alternanthera sessilis (L.) R. Br. Ex DC. (Amaranthaceae)	Honagonne	Leaf, stem	Cooked
Amaranthus spinosus L. (Amaranthaceae)	Mullu harive, mullu padpe	Leaf, stem	Cooked
Amaranthus tricolor L. (Amaranthaceae)	Harive, padpe	Leaf, stem, seed	Cooked
Artocarpus altilis (Parkinson ex F.A.Zorn) Fosberg (Moraceae)	Deevi halasu, deegujje	Fruit	Cooked
Artocarpus gomezianus Wall ex. Trec. (Moraceae)	Hebbalasu, pejakkayi	Fruit	Cooked
Asparagus racemosus Willd. (Asparagaceae)	Halavu makkala beru, udri kande	Tuber	Cooked
Atalantia monophylla (Roxb.) DC. (Rutaceae)	Kaadu nimbe, kaipe puli	Fruit	Raw
Bambusa bambos (L.)Voss (Poaceae)	Bidiru, kanile	Tender stem	Cooked
Basella alba L. (Basellaceae)	Basale	Leaf, stem	Cooked

Boehravia diffusa L. (Nyctaginaceae)	Nela komme, teglame	Leaf	Cooked
Borassus flabellifer L. (Arecaceae)	Thaale, thaari	Fruit	Raw
Bulbophyllum sterile (Lam.) Suresh (Orchidaceae)	Marabaale	Petiole	Cooked
Caesalpinia mimosoides Lam. (Fabaceae)	Kengige, chimullu	Tender leaf, seed	Cooked
Canna indica L. (Cannaceae)	Baare poo	Rhizome	Cooked
Canthium coromandelicum (Burm. F.) Alston (Rubiaceae)	Kaare kayi, adkaare	Fruit	Raw/cooked
Centella asiatica (L.) Urban (Apiaceae)	Ondelaga, thimare	Leaf	
Centrosema pubescens Benth. (Fabaceae)	Kadu alasande	Fruit	Cooked
Cheilocostus speciosus (J. Koen.) C. Specht (Costaceae)	Naayi karmbu	Leaf	Cooked
Cissus quadrangularis L. (Vitaceae)	Mangaravalli, sanduballi	Stem	Cooked
Cleome viscosa L. (Cleomaceae)	Kaadu sasive, santhemi	Leaf	Cooked
Colocasia esculenta (L.) Schott. (Araceae)	Kesu, thevu	Leaf, corm	Cooked
Cordia dichtoma Forst.f. (Boraginaceae)	Mannadake, challehannu	Fruit	Raw
Cynodon dactylon (L.) Pers (Poaceae)	Kadikke	Leaf	Cooked
Dioscorea alata L. (Dioscoreaceae)	Mudigenasu, soona kereng	Tuber, bulbil	Roasted/cooked
Dioscorea hispida Dennst. (Dioscoreaceae)	Nore	Tuber	Roasted/cooked
Dioscorea oppositifolia L. (Dioscoreaceae)	Nore	Tuber	Roasted/cooked
Elaeagnus conferta Roxb. (Elaeagnaceae)	Halage hannu	Fruit	Raw
Entada rheedei Spremg Spreng (Fabaceae)	Palle	Seed	Cooked
Ficus racemosa L. (Moraceae)	Atthi, arthi	Fruit	Raw/cooked
Flacourtia indica (Burm.f.) Merr. (Salicaceae)	Mullu hannu	Fruit	Raw
Flacourtia montana Graham (Salicaceae)	Abbalu hannu, arpu parnd	Fruit	Raw
Garcinia indica Thouars) Choisy (Clusiaceae)	Murgala, punarpuli	Fruit	Raw
Garcinia xanthochymus Hook. F. ex. T. Anderson (Clusiaceae)	Jarige	Fruit	Raw
Glycosmis pentaphylla (Retz) DC. (Rutaceae)	Pandilu	Fruit	Raw
Hibiscus cannabinus L. (Malvaceae)	Pundi soppu	Leaf	Cooked
Hibiscus hispidissimus Griff. (Malvaceae)	Kaira puli	Tender leaf, fruit	Cooked
Hibiscuss rosa-sinensis L. (Malvaceae)	Dasavala	Leaf, flower	Cooked
Holigarna ferruginea Marchand (Anacardiaceae)	Holegeru, chere	Tender leaf	Cooked
Hugonia mystax L. (Linaceae)	Ankole,	Fruit	Raw
Ixora coccinea L. (Rubiaceae)	Kiskaara, kepula	Fruit	Raw
Madhuca longifolia (L.) J.F. (Sapotaceae)	Irpe	Flower, seeds	Cooked
Momordica dioica Roxb. ex. Willd. (Cucurbitaceae)	Mada haagala, kaat kanchel	Fruit, root	Cooked
Maranta arundinacea L. (Marantaceae)	Koove	Rhizome	Cooked
Melastoma malabathricum L. (Melastomataceae)	Nekkarika, nekkare	Fruit	Raw
Moringa oleifera Lam. (Moringaceae)	Nugge, nurge	Leaf, fruit	Cooked
Musa paradisiaca L. (Musaceae)	Baale, baare	Stem	Cooked
Oxalis corniculata L. (Oxalidaccae)	Puliyarile, pullampuruche	Leaf	Cooked
Pandanus odorifer (Forssk.) Kuntze (Pandanaceae)	Mundovu, mundige, kedige	Fruit	Raw
Persicaria chinensis (L.) H. Gross (Polygonaceae)	Nelagumbala, bili konde	Leaf, root	Cooked
Physalis angulata L. (Solanaceae)	Guppate	Fruit	Raw
Portulaca oleracea L. (Portulacaceae)	Goli soppu, goli padpe	Leaf	Cooked
Remusatia vivipara (Roxb.) Schott. (Araceae)	Mara kesu, mara thevu	Leaf, rhizome	Cooked
Salacia chinensis L. (Celastraceae)	Ekanayaka	Fruit	Raw
Schleichera oleosa (Lour.) Merr. (Sapindaceae)	Chakate kayi	Fruit	Raw
Senna sophera (L.) Roxb. (Fabaceae)	Kaasamarda	Leaf	Cooked
Senna tora (L.) Roxb. (Fabaceae)	Tajank	Leaf	Cooked
Smilax zeylanica L. (Smilacaceae)	Chennere balli, chennere booru	Fruit	Raw/cooked
Solanum americanum Mill. (Solanaceae)	Kooki	Fruit	Raw
Solanum lasiocarpum Jacq. (Solanaceae)	Mullu badane	Fruit	Cooked
Solanum torvum Sw. (Solanaceae)	Kudane	Fruit	Cooked
Solena heterophylla Lour. (Cucurbitaceae)	Karvolu	Fruit	Raw
Spondias pinnata (L.F) Kurz. (Anacardiaceae)	Ambate	Fruit	Raw/cooked
Sterculia foetida L. (Malvaceae)	Peenari, atte kayi	Seed	Roasted
Syzygium caryophyllatum (L.) Alston (Myrtaceae)	Kuntanerale, kuntangeru	Fruit	Raw
Syzygium cumini (L.) Skeels (Myrtaceae)	Nerale	Fruit	Raw
Tamilnadia uliginosa (Retz.)Tirv. & Sastre (Rubiaceae)	Adka bare	Fruit	Raw
Terminalia bellirica (Gaertn.) Roxb. (Combretaceae)	Shaanthi kaayi	Seed	Raw
Toddalia asiatica (L.)Lam. (Rutaceae)	Are madala	Fruit	Raw
Xylia xylocarpa (Roxb.) Taub (Fabaceae)	Jamba, chirve	Seed	Cooked
Zanthoxylum rhetsa (Roxb.) DC. (Rutaceae)	Jummana kaayi, kaavate, gaamate	Fruit	Raw/cooked
Ziziphus mauritiana Lam. (Rhamnaceae)	Bore hannu	Fruit	Raw
Ziziphus oenoplia (L.) Mill (Rhamnaceae)	Choorimullu	Fruit	Raw
Ziziphus rugosa Lam. (Rhamnaceae)	Kotte mullu, kotte parndu	Fruit	Raw

Plants used as piscicides

Fishes form an essential component of the people's food of Coastal Karnataka. Rural folk used a variety of local plants either to kill or stupefy fishes, in addition to different types of fish traps, in their fishing activity. These piscicidal plants were commonly employed to catch fishes from shallow and stagnant freshwater bodies, such as ponds, pools, and streams. In this primitive method of fishing, a sufficient quantity of crushed or finely chopped plant material was added to water which was then thoroughly churned—this action aids in releasing ichthyotoxic substances from the plant material to moisture. Fishes killed or inactivated by the activity of such substances were then either handpicked or collected using nets or fish traps. Eating such fish was claimed harmless to the human body. Plants commonly used as piscicides by the people of Coastal Karnataka are listed in Table 3.

Figure 2. Species of wild edible plants commercially sold in the markets of coastal Karnataka, India. A. Leaves of *Senna tora* (Local Name: *Tajank*), B. Leaves of *Colocasia esculenta* (Local Name: *Thevu*) and tender shoots of *Bambusa bambos* (Local Name: *Kanile*) placed one above the other, and C. Leaves of *Remusatia vivipara* (Local Name: Mara thevu)

Table 3. Plants used as piscicides by traditional communities of Coastal Karnataka, India

Name of species and family	Local name(s)	Part(s) used
Adenia hondala (Gaertner) W.J. de Wilde (Passifloraceae)	Irolu kande	Root
Allophyllus rheedii (Wight) Radik. (Anacardiaceae)	Mooji kabar tappu	Fruit
Anamirta cocculus (L.) Wt. & Arn. (Menispermaceae)	Chiplu kotte	Seed
Barringtonia racemosa (L.) Spreng. (Lecythidaceae)	Samudra phala	Fruit / Stem bark
Canthium coromandelicum (Burm. F.) Alston (Rubiaceae)	Kaare	Fruit
Catunaregam spinosa (Thunb.) Tirvengadum (Rubiaceae)	Kaare	Fruit
Cerbera odollam Gaertner (Apocynaceae)	Thende	Fruit
Croton tiglium L. (Euphorbiaceae)	Jaapala, Byari bithu	Fruit
Derris scandens (Roxb) Benth. (Fabaceae)	Madengi booru	Stem
Euphorbia neriifolia L. (Euphorbiaceae)	Kalli	Stem
Falconeria insignis Royle (Euphorbiaceae)	Kanappati	Stem
Guidonia esculenta (Roxb.) Baill (Salicaceae)	Modia	Stem bark
Hopea parviflora Beddome (Dipterocarpaceae)	Karmar	Stem bark
Hydnocarpus pentandra (Buch.-Ham.) Oken (Achariaceae)	Soorante	Fruit
Pandanus kaida Kurz (Pandanaceae)	Mundovu	Fruit
Piper nigrum L. (Piperaceae)	Adde munchi	Stem
Sapindus trifoliatus L. (Sapindaceae)	Narvolu	Fruit
Strychnos nux-vomica L. (Loganiaceae)	Kayer	Fruit

The Malai Pandaram tribals living in the Achankovil River basin of Kerala, India, used as many as 41 plant species belonging to 33 genera and 18 families for piscicidal purposes (Sasi and Mohan 2018), while tribals of Nagaland used only 17 species (Dominic and Ramanujam 2012). A review of ethnobotanical reports of plants used as piscicides has revealed that as many as 307 species of plants are used for this purpose in the whole of India (Jawale 2018). Out of the 18 species used in Coastal Karnataka, 11 species have already been used in other parts of India as piscicides, supporting their piscicidal property. The remaining seven species, namely *Adenia hondala* (Gaertner), W.J. de Wilde (Passifloraceae), *Allophyllus rheedii* (Wight) Radik. (Anacardiaceae), *Canthium coromandelicum* (Burm. F.) Alston (Rubiaceae), *Hopea parviflora* Beddome (Dipterocarpaceae), *Hydnocarpus pentandra* (Buch.-Ham.) Oken (Achariaceae), *Pandanus kaida* Kurz (Pandanaceae), and *Piper nigrum* L. (Piperaceae) are reported for the first time in this study.

Plants used in material culture

Material culture has been generally defined as the full range of objects produced by a particular society, including functional items such as tools, shelters, clothing, and more decorative arts and handicrafts (Bahru et al., 2012). Throughout the world, plants are the basis of human material culture. Most indigenous societies which traditionally have lacked the metals and synthetic materials ubiquitous in modern society rely almost entirely on plants for their material needs. The number and variety of uses to which indigenous people put plants are astonishing, ranging from woven cords and plant adhesives of sufficient strength to hold large ocean-going rafts together to arrow poisons (Balick and Cox 1996). According to Cotton (1996), although synthetic products have an increasing influence on the material culture of traditional societies, plants remain vital to many aspects of traditional life.

Various containers and baskets woven from plant parts were used as household articles in Coastal Karnataka. Processed fibrous stems of woody climbers such as *Getonia floribunda* Lam. (Combretaceae), *Pristimera indica* (Willd), A.C. Sm. (Celastraceae), and *Calamus rotang* L. (Arecaceae) were the mainly used plant materials. Mats woven from dried and processed leaves of *Pandanus odorifer* and *Borassus flabellifer* were used in most traditional houses. A complete list of these and other plants used in basket making and other weaving practices is given in Table 4.

Weaving baskets, containers, and mats from plants and supplying them to the peasant communities was the main life-sustaining occupation of one of the tribes of Dakshina Kannada, the *Koragas*. Both men and women of this tribe participate in gathering the plant materials from the nearby forests, processing them, and weaving the artifacts (Figure 3). In the olden days, these products were directly supplied to the farmers in exchange for foodstuffs. However, presently, they are sold through middlemen in the local market for monetary prices.

The indigenous agrarian communities of Coastal Karnataka prepared and used a variety of implements widely used in their agricultural activities, from plants. Plowing tools such as *noga*, *naayer*, and *palaya* were made from the wood of commonly growing and easily accessible trees like *Anacardium occidentale* L. (Anacardiaceae), *Mangifera indica* L. (Anacardiaceae), and *Strychnos nux-vomica* L. (Loganiaceae). These implements formed an intimate part and parcel of most of the rural agricultural houses and occupied a place of honor in the cultural life of the local people.

Table 4. Plants used for making baskets, mats, and such other artifacts by the traditional communities of Coastal Karnataka, India

Name of species and family	Local name(s)	Part(s) used
Acacia pennata (L.) Willd. (Fabaceae)	Chende	Stem
Bambusa bambos (L.)Voss (Poaceae)	Bedru, Bidiru	Stem
Borassus flabellifer L. (Arecaceae)	Thaari	Leaf
Bridelia stipularis (L.) Blume (Phyllanthaceae)	Banda naru	Stem
Calamus rotang L. (Arecaceae)	Bettha	Stem
Careya arborea Roxb. (Lecythidaceae)	Daddala	Stem bark
Caryota urens L. (Arecaceae)	Indu	Stem, Leaf
Dalbergia volubilis Roxb. (Fabaceae)	Parantolu	Stem
Getonia floribunda Lam. (Combretaceae)	Enjir	Stem
Helicteres isora L. (Malvaceae)	Kayyolu naar	Stem
Ichnocarpus frutescens (L.) W. T. Aiton (Apocynaceae)	Per ballu	Stem
Jasminum malabaricum Wt. (Sphenocleaceae)	Adroli	Stem
Leea indica (Burm.f.) Merr. (Vitaceae)	Nedil	Stem
Merremia umbellata (L.) Hall. f. (Convolvulaceae)	Kulovu	Stem
Pandanus odorifer (Forssk.) Kuntze (Pandanaceae)	Mundovu	Leaf
Pristimera indica (Willd) A. C. Sm. (Celastraceae)	Maderi	Stem
Smilax zeylanica L. (Smilacaceae)	Chennere ballu	Stem
Strychnos wallichiana Steud. ex. DC. (Loganiaceae)	Ballu Kayer	Stem
Uvaria narum (Dunal) Wall. Ex Wight & Arn. (Annonaceae)	Kari maderi	Stem

In addition, they also followed an indigenous system of measuring their agricultural produces. Different types of wooden containers of a fixed volume known variously as *paavu, konde, balla,* and *kalase* were employed in this measurement system (Figure 4). Hollow stems of *Bambusa bambos*, the bole of palms like *Borassus flabellifer* and *Caryota urens*, and the branch of *Calamus rotang* were the primary plants from which such articles are made.

Plants used as fodder

Agriculture with animal husbandry is the predominant traditional livelihood of the study area. Livestock relies mainly on fresh fodder extracted from local ecosystems. In the domestic cattle-rearing practice of Coastal Karnataka, a variety of local plants were used as fodder and galactagogues. Parts of these plants were fed to cattle, either in raw form or after cooking and mixing with other materials like paddy husk or rice-bran. A list of commonly used fodder and galactogenic plants is given in Table 5. These species comprise a mix of trees, shrubs, and herbs and are available during different seasons. This ensures an uninterrupted supply of fodder to livestock throughout the year (Rashid 2012).

Figure 3. A basket prepared from the stems of *Pristimera indica,* locally called maderi (A), and a Koraga tribal weaving basket from processed branches of *Getonia floribunda* (locally called enjir, B)

Table 5. Plants used as fodder and galactagogues by traditional communities of Coastal Karnataka, India

Name of species and family	Local name(s)	Part(s) used
Albizia lebbeck (L.) Benth. (Fabaceae)	Baage	Leaf
Aporosa cardiosperma (Gaertn) Merr. (Phyllanthaceae)	Saroli	Leaf
Asparagus racemosus Willd. (Asparagaceae)	Udri kande	Tuber
Dillenia pentagyna Roxb. (Dilleniaceae)	Mucchir	Leaf
Dracaena terniflora Roxb. (Asparagaceae)	Kaadu Koove	Leaf
Elephantopus scaber L. (Asteraceae)	Nela mucchir	Entire plant
Ficus racemosa L. (Moraceae)	Arthi, Atti	Leaf
Ficus hemicordata Buch.-Ham. (Moraceae)	Arthi, atti	Leaf
Flemingia strobilifera (L.) W. T. Aiton (Fabaceae)	Kankuta	Entire plant
Ipomoea batatas (L.) Hallier (Convolvulaceae)	Genasu, Kereng	Entire plant
Ipomoea mauritiana (L.) Hallier (Convolvulaceae)	Nela genasu, Nela Kereng	Entire plant
Lagenandra toxicaria Dalzel (Araceae)	Neer Koove	Leaf
Maranta arundinacea L. (Marantaceae)	Koove	Leaf
Merremia tridentata (L.) Hall. f. (Convolvulaceae)	Kulovu	Stem, Leaf
Merremia umbellate (L.) Hall. f. (Convolvulaceae)	Kulovu	Stem, Leaf
Mussaenda laxa (Hook. F.) Hutch. Ex Gamble (Rubiaceae)	Bolle tappu	Leaf
Pothos scandens L. (Araceae)	Arke	Stem, Leaf
Pterocarpus marsupium Roxb. (Fabaceae)	Honne	Leaf
Sida cordata (Burm.f.) Borss. (Malvaceae)	Kurundoti	Entire Plant
Trema orientalis (L.) Blume (Ulmaceae)	Bedikeri	Leaf
Xylia xylocarpa (Roxb.) Taub. (Fabaceae)	Jambe	Leaf

Figure 4. Traditional wooden measuring instruments of coastal Karnataka, India

In conclusion, the use of as many as 125 species of local wild plants for non-medicinal purposes, such as edible, piscicidal, fodder, and artifact making, by the different traditional and tribal communities of coastal districts of Karnataka, India, indicate that these communities possess a rich wealth of traditional ecological knowledge. Many wild edible plants, including those part of seasonal food customs, have proven nutritional and medicinal advantages.

The art of weaving and artifact making using plant materials, an intimate part of the local tribal material culture, has gradually disappeared. Thanks to various factors, the major ones being the lack of interest among the newer generation, scarcity of plant raw materials, improper marketing system, and the popularity of plastic and other synthetic substitutes. Nonetheless, a revival of tribal interest in this techno-cultural skill with steps, such as training the younger generation, ensuring a sustainable supply of raw materials, and arranging for proper marketing for finished products carry great potential for community development without distancing them from their original culture.

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Short Communication: Do women have a piece of traditional knowledge of medicinal plants? A case study around Jambi Urban Forest, Indonesia

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Abstract. *Novriyanti N, Nursanti N, Wulan C. 2021. Short Communication: Do women have a piece of traditional knowledge of medicinal plants? A case study around Jambi Urban Forest, Indonesia. Asian J Ethnobiol 4: 115-119.* Gender, especially women, significantly affect knowledge, especially maintaining knowledge and practice of medicinal plants. But the question, also will be the research aims is, do they know medicinal plants and grow them themselves in their yards? Data was collected using open and closed interviews with families, including the village shamans. The results showed half of the women around Urban Forest know traditional medicinal plants. Women use 27 plants species to protect and heal their families from minor ailments. Some of the plants found around Urban Forest also plant in their yards; unfortunately, the number of traditional medicinal plant users decreases over time.

Keywords: gender knowledge, Muhammad Sabki Urban Forest, planting behavior, traditional medicine, urban forestry

INTRODUCTION

Plants are one of the forest components with many benefits for the human body. Plants function as a source of energy-rich food to drive healthy body growth (van Holthoon 1999) and can be a healing option. Medicinal plants are the non-timber forest products that all types of forest management can utilize, either in protected, production, or conservation forests (Akiefnawati and Rahayu 2016). It also refers to the plant's function in healing.

In Indonesia, using plants as a healer has a long tradition, starting at the beginning of the 20th century. It has correlated with the World Health Organization (WHO) report that almost 80 percent of developing countries depend on wild plants to care for their health (Balick et al., 1996). Many research articles found that medicinal plants commonly used by people or ethnicity who live around the forest (Elagupillay 2009; Putri et al. 2014; Walujo 2008) or in Indonesia rural communities (Darusman et al. 2004; Katili et al. 2015; Roosita et al. 2008; Royyani and Rahayu 2010). For example, there were 344 plant species sold in traditional markets in North Sumatra (Silalahi et al., 2015). Communities in Maluku Seram Island utilize as many as 45 types of medicinal plants (Susiarti 2015). Suku Anak Dalam, who lives in Tabun Village, Tebo Regency, Jambi Province, utilizes as many as 39 traditional medicinal plants species (Indriati 2014). That medicinal plants also can be obtained from various locations, like yards (72 plants species), gardens (69 plants species), on the edge of rice fields (12 plants species), and riverside (9 plants species) (Nurjannah et al. 2015).

Rural communities and most urban populations in tropical Asia depend on plants as therapeutic agents daily (Balick et al. 1996; Novriyanti et al. 2021). In this case, women play an essential role, especially in maintaining the knowledge and practice of using medicinal plants, as commonly the forest resources management (Sujarwo et al. 2014). The meta-analysis result conducted by De Boer and Cotingting (2014) shows that almost 2000 different species of medicinal plants are still used to maintain the health of Southeast Asian women. However, there is no data on Indonesian women. Do the urban women in Indonesia behave and do the same practice as a rural community that depends on medicinal plants as a necessary treatment? Do the urban women know medicinal plants, and they plant by themselves?

Based on these findings, this study aims to explain knowledge of urban communities around Jambi's urban forest on medicinal plants. Do they grow it in their yard, and what types are they?. This research chose the Muhammad Sabki Urban Forest to study, and so far, the research conducted here has not reached the medicinal aspect. Another research done is the diversity and abundance of butterfly species (Rahayu and Basukiriadi 2012), epiphyte potential communities as one of the drivers on microclimate stability, biomass (Ihsan et al. 2015).

MATERIALS AND METHODS

Study area

This study surveyed Muhammad Sabki Urban Forest, one of the green open spaces in Jambi Province (Jambi's Urban Forest), for two months, from August until September. Muhammad Sabki Urban Forest has an area of about 11 hectares, which improves and maintains the micro-climate, the city's aesthetics, absorbs water, creates balance and harmony in the city's physical environment, and supports the conservation of Indonesia's biodiversity. The kind of vegetation there has been planted or naturally grown. Earlier vegetations are the rubber forest, Pteridophyta community, Fungi, Asteraceae, Bryophyta, Araceae, lianas, and plant saplings until the pole level. In these areas also found some medicinal plants which are known utilized on the world. Some of them are *Syzygium* spp., *Arcangelisia flava*, *Uncaria* spp., *Eurycoma longifolia*, *Coptosapelta flavescens*, and much more (Nursanti et al. 2018).

We chose three locations out of the residential unit, nearest to the administrative area of Mayang Mangurai village in Jambi City, to explore the women's knowledge on plants utilization. The group's study is on Muhammad Sabki Urban Forest (500-700 meters from the village). It takes 30 minutes to travel from this residential unit to the city center. Muhammad Sabki Urban Forest coordinates 103º34'52" up to 103º35'11" East Longitude and 01º39'08" up to 01º39'22" South Latitude. This study location is also close to the Public Health Center.

Data collection and analysis

This research used open and closed combination interviews with 10 respondents and some informants. A research questionnaire guided the interview data. The stratification data resources, as follows: (i) The traditional village healers and birth attendants. Information about these traditional healers was traced using the snowball sampling method. The informants were determined based on indigenous leaders, tribal chiefs, village chiefs, and other reliable sources (Katili et al., 2015). (ii) The family healers include a married woman in each family head (KK) residential unit. Married women are assumed to have more caring in their family healthiness (Sumarmiyati and Rahayu 2015). Women studied generally work as housewives. The number of women interviewed was bound in 10 persons because the data was saturated, and the interview was stopped if it had happened (Morse 2015).

Data analysis

Data has been collected, analyzed quantitatively by descriptive statistics to describe various plants used by urban women and their characteristics. Then data is analyzed by qualitative to explain categorization already used by urban women around Muhammad Sabki Urban Forest.

RESULTS AND DISCUSSION

Result

As a common, communities in Jambi Province come from various ethnicities, such as Malay, Java, Minangkabau, Batak, Sundanese, Chinese, and others. Our survey identified as many as three ethnicities living around Jambi urban forest. The interviewed women mainly were Javanese (67%), Sundanese (17%), and Malay (16%). Most of them work as housewives.

Studies conducted on married women show that half of the interviewed knew the benefits of medicinal plants around them. Women use 27 plants to heal his family (Table 1). These plants are categorized into 22 families; each family contains 1-2 plant species (Figure 1). Phyllantaceae, Zingiberaceae, and Asteraceae are the top 3 types of medicinal plants found.

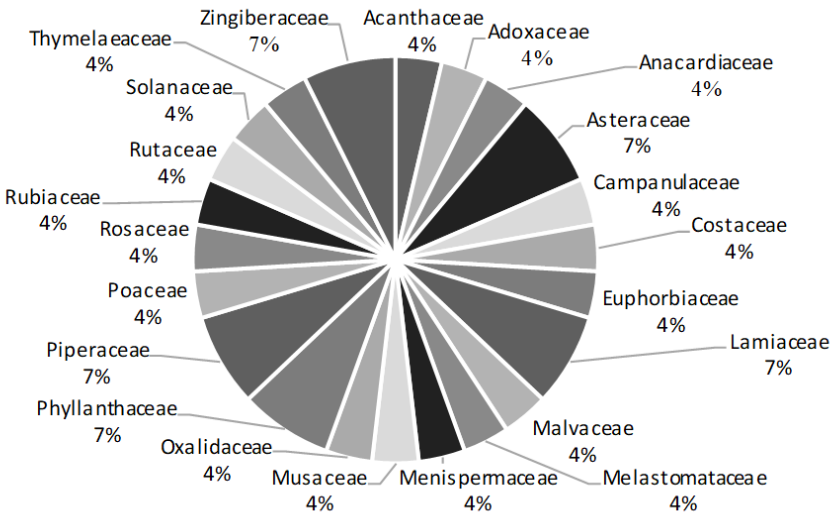

Figure 1. Family names distribution of plant species used as medicine by the community around Jambi Province Urban Forest, Indonesia

Table 1. Types of medicinal plants used by the community around Jambi Province Urban Forest, Indonesia

Kind of species		Family	Utility	
Local name	**Scientific name**		**Bahasa**	**English**
Sambiloto	*Andrographis paniculata*	Acanthaceae	*Obat panas, obat gatal-gatal*	Cough, dermatitis
Daun kerak-kerak	*Sambucus javanica*	Adoxaceae	*Obat rematik*	Rheumatic
Mangga	*Mangifera indica*	Anacardiaceae	*Obat imunitas tubuh*	Immunity
Daun sambung nyawa	*Gynura procumbens*	Asteraceae	*Obat Lelah*	Muscle pain
Daun beluntas	*Plucheacea folium*	Asteraceae	*Obat demam*	Fever
Daun katarak	*Isotoma longiflora*	Campanulaceae	*Obat mata katarak*	Eye disease
Sedingin	*Costus speciosus*	Costaceae	*Obat demam, obat kejang, obat untuk pasutri yang sulit punya anak*	Fever
Daun betadin	*Jatropha mulitifida*	Euphorbiaceae	*Obat gatal pada kulit; obat pencegahan infeksi*	Dermatitis
Kembang gunung	*Clerodendrum paniculatum*	Lamiaceae	*Obat pencahar*	Laxative
Daun ati-ati	*Plectranthus scutellarioides*	Lamiaceae	*Obat batuk, obat bisul*	Cough, dermatitis
Kembang sepatu	*Hibiscus rosa sinensis*	Malvaceae	*Obat panas*	Fever
Senduduk	*Melastoma malabthricum*	Melastomataceae	*Menghilangkan pahit pada pepaya; obat nyeri; obat peradangan*	Muscle pain, inflammation, injury, hemorrhage
Brotowali	*Tinospora cordifolia*	Menispermaceae	*Obat pusing*	Headache
Jantung pisang kepok	*Musa acuminata*	Musaceae	*Obat demam untuk anak*	Fever (for child)
Kembang belimbing wuluh	*Averrhoa bilimbi*	Oxalidaceae	*Obat hypertensi, obat flu untuk anak*	Hypertension, colds (for child)
Meniran	*Phyllanthus urinaria*	Phyllanthaceae	*Obat diabetes, kencing batu*	People with diabetes, urinary disease
Sayur katu	*Sauropus androgynus*	Phyllanthaceae	*Pelancar ASI pada ibu yang menyusui*	Asi stimulant
Sirih	*Piper betle*	Piperaceae	*Obat mata, obat kesehatan reproduksi wanita, obat sakit perut*	Eye irritation, postpartum remedy, stomach-sore
Cabe jawa	*Piper longum*	Piperaceae	*Obat nyeri, anti inflamasi, obat pilek/ flu*	Inflammation, injury, bleeding, colds
Serai	*Cymbopogon citratus*	Poaceae	*Obat hypertensi, obat pencernaan*	Hypertension, laxative
Bunga mawar	*Rosa* sp.	Rosaceae	*Obat campak, cacar, demam*	Fever, measles
Mengkudu	*Morinda citrifolia*	Rubiaceae	*Obat diabets, batuk, obat radang lambung*	Diabetics, colds, maag
Jeruk nipis	*Citrus aurantifolia*	Rutaceae	*Obat batuk*	Cough
Takokak	*Solanum torvum*	Solanaceae	*Obat mata minus*	Eye disease
Mahkota dewa	*Phaleria macrocarpa*	Thymelaeaceae	*Sebagai detoksifikasi*	Detox
Kunyit	*Curcuma longa*	Zingiberaceae	*Obat peradangan, luka*	Inflammation, injury, bleeding
Jahe	*Zingiber officinale*	Zingiberaceae	*Obat batuk, masuk angin*	Cough, colds

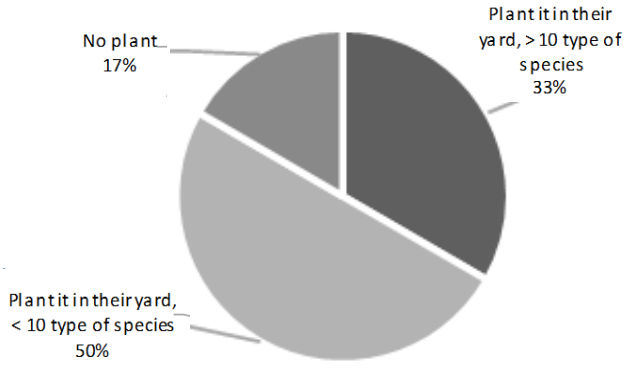

Figure 2. Number of Women Around Urban Forest who plant medicinal plants in their yard.

The women around the Urban Forest of Jambi, Indonesia, did not collect the plant from the forest to heal their families. These plant species are generally planted around their home yard (83%). Some grew more than ten species (33%), and much grew less than ten species in their yard (50%) (Figure 2).

One of their best practices is using a mixture of the beneficial plant called Jamu (an extraction of some medicinal plants in liquid form produced by small-scale home industries) to maintain their health. Unfortunately, most of them prefer to visit public health centers (PUSKESMAS) or see a doctor to treat illness instead of drinking Jamu. Only as many as 17% of interviewed women said they prefer to plant it in the yard to heal their family. Especially women who have traditional views that traditional treatment (Jamu) is better than doctors or visiting the public health center.

Discussion

The knowledge level about using plants as healers in the community, especially women, can affect their family's healing options. If the women or people in a community knew more utilization of plant species and its available in their yard, they might prefer to treat the disease by themselves at home. Since 2009-2014, the Central Statistics Agency (BPS) stated that women who have health complaints treat themselves with home remedies or do not visit health centers have declined (BPS 2016). This fact is similar to most people who live around Muhammad Sabki Urban Forest. They prefer to visit the public health center (PUSKESMAS) or see a doctor to treat their illness than to heal by themselves. It also means that people who use plants and traditional medicine are getting smaller.

Although many people are turning to modern medicine, plants still exist as an alternative medicinal treatment. Several plants found in this study can cure more than two diseases, such as *Piper betle*, *Curcuma longa*, *Piper longum*, *Melastoma malabthricum*, and *Morinda citrifolia*. Urban communities studied used medicinal plants to prevent or become first aid for minor diseases like fever, flu, stomach ache, and cough. Indeed, most diseases generally treated using medicinal plants are fever and cough. For example, in Iran (Mohsenzadeh et al. 2016) and India (Negi et al. 2011), fever has been commonly treated with medicinal plants.

However, first efforts using these medicinal plants may depend on their yard variety. Although there is a lack of medicinal plant species planted in the community yard, it still shows positive attitudes of urban communities, especially women, in improving the quality of life through the surrounding. Planting behavior may be related to their ethnicity. Our study show, 80 out of 87 % interviewed Javanese women who planted the medicinal plant in their yard. Javanese have been known to utilize 114 species of medicinal plants (Darusman et al. 2004). Javanese women have a good habit from their ancestors to plant anything, including medicinal plants (Sari et al., 2015). Besides that, the city's limited homeward area may also influence; they grow only the most valuable species. The people who live closest to the forest tend to possess fewer medicinal plants in their yard because they are available nearby (Kujawska et al., 2018).

Unfortunately, our findings show that most women interviewed declare species planted in the community yard such as Kembang gunung (*Clerodendrum paniculatum*), senduduk (*Melastoma malabathricum*), Sedingin (*Costus speciosus*), Daun kerak-kerak (*Sambucus javanica*), and Kembang belimbing wuluh (*Averrhoa blimbi* are not from the urban forest area. But, another research (by Nursanti et al., 2018) showed that these five plants were found in Muhammad Sabki Urban Forest. Based on this situation, it is implied that the community of medicinal plants in their yard can be spread up into conservation areas, which is Muhammad Sabki Urban Forest or vice versa. With the community's existing conservation in the community's yard, there are opportunities to protect plant species within the conservation areas.

Some plants also are known to have multiple benefits besides being traditional medicines. There are aromatic plants like *P. betle*, *Citrus aurantifolia*, *Rosa* sp., *Cymbopogon citratus*; fruit-producing plant-like *Citrus aurantifolia*, *Mangifera indica*, *Musa acuminata*; vegetable plants like *Solanum torvum*, *Sauropus androgynous*, *Averrhoa bilimbi*, and herbs like *C. longa* and *Zingiber officinale*. Herbs are the most plant found in several places. Some herbs known as Ayurvedic medicine of India composed of *C. longa* and *Z. officinale* have been found in the community yard. These plants are used to treat some illnesses, especially for anorexia, chronic nausea, and change in body image (Negi et al., 2011). De Boer and Cotingting stated that *C. longa* and *H. rosa-sinensis* were commonly used by Asian people (De Boer and Cotingting 2014).

Using plants as traditional medicine is an effort to maintain the nation's cultural heritage so that it needs to be preserved (Dewoto 2007). But as some studies show that knowledge of environmental management, including biodiversity conservation, especially for forest restoration, is decreasing (Wulandari et al. 2021) from generation to generation, we assume that broad technological developments and less information may affect that. Some research reported that older women mostly own this local knowledge and practice medicinal plants (Chaniago and Siebert 1998; Royyani and Rahayu 2010). Meanwhile, most of today's generations have no sense of plant used as a healer (Sari et al. 2015). It also means that the number of people employed plants and traditional medicine is getting smaller.

Nevertheless, the research findings show that urban women around the city forest are still practicing one of the local pearls of wisdom in using medicinal plants, namely Jamu. Jamu is the extraction of medicinal plants in liquid form produced by small-scale home industries. It is one of the urban community's best practices for using a beneficially plant mixture. This condition is similar to other Indonesian rural people (Roosita et al. 2008) that use Jamu to maintain their health, especially during the Covid-19 pandemic, which forced the entire community to survive and increase immunity. Jamu is also a form of social empowerment among women in Indonesia (Torri 2012).

Factors that influence people using medicinal plants are the high cost or unavailability of chemical drugs and the trust that traditional medicines are safer than others (Dewoto 2007). However, using plants as a medical treatment should be conscientious because it could be dangerous, mainly if used to treat serious diseases, such as diseases that do not have a satisfactory healer, such as cancer, AIDS, and various chronic diseases (e.g., hypertension and diabetic) without supervised by a doctor. Developing utilization medicinal plants in urban communities, incredibly close to the forest, the communities yard or home garden is quite well by creating it as a good plant nursery.

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