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An ethnobotanical study of medicinal plants in Palamalai region of Eastern Ghats, India

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ABSTRACT

Ethnopharmacological relevance: During the last few decades there has been an increasing interest in the study of medicinal plants with their traditional use and related pharmacological research all over the World. This paper enumerated folk medicinal plants used by Malayali tribal people in an unexplored and biodiversity rich region of Eastern Ghats in southern India.

Aim of study: The aim of this study is to collect and identify the plants used in medicinal therapy by the local people and professional traditional healers with quantitative analysis.

Materials and methods: An ethnobotanical survey was carried out during January to December 2014 among the Malayali tribal people in four villages of Palamalai region in Eastern Ghats, India. The information was obtained through open and semi-structured face-to-face interviews with the local knowledgeable people and professional traditional healers. The statistical analysis, use value, family use value, informants' consensus factor, fidelity level, frequency of citation, relative frequency citation and informants' agreements ratio were calculated for the quantitative study of ethnomedicinal data.

Results: A total of 118 plant species belonging to 95 genera and 55 families dominated by the families like Leguminosae, Asteraceae and Lamiaceae were enumerated with detailed information on parts used, method of preparation, mode of administration and ailments treated. Leaves were mostly used plant part and predominantly used herbal preparations were decoction and paste. *Moringa oleifera* Lam. was reported by all the interviewed informants and gives the highest UV of 3.9 with 78 use reports due to its diverse medicinal uses.

Conclusion: The present study demonstrated the need for importance of documenting the traditional knowledge of forest dwelling people. As a result of the study, *Abutilon indicum* (L.) Sweet., *Andrographis echioides* (L.f.) Nees., *Bacopa monnieri* (L.) Wettst., *Canarium strictum* Roxb., *Centella asiatica* (L.) Urban., *Senna auriculata* (L.) Roxb. and *Tribulus terrestris* (L.) were recommended for further ethnopharmacological studies since these plants were recorded with high UV, IAR, RFC and FL values.

1. Introduction

Traditional medicine is used worldwide and having great economic value in the 21st century in both developed and developing countries. The plants are rich in active ingredients, thus knowledge on plant diversity of an area and knowledge on medicinal uses of those plants by local people is of prime importance for development of those species considered effective in the treatment of various ailments (Tuttolomondo et al., 2014). The plants also used as source of nutrition, appetizers, energy boosters and for aroma in tea's (Maundu et al., 2001). Herbal medicines are considered proficient among different rural or indigenous communities (Ghosh, 2003). Medicinal plants play a pivotal role in healthcare and are major raw materials for both traditional and conventional medical preparations, since most of the people choose herbal medicines than conventional medicines (World Health Organisation, 2002).

Ethnobotanical studies are very important to reveal the past and present culture about plants in the world and preserving indigenous knowledge on medicinal plants. The quantitative ethnobotanical studies were utilized to detect the plant uses as food (Pieroni, 2001), veterinary medicine (Upadhyay et al., 2011), human health care medicines (Kim and Song, 2013) and economically important (Reyes-Garcia et al., 2006). However, many ethnic groups are failing to retain their collective knowledge of such medicinal plant use. Younger generations are not interested to follow these traditional medicinal practices from their ancestors and are migrating to lucrative jobs in more developed nearby urban areas. In rural communities, medicinal plants expanded attention due to their effectiveness, lack of modern medical alternatives, rising costs of allopathic medicines and cultural preferences (Heinrich, 2000; Tabuti

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et al., 2003). Many ethnic groups rely on wild plants for food and many other purposes from birth to death and traditionally all herbal preparations were developed from plants either as simple or complex form of crude extracts (Ayyanar et al., 2013).

In India, attention has been paid in the field of ethnobotanical studies by various researchers and hundreds of reports has been published in the last three decades (Jain and Puri, 1984; Nagaraju and Rao, 1990; Bhandary et al., 1995; Ansari and Tiwari, 1998; Rajan et al., 2002; Katewa et al., 2004; Ayyanar and Ignacimuthu, 2005, 2011; Chellappandian et al., 2012; Yabesh et al., 2014) however, still much effort is necessary to save this treasure that is being diminished with the passage of time. In this scenario, the present study was conducted to document the ethnomedicinal knowledge of Malayali tribal communities in Palamalai region of Eastern Ghats in southern India. The main objective of this study is to analyse the documented medicinal plants through quantitative indicators and the extent of current knowledge of traditional healers on plants in the study area.

2. Methodology

2.1. Study area

The present survey was conducted in Palamalai (also known as Siddeswaramalai constituted with four tribal inhabited villages) which is one of the most significant hills in Salem district of Tamilnadu in South India. Palamalai is situated near to the Satyamangalam forest area and falls under the southern Eastern Ghats covering an area of 68 km^2 (Fig. 1) with an altitude ranges from 324 to 1403 m above mean sea level. These hills are ~200 and 40 km away from the well-known cities like Coimbatore and Salem, respectively. Average annual rainfall was measured between 750 and 848 mm. The floristic diversity of Palamalai is very rich compared to other regions of nearest hills due to less anthropogenic activities and these hills doesn't have electricity and transport facilities.

2.2. Studied tribal people

All the inhabitants of the surveyed four villages are belongs to Malayali tribal group and their mother tongue is Tamil. Total population of the four tribal villages (410 families) is 1611 with 711 males and 900 females. The village wise population of surveyed four villages are Guruvarettiyur (299), Thimmampathi (235), Nagampathi (494) and Kannamoochchi (583) which were situated in 10 km radius in the study area. The major livelihood of these Malayali tribals were cattle farming, agriculture, collection of fuel-wood and forest resources such as herbal medicines, honey and some edible fruits and tubers from the forests. Most of the tribal people's local economy is hill based agriculture and few of them are cattle growers and plant raw material collectors. Malayali tribals are frequently using plant based medicines, since hospital facility is not offered to these people and this leads them to practice traditional herbal medicines. Malayali tribals are one of the 36 scheduled tribal communities in Tamil Nadu with rich population when compared to other major tribal people of Tamil Nadu. They are spread along the contiguous hill ranges of Eastern Ghats of Tamil Nadu such as Pachamalai, Servarayan, Kollimalai, Sitheri hills, Palamalai, Javvadhu and Yercaud hills.

2.3. Data collection

Ethnobotanical survey was carried out during January to December 2014. Totally six field visits were carried out in the study area which includes six to ten days per visit. Knowledgeable traditional healers were identified based on their experience on

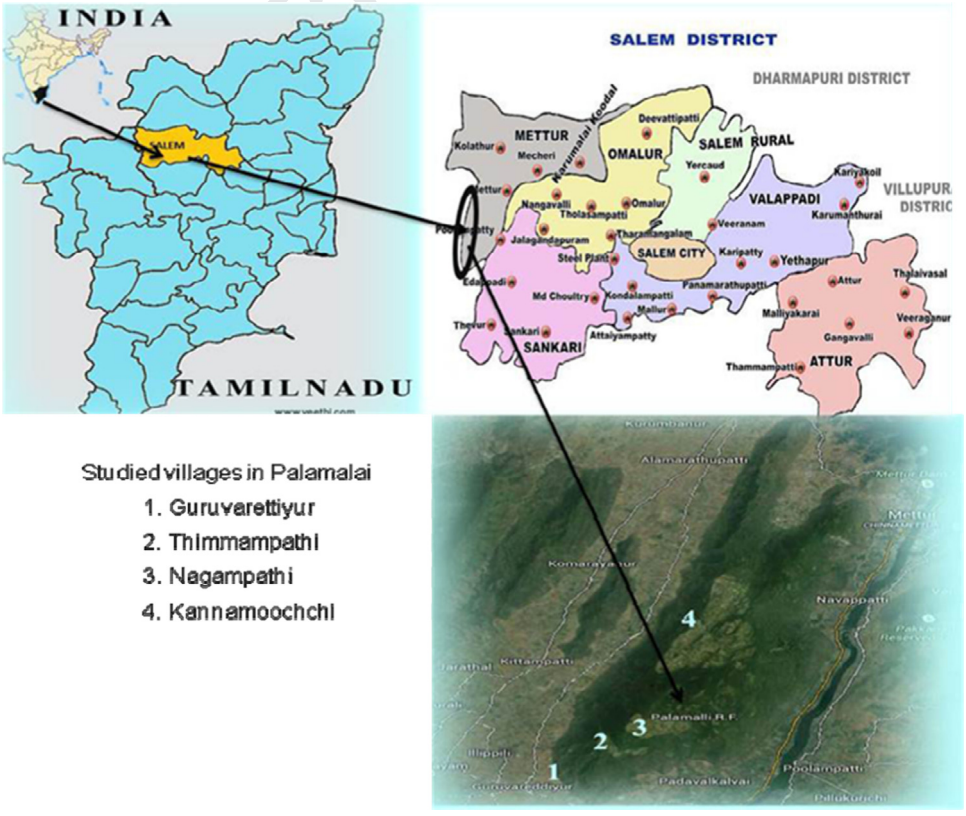

Fig. 1. Location map of study area in Palamalai region of Eastern Ghats, India.

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herbal medicine with frequent field visits in the study area and interviews were carried out with the identified local people and traditional healers. During the course of time, twenty informants were identified, of which four were professional traditional healers (herbalists) and other sixteen were local knowledgeable persons who had much knowledge on medicinal plants and frequently practicing herbal medicines. Age of the interviewed informants is ranging between 30 and 80 (Table 1). The detailed information about the professional healers and related information are given in Table 2. The collection of ethnomedicinal data includes local name of the plant, part used, mode of application, route of administration, medicinal uses, other plant parts used for preparation of medicine along with information on place of collection and simple morphology of the collected plants for identification purposes. The data on ethnomedicinal uses collected from the informants were recorded for statistical analysis.

2.4. Plant collection and identification

The documented ethnomedicinal plants were collected in triplicate and preserved for preparation of herbarium specimens using standard methodologies. The plant materials were identified based on the recorded morphological, flowering and fruiting characters which were noted during the field visits. The binomials of preserved herbarium specimens were identified using 'The Flora of Tamilnadu Carnatic' (Matthew, 1983) and 'The Flora of Presidency of Madras' (Gamble, 1935). Angiosperm Phylogeny Group III (2009) was followed for nomenclature of plants and families. We also identified scientific names of plant species according to the standard database 'plant list' (http://www.theplantlist.org/). The identified plant specimens were labelled on herbarium sheets and deposited in the herbarium of A.V.V.M. Sri Pushpam College, Poondi (SPCH), Thanjavur, India for future reference.

Table 1
Demographic profile of the studied tribal people in Palamalai region of Eastern Ghats, India.

Characteristics	No. of interviewees		Total number	Percentage (%)
	Male	**Female**		
Sex	12	8	20	60:40
Age				
20–30	2	0	2	10%
30–40	2	2	4	20%
40–50	3	3	6	30%
50–60	1	2	3	15%
60–70	3	1	4	20%
70–80	1	0	1	5%
Herbalists (Professional healer)	3	1	4	20%
Local people	9	7	16	80%
Education level				
Illiterate	6	5	11	55%
Adult education	2	1	3	15%
10th	2	1	3	15%
12th	2	1	3	15%
Graduation	0	0	0	0
Occupation				
Herbalist	3	1	4	20%
Agriculturist	3	4	7	35%
Driver (Jeep)	1	0	1	5%
Grocery shop	3	0	3	15%
Cattle drover	2	3	5	25%

2.5. Analysis of ethnomedicinal data

Data associated with collected ethnomedicinal plants were sorted in MS Excel 2010 and analysed for descriptive statistical patterns such as use value (UV), family use value (FUV), informant consensus factor (ICF), fidelity level (FL), frequency of citation (FC), relative frequency citation (RFC) and informants agreement ratio (IAR). The knowledge on medicinal plants used for the treatment of different types of ailments among the informants of the study area were analysed using the above statistical formulae.

2.5.1. Use value (UV)

The relative importance of each plant species known locally to be used as herbal remedy is reported as use value (UV) and it was calculated using the following formula (Phillips et al., 1994),

$$UV = \sum U/n$$

where, U is number of use reports cited by each informant for a given plant species and n is the total number of informants interviewed for a given plant. The UV is helpful in determining the plants with highest use in the treatment of an ailment. UV_s are high when there are many use reports for a plant and low when there are few reports related to its use.

2.5.2. Family use value (FUV)

Family use value was calculated in order to identify the essential medicinal plant families in the study area. FUV was calculated by the following formula,

$$FUV = UV_s/N_s.$$

where UV_s is the sum of use value of the species within a given family and N_s is the total number of species within a given family (Cadena-González et al., 2013). The FUV is an index of cultural importance which can be applied in ethnobotany to calculate a value of plant species (Gakuubi and Wanzala, 2012).

Table 2
Detailed information about the professional traditional healers.

	Healer 1	Healer 2	Healer 3	Healer 4
Name	T. Ramasamy	S. Karuppasamy	M. Veeran	N. Ramaayi
Age	75	68	64	67
Gender	Male	Male	Male	Female
Literacy	Illiterate	Illiterate	Illiterate	Nil illiterate
Other source of income	Collecting and selling plant raw materials (fresh/dried)			
Specialization, if any	–	Bone fracture	–	Skin disease
Source of knowledge	Parents	Parents	Parents	Parents
Village name	Nagampathi	Thimmampathi	Kannamoochi	Guruvarettiyur
Family members	15 (joint family)	19 (joint family)	21 (joint family)	12 (joint family)

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2.5.3. Fidelity level (FL)

Fidelity level (FL) is calculated to identify the most important medicinal plant species used in the treatment of various diseases. FL was calculated using the following formula,

$$FL = N_s/N*100$$

where, N_s is the frequency of citation of a species for a particular ailment and N is the total number of citations of the species (Friedman et al., 1986)

2.5.4. Informants' consensus factor (ICF)

ICF was calculated to identify the agreement of informants on the reported use reports for different type of diseases. ICF value was calculated using the following formula (Heinrich et al., 1998),

$$ICF = N_{ur} - N_t/N_{ur} - 1$$

where N_{ur} is the number of use reports of particular ailment category and N_t is the number of taxa used for the particular ailment category.

2.5.5. Frequency citation (FC)

The frequency of citation of the plant species used was done using following formula,

$$FC = N_i/\sum N_i$$

where, N_i is the number of times particular plant species was mentioned and $\sum N_i$ is the total number of times that all species were mentioned.

2.5.6. Relative frequency citation (RFC)

Local importance of each plant species was calculated using relative frequency of citation (Tardio and Pardo-De-Santayana, 2008). The RFC value was calculated using the following formula,

$$RFC = F_c/N$$

where F_c is number of use reports of particular plant taxa mentioned by number of informants and N is total number of informants

2.5.7. Informants' agreement ratio (IAR)

The importance of individual species was assessed by calculating the IAR for each species (Trotter and Logan, 1986). IAR was calculated by following formula,

$$IAR = N_r - N_a/N_r - 1$$

where N_r is the total number of citations recorded for individual taxa and N_a is the number of illness categories treated with this species. The IAR value zero (0) indicate the number of illness category equals the number of citations and one (1) indicate all the participants mentioned the plant species for particular disease (Thomas et al., 2009).

2.6. Ailment categories

The diseases recorded in the present study were classified into 18 ailment categories (Table 3) such as, circulatory system and cardiovascular diseases (CSCD), dental care (DC), dermatological infections and diseases (DID), ear, nose and throat problems (ENT), endocrinal disorders (ED), fever (FVR), gastro-intestinal ailments (GIA), general health (GH), genito-urinary ailments (GUA), gynaecological disorders (GD), hair care (HC), haemorrhoids (HEM), kidney problems (KP), liver problems (LP), oncology (ONC), poisonous bites (PB), respiratory system disorders (RSD) and skeleton-muscular system disorder (SMSD).

3. Result and discussion

3.1. Demographic profile of the informants

Demographic characteristics of the informants in the present study were determined and recorded through face-to-face interviews with 20 informants in Palamalai region of Eastern Ghats (Table 1). Of which, male informants (12) were dominating women informants (8) in the practice of traditional medicine since most of the women in the tribal families are not interested to practice herbal medicines. The informants were learned this knowledge from their ancestors, other family members and neighbours, etc. The medicinal plants knowledge shared by the professional traditional healers and local people who are practicing herbal medicines is totally different with each other due to the way of learning medicinal practices from their ancestors.

Most of the interviewed informants were illiterate, only a few people had primary, secondary and adult education (Table 1). The professional healers were treating patients on payment basis based on the nature of disease, type of disease, availability of plant parts in their environs and duration of the treatment. For example, a professional medicine man in the study area charging Rs. 150/– to 200/– for diabetes treatment and it varies for outsiders and members of their communities. They were also collecting medicinal plant parts in the forest areas and selling them in nearby market, which is situated 40 km away from their village. Two of the interviewed professional healers are specialized in particular diseases like bone fracture and skin diseases (Table 2).

3.2. Medicinal plant diversity and their uses

In the present study, 118 species of medicinal plants belonging to 95 genera and 47 families for the treatment of various ailments were documented (Table 4). Of the collected ethnomedicinal plants, 48 were herbs (41%) followed by trees (27%), climbers (19%) and shrubs (12%) (Fig. 2). The life form of reported ethnomedicinal plants were confirmed using 'The Flora of Tamilnadu Carnatic' (Matthew, 1983). The recurrent use of herbaceous plants among the indigenous communities is a result of wealth of herbs in their environments (Uniyal et al., 2006; Giday et al., 2010; Ayyanar and Ignacimuthu, 2011; Sivasankari et al., 2014). The family Leguminosae (13 plants, 11%) is most speciose family in this study followed by Lamiaceae (8 plants each, 6.8%), Asteraceae (7 plants, 6.0%) Apocynaceae (6 plants, 5.1%), Cucurbitaceae and Malvaceae (5 plants each, 4.2%), Acanthaceae, Menispermaceae and Moraceae (4 plants each, 3.3%), Amaryllidaceae, Apiaceae, Combretaceae, Convolvulaceae, Euphorbiaceae, Rutaceae and Sapindaceae (3 plants each, 2.5%). Sreekeesoon and Mahomooodally (2014) also stated that Leguminosae and Asteraceae are dominant families used by the tribal people in Mauritius for the treatment of pain. Of the documented plant species, *Allium sativum* L., *Cinnamomum tamala* (Buch.-Ham.) T. Nees & Eberm., *Cinnamomum verum* J. Presl., *Glycyrrhiza glabra* L., *Nigella sativa* L., *Picrorhiza kurroa* Royle ex Benth. and *Senna alexandrina* Mill. were purchased from the nearby herbal markets for the preparation of various herbal medicines.

3.3. Plant parts used

Among the plant parts used for preparation of medicine, leaves (41 reports, 23%) were most frequently used individually or in combination with other plant parts. It was followed by whole ripe fruit (24 reports, 13%), seed (23 reports, 13%), root (16 reports, 9%), aerial parts (13 reports, 7%), stem bark (10 reports, 6%), whole plant and rhizome (8 reports each, 4%), stem (5 reports, 3%), fruit rind, flower head and latex (4 reports each, 2%), flower resin and tuber (3 reports each, 2%) and remaining parts with 1% (Fig. 3).

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Table 3
Ailment categories and biomedical terms of the illnesses with their Tamil names.

Ailment categories	Biomedical terms	Tamil term
Circulatory system /	Blood circulation	Raththa ottam (ரத்த ஒட்டம்)
Cardiovascular disease (CSCD)	Blood formation	Raththam urpaththi (ரத்த உற்பத்தி)
	Blood purification	Raththa thooimai (ரத்த தூய்மை)
	Heart problem	Ithaya koloaru (இதய கோளாறு)
	Heart strength	Ithaya valimai (இதய வலிமை)
	Memory power	Puththi koormai (புத்தி கூர்மை)
Dental care(DC)	Mouth ulcer	Vaai pun (வாய்புண்)
	Toothache	Palvali (பல்வலி)
	Tooth strength	Pal valimai (பல் வலிமை)
	Worms in teeth & gum	Pal soththai (பல்சொத்தை)
Dermatological Infection and Disorder (DID)	Burning	Erichchal (எரிச்சல்)
	Fungal infection on head	Poonjai thotru (பூஞ்சை தொற்று)
	Leprosy	Tholu noi (தொழு நோய்)
	Scabies	Sori, sirangu (சொறி, சிரங்கு)
	White patches in skin	Themal (தேமல்)
	Wound	Kaayam (காயம்)
Ear, Nose & Throat infections (ENT)	Eye Pain	Kan vali (கண் வலி)
	Ear ache	Kaadhu vali (காது வலி)
Endocrinal Disorder (ED)	Diabetes	Sarkkarai noi (சர்க்கரை நோய்)
Fever (FVR)	Fever	Kaichchal (காய்ச்சல்)
Gastro Intestinal Ailments (GIA)	Dysentery	Vayitrupokku (வயிற்றுபோக்கு)
	Gastric trouble	Vaivu (வாய்வு)
	Indigestion	Serimanaminmai (செரிமாணமின்மை)
	Killing worms in stomach	Vayitru pulu (வயிற்று புழு)
	Stomach ache	Vayitru vali (வயிற்று வலி)
	Stomach ulcer	Vayitru pun (வயிற்று புண்)

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Table 3 (*continued*)

General Health (GH)	Reduce burning sensation in body	Udal veppam agatri (உடல் எரிச்சல் குறைக்கும்)
	Body refreshment	Udal putthunarcchi (உடல் புத்துணர்ச்சி)
	Body shining	Udal palapalappu (உடல் பளபளப்பு)
	Body strength	Udal valimai (உடல் வலிமை)
Genito urinary problem (GUP)	To stimulate sexual power to men	Kamam perukki (காமம் பெருக்கி)
	Abortion	Karukalaippu (கருகலைப்பு)
	Delivery pain	Pirasava vali (பிரசவ வலி)
	Increase sperm count	Vindhanuu adhikarippu (விந்தணு உற்பத்தி)
	Male fertility	Pen valamai (பெண்வளமை)
	Female fertility	Aan valamai (ஆண் வளமை)
	Pregnancy pain	Pirasava kalavali (பிரசவ கால வலி)
	Urinary problem	Siruneer pirachchanai (சிறுநீர்பிரச்சினை)
Gynaecological disorder (GD)	White discharge in female	Vellaipaduthal (வெள்ளைபடுதல்)
	Uterine disorder	Karuppai kolaru (கருப்பை கோளாறு)
Hair care (HC)	Hair growth	Mudi valarchchi (முடி வளர்ச்சி)
	Hair loss	Mudi udhirthal (முடி உதிர்தல்)
	Dandruff	Podugu (பொடுகு)
Hemorrhoides (HEM)	Piles	Moolam (மூலம்)
Kidney problem (KP)	Stone formation	Siruneer kal pirachchinai (சிறுநீர் கல் பிரச்சினை)
Liver problem (LP)	Jaundice	Kaamalai (காமாலை)
Oncology (ONC)	Cancer	Kattikal (கட்டிகள்)
Poisonous bite (PB)	Scorpion sting	Theal kottuthal (தேள் கொட்டுதல்)
	Snake bite	Pambu kadi (பாம்பு கடி)
	Poison bites	Nanjaruppaan (நஞ்சறுப்பான்)

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Table 3 (*continued*)

Respiratory system disorders (RSD)	Asthma	Moochchu thinaral (மூச்சு திணறல்)
	Chest pain	Nenju vali (நெஞ்சு வலி)
	Cold	Jalathosam (சலதோசம்)
	Cough	Irumal (இருமல்)
Skeleton Muscular System Disorders (SMSD)	Body pain	Udal vali (உடல் வலி)
	Bone fracture	Elumbu murivu (எலும்பு முறிவு)
	Head ache	Thalaivali (தலைவலி)
	Rheumatism	Moottu vali (மூட்டு வலி)
	Swelling	Veekkam (வீக்கம்)

Likewise, most of the tribal communities around the World using leaves for the preparation of herbal medicines (Teklehaymanot et al., 2007; Gonzalez et al., 2010; Ayyanar and Ignacimuthu, 2011; Giday et al., 2010; Amri and Kisangau, 2012; Ullah et al., 2013) because of the availability of leaves throughout the year and can be easily collected from the forests (Giday et al., 2009).

In Tamilnadu too, Irular tribals in Nilgiri hills (Balasubramanian and Narendra Prasad, 1996), Kadars, Malasars and Muthuvan tribals in Coimbatore district (Hosagoudar and Henry, 1996), Paliyar tribals in Madurai district (Ignacimuthu et al., 2006), Malayali tribals in Tiruvannamalai district (Ravikumar and Vijayasankar, 2003) and Salem district (Selvaraju et al., 2011), Kani tribals in Tirunelveli district (Ayyanar and Ignacimuthu, 2011) and local people in Villupuram district (Prabhu et al., 2014) were also utilized mostly leaves for preparation of herbal formulations to treat various diseases.

3.4. Preparation of herbal medicines

Medicinal preparation from raw material of the plants is one of the important methods in herbal therapy (Shil et al., 2014). The informants in the present survey were practicing nine different types of preparation methods. Of which mostly used herbal preparations were decoction (55 reports, 24%) and paste (54 reports, 23%) followed by taken as raw (48 reports, 21%), powder (34 reports, 14%), juice (30 reports, 13%) and remaining methods with a very few preparations (Fig. 4). The decoction was prepared by boiling the plant in water until the volume of water reduced to half of its original volume. The infusion was prepared by soaking the plant material in water or hot water for some time. Paste was prepared by grinding the raw (fresh or dried) material of the plant part with water, oil or ghee. Juice was prepared by crushing the fresh raw material and separates the juice after filtration. Powder was prepared by grinding the shade dried raw materials. Soup was prepared by boiling the plant with some green vegetables or other ingredients like salt, ghee, oil, sugar, etc.

For herbal preparations with bitter taste, some sweet ingredients (sugar, honey, palm sugar) were added during the preparation of medicines to reduce bitterness. The same observation was also reported among the Kalanguya tribe in Philippines (Balangcod and Balangcod, 2011). Chander et al. (2014) revealed that coconut milk, rainwater, seawater, pig blood, toddy, pig ghee and honey are some of the important ingredients used by Nicobarese tribal people in India; of which water and coconut oil are common and readily available ingredients since, good solubility of active components in water made it commonly used in herbal remedies by practitioners for oral administration.

There were several application methods followed by informants in the Palamalai region of Eastern Ghats, in which oral application (178 reports, 75%) was most commonly followed than other mode of administrations such as topical (51 reports, 21%), chewing (5 reports, 2%), used as tooth brush (3 reports, 2%), bath and inhalation (single reports) (Fig. 5). Likewise, in most of the previous studies oral application was reported as most frequently used approach for the treatment of various types of ailments. In the mean time, topical application was also important way of remedy for the ailments like skin infection, wound, poison bite, rheumatic pain, body pain, body strength, burns and head ache (Seyid et al., 2013). Physiologically topical mode of administration provides better action and also remedial power in herbal medicine (Mahmood et al., 2012).

3.5. Quantitative analysis of data

3.5.1. Use value

Moringa oleifera Lam. was reported by all the interviewed informants and gives the highest UV of 3.9 with 78 use reports due to its medicinal importance and great diversity in this area (Table 4). Majority of the local people were using this plant for various troubles mainly fertility problems (males were using this plant to increase sperm count and women were using to treat uterine problems). Our report on the UV of *M. oleifera* Lam. resembles some of the prior studies by Mutheeswaran et al. (2011), Abe and Ohtani (2013) and Yabesh et al. (2014). *Artocarpus heterophyllus* Lam. and *Ficus benghalensis* L. were stand next to *M. oleifera* Lam. with an UV 2.6. Other plants with high UV in our study were *Andrographis paniculata* (Burm. f.) Nees., *Cardiospermum halicacabum* L. and *Syzygium cumini* (L.) Skeels (2.45), *Curcuma longa* L. (2.25), *Aristolochia indica* L. and *Citrullus colocynthis* (L.) *Schrad.* (2.0), *Boerhavia diffusa* L. (1.9), *Senna auriculata* (L.) Roxb., *Citrus limon* (L.) Burm.f. and *Cocos nucifera* L.(1.9). *A. paniculata* (Burm. f.) *Nees* was reported with lowest UV of 0.1. The

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Table 4
Ethnomedicinal plants used by the studied tribal people in Palamalai region of Eastern Ghats, India.

Botanical name, Family, Habit and Voucher number	Local name	FC	RFC	UV	IAR	Parts used	Ailment category: No. of use reports (ailments treated)	FL	Preparation	Application
Abrus precatorius L. (Leguminosae)—Climber SPCH-23	fx1	15	0.75	0.95	0.94	Root Leaf	PB: 12 (Scorpion sting, snake bite)	63.2	Decoction	Oral
							DC: 7 (To kill worms in teeth)	36.8	Raw	Chewing
Abutilon indicum (L.) Sweet (Malvaceae)—Shrub, SPCH- 24	fx1	15	0.75	0.75	1.00	Whole plant	GIA: 15 (Dysentery)	100	Decoction	Oral
Acacia nilotica (L.) Delile (Leguminosae)—Tree SPCH- 29	fx1	17	0.85	1.4	0.81	Stem Stem bark Leaf Resin	DC:14 (Teeth strength)	50	Raw	Tooth brush
							GIA:6 (Dysentery)	21.4	Juice	Oral
							RSD: 3 (Cough)	10.7	Decoction	Oral
							GUA: 5 (Male fertility)	17.9	Powder	Oral
Acalypha indica L. (Euphorbiaceae)—Herb SPCH- 45	fx1	16	0.80	2.00	0.8	Leaf Root	DID: 8 (Fungal infection on head)	20	Paste	Topical
							LP: 12 (Jaundice)	30	Decoction	Oral
							RSD: 5 (Chest pain)	12.5	Paste	Oral
							HEM: 15 (Piles)	37.5	Powder	Oral
Acmella paniculata (Wall. ex DC.) R. K. Jansen (Asteraceae)—Herb, SPCH- 27	fx1	2	0.10	1.1	1	Flower head	DC: 2 (Tooth ache)	100	Raw	Chewing
Acmella ciliata (Kunth.) Cass. (Asteraceae)—Herb SPCH- 38	fx1	4	0.20	1.85	1	Flower head	DC: 4 (Tooth ache)	100	Raw	Chewing
Adhatoda vasica Nees (Acanthaceae)—Shrub, SPCH- 33	fx1	18	0.90	0.95	0.94	Leaf Root	RSD: 17 (Asthma, cough)	77.3	Juice	Oral
							GIA: 5 (Intestinal worms)	22.7	Decoction	Oral
Aegle marmelos (L.) Corr. (Rutaceae)—Tree SPCH- 35	fx1	14	0.70	1.3	0.77	Leaf Fruit pulp Whole ripe fruit	CSCD: 12 (Blood purifier)	32.4	Juice	Oral
							HC: 11 (Removing dandruff)	29.7	Paste	Bath
							DID: 7 (Wound)	18.9	Paste	Topical
							SMSD: 7 (Swelling)	18.9	Paste	Topical
Allium cepa L. (Amaryllidaceae)—Herb SPCH- 46	fx1	16	0.80	1.65	0.93	Leaf Bulb	GIA: 3 (Indigestion)	15.8	Soup	Oral
							CSCD: 16 (Blood purifier)	84.2	Raw	Oral
Allium sativum L. (Amaryllidaceae)—Herb, SPCH- 15	fx1	16	0.80	1	0.93	Bulb	CSCD: 14 (Blood purifier)	53.8	Paste	Oral
							GUA: 12 (To stimulate sexual power in men)	46.2	Raw	Oral
Anacardium occidentale L. (Anacardiaceae)—Tree SPCH- 49	fx1	18	0.90	0.5	0.82	Whole ripe fruit Seed	RSD: 5 (Asthma)	15.2	Raw	Oral
							SMSD: 8 (Head ache)	24.2	Raw	Oral
							DID: 3 (Burn)	9.1	Paste	Topical
							GUA: 17 (Male fertility)	51.5	Raw	Oral
Andrographis alata (Vahl.) Nees. (Acanthaceae)—Herb, SPCH- 78	fx1	13	0.65	2.45	0.91	Aerial part	PB: 9 (Snake bite)	45	Juice	Oral
							FVR: 11 (Fever)	55	Decoction	Oral
Andrographis echioides (L.f.) Nees (Acanthaceae)—Herb, SPCH- 12	fx1	10	0.50	0.65	1.0	Aerial part	PB: 10 (Snake bite)	100	Paste	Oral
Andrographis paniculata (Burm. f.) Nees. (Acanthaceae)—Herb, SPCH-11	fx1	19	0.95	1.3	0.89	Aerial part Leaf	FVR: 18 (Malarial fever)	36.7	Decoction	Oral
							ED: 12 (Diabetes)	24.5	Powder	Oral
							PB: 19 (Snake bite)	38.8	Paste	Topical
Anisomeles malabarica (L.) R. Br. ex Sims. (Lamiaceae)—Herb, SPCH- 58	fx1	13	0.65	0.2	1.0	Leaf	SMSD: 13 (Rheumatism)	100	Paste	Topical
Annona squamosa L. (Annonaceae)—Shrub SPCH- 61	fx1	15	0.75	1.35	0.85	Whole plant Whole ripe fruit Seed	SMSD: 6 (Body pain)	23.1	Juice	Oral
							GH: 12 (Body refreshment)	46.2	Raw	Oral
							HC: 8 (Hair growth)	30.8	Powder	Topical
Aristolochia bracteolata Lam. (Aristolochiaceae)—Climber SPCH- 68	fx1	4	0.20	2.6	1.0	Aerial part	PB: 4 (Snake bite, scorpion sting)	100	Decoction	Oral
Aristolochia indica L. (Aristolochiaceae)—Climber SPCH- 69	fx1	17	0.85	0.75	0.88	Root	FVR: 7 (Fever)	25.9	Decoction	Oral
							RSD: 6 (Cold, cough)	22.2	Decoction	Oral
							PB: 14 (Snake bite)	51.9	Decoction	Oral
Artocarpus heterophyllus Lam. (Moraceae)—Tree SPCH- 74	fx1	18	0.90	0.85	0.82	Leaf Root Whole ripe fruit Seed	GIA: 11 (Indigestion)	21.2	Decoction	Oral
							DID: 8 (Leprosy)	15.4	Paste	Topical
							GH: 16 (Body strength)	30.8	Raw	Oral
							GUA: 17 (Male fertility)	32.7	Powder	Oral
Asparagus racemosus Willd. (Asparagaceae)—Climber SPCH-79	fx1	15	0.75	0.55	1.0	Rhizome	GUA: 15 (Male and female fertility)	100	Powder	Oral
Bacopa monnieri (L.) Wettst. (Plantaginaceae)—Herb SPCH- 42	fx1	17	0.85	1.95	1.0	Whole plant	CSCD: 17 (Memory power)	100	Powder	Oral
Bambusa bambos (L.) Voss. (Poaceae)—Shrub, SPCH- 32	fx1	11	0.55	1.6	1.0	Seed	SMSD: 11 (Rheumatism)	100	Paste	Topical
Boerhavia diffusa L. (Nyctaginaceae)—Herb SPCH- 37	fx1	17	0.85	0.9	0.88	Root Leaf	DID: 15 (Scabies)	38.5	Paste	Topical
							KP: 13 (Stone formation)	33.3	Decoction	Oral

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Borassus flabellifer L. (Palmaceae)—Tree, SPCH- 22	fx1	18	0.90	0.7	0.94	Fruit pulp Stem latex	CSCD: 11 (Blood purifier) GH: 17 (To reduce burning sensation in body)	28.2 53.1	Juice Raw	oral Oral
Calotropis gigantea (L.) Dryand. (Apocynaceae)—Shrub, SPCH-21	fx1	12	0.60	0.75	0.91	Flower Stem latex	DID: 15 (White patches in skin) RSD: 7 (Cold) PB: 11 (Scorpion sting)	46.9 38.9 61.1	Juice Raw Raw	Topical Oral Topical
Canarium strictum Roxb. (Burseraceae)—Tree, SPCH- 13	fx1	16	0.80	0.3	1.0	Resin	SMSD: 14 (Rheumatism)	100	Powder	Topical
Caralluma adscendens var. attenuata (Wight) Grav. & Mayur. (Apocynaceae)—Herb, SPCH- 19	fx1	15	0.75	0.3	1.0	Stem	ED: 15 (Diabetes)	100	Raw	Oral
Caralluma umbellata Haw. (Apocynaceae)—Herb, SPCH- 20	fx1	6	0.30	2.2	1.0	Stem	ED: 6 (Diabetes)	100	Raw	Oral
Cardiospermum corindum L. (Sapindaceae)—Climber SPCH- 25	fx1	6	0.30	0.55	1.0	Aerial part	SMSD: 6 (Rheumatism)	100	Decoction and paste	Oral and topical
Cardiospermum halicacabum L. (Sapindaceae)—Climber SPCH- 26	fx1	19	0.95	2.2	0.89	Aerial part	GUA: 13 (Delivery pain) SMSD: 19 (Rheumatism)	29.5 43.2	Decoction Decoction& Paste	Oral Oral and topical
Carthamus tinctorius L. (Asteraceae)—Herb, SPCH- 154	fx1	11	0.55	0.55	1.0	Seed	GH: 12 (Body refreshment) CSCD: 11 (Heart problem)	27.3 100	Juice Oil	Oral Oral
Cassia fistula L. (Leguminosae)—Tree SPCH- 17	fx1	15	0.75	1.15	0.86	Root Whole ripe fruit Seed	PB: 6 (Snake bite) GIA: 13 (To kill tape worm) GIA: 4 (Dysentery)	26.1 56.5 17.4	Paste Powder Powder	Topical Oral Oral
Celastrus paniculatus Willd. (Celastraceae)—Climber SPCH- 81	fx1	7	0.35	0.35	1.0	Seed	SMSD: 7 (Rheumatism)	100	oil	Topical
Centella asiatica (L.) Urban. (Apiaceae)—Herb, SPCH- 44	fx1	15	0.75	0.75	1.0	Aerial part	CSCD: 15 (Memory power)	100	Soup	Oral
Chloroxylon swietenia DC. (Sapindaceae)—Climber SPCH- 05	fx1	16	0.80	1.75	0.87	Leaf Stem bark Root bark	FVR: 11 (Malarial fever) LP: 11 (Jaundice) DC: 1 (Tooth ache)	31.4 31.4 37.1	Decoction Decoction Raw	Oral Oral Tooth brush
Cinnamomum tamala (Buch.-Ham.) T. Nees & Eberm. (Lauraceae)—Tree, SPCH- 7	fx1	16	0.80	1.35	0.93	Leaf Stem bark	SMSD: 12 (Rheumatism) ONC: 15 (Cancer)	44.4 55.6	Decoction Paste	Oral Topical
Cinnamomum verum J. Presl. (Lauraceae)—Tree, SPCH- 09	fx1	13	0.65	0.65	1.0	Stem bark	GH: 13 (Body stimulant)	100	Decoction	Oral
Cissampelos pareira L. (Menispermaceae)—Climber SPCH- 36	fx1	7	0.35	0.35	1.0	Leaf	SMSD:7 (Bone fracture)	100	Paste	Topical
Cissus quadrangularis L. (Vitaceae)—Climber, SPCH- 32	fx1	13	0.65	0.65	1.0	Stem	GIA: 13 (Stomach ache)	100	juice	Oral
Citrullus colocynthis (L.) Schrad. (Cucurbitaceae)—Climber SPCH- 31	fx1	17	0.85	2	0.87	Whole ripe fruit Seed	HC: 15 (Hair loss) GIA: 13 (Stomach ache) LP: 12 (Jaundice)	37.5 32.5 30	Raw Paste Oil	Topical Oral Oral
Citrus limon (L.) Burm. f. (Rutaceae)—Shrub SPCH- 134	fx1	16	0.80	1.9	0.87	Leaf Whole ripe fruit	FVR: 11 (Fever) HC: 12 (Dandruff) GH: 15 (Body refreshment)	28.9 31.6 39.5	Decoction Juice Juice	Oral Topical Oral
Cocos nucifera L. (Palmaceae—Tree) SPCH- 145	fx1	15	0.75	1.9	0.79	Root Fruit pulp Young Fruit Water	RSD: 6 (Asthma) GUA: 13 (To stimulate sexual power in men) GIA: 5 (Dysentery) GH: 12 (Body strength)	15.8 34.2 13.2 36.8	Decoction Raw Paste Juice	Oral Oral Oral Oral
Coccinia grandis (L.) Voigt. (Cucurbitaceae)—Climber SPCH- 34	fx1	12	0.60	1.85	0.73	Leaf Whole ripe fruit	ED: 11 (Diabetes) ONC: 8 (Cancer) LP: 6 (Jaundice) GH: 12 (Body strength)	29.7 21.6 16.2 32.4	Decoction Raw Cooked Cooked	Oral Oral Oral Oral
Cocculus hirsutus (L.) W. Theob. (Menispermaceae—Climber) SPCH-39	fx1	13	0.65	0.65	1.0	Leaf	DID: 13 (White patches in skin)	100	Paste	Topical
Coriandrum sativum L. (Apiaceae)—Herb SPCH- 41	fx1	13	0.65	1.2	0.83	Aerial part Seed	GH: 7 (Body stimulant) KP: 5 (Stone formation) GH: 12 (Body stimulant)	29.2 20.8 50	Cocked Decoction Decoction	Oral Oral Oral
Cullen corylifolium (L.) Medik. (Leguminosae)—Herb, SPCH- 43	fx1	14	0.70	0.7	1.0	Seed	DID: 14 (Leprosy)	100	Paste	Topical
Cuminum cyminum L. (Apiaceae)—Herb, SPCH- 48	fx1	7	0.35	0.35	1.0	Seed	GIA: 7 (Gastric problem)	100	Decoction	Oral
Curculigo orchioides Gaertn. (Amaryllidaceae)—Herb SPCH- 66	fx1	18	0.90	1.45	0.94	Rhizome	PB: 17 (Snake bite) GIA: 12 (Stomach ache)	58.641.4	PasteInfusion	TopicalOral
Curcuma longa L. (Zingiberaceae—Herb) SPCH- 55	fx1	19	0.95	2.25	0.89	Rhizome	DID:19 (White patches in skin, wound) FVR:15 (Fever) ONC: 11 (Cancer)	42.2 33.3 24.4	Paste Decoction Paste	Topical Oral Topical
Cyclea peltata (Lam.) Hook. f. & Thomson (Menispermaceae)—Climber SPCH- 83	fx1	14	0.70	1.25	0.85	Root	FVR: 13 (Malarial fever) LP: 4 (Jaundice) GIA: 11 (Stomach ache)	46.4 14.3 39.3	Decoction Decoction Decoction	Oral Oral Oral
Cynodon dactylon (L.) Pers. (Poaceae—Herb), SPCH- 4	fx1	15	0.75	1.2	0.93	Leaf Whole plant	CSCD: 13 (Blood purifier) GIA: 11 (Gastric problem)	54.2 45.8	Juice Decoction	Oral Oral

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Table 4 (*continued*)

Botanical name, Family, Habit and Voucher number	Local name	FC	RFC	UV	IAR	Parts used	Ailment category: No. of use reports (ailments treated)	FL	Preparation	Application
Cyperus rotundus L. (Cyperaceae—Herb) SPCH- 6	fx1	12	0.60	1.05	0.82	Rhizome Leaf	KP: 11 (Stone formation)	52.4	Powder	Oral
							GIA: 5 (Dysentery)	23.8	Decoction	Oral
							PB: 5 (Poison bites)	23.8	paste	Topical
Decalepis hamiltonii Wight & Arn. (Apocynaceae)—Climber SPCH- 86	fx1	12	0.60	0.6	1.0	Root	ED: 12 (Diabetes)	100	Paste	Oral
Delonix elata (L.) Gamble (Leguminosae)—Tree, SPCH- 30	fx1	8	0.40	0.4	1.0	Leaf	HEM: 8 (Piles)	100	Decoction	Oral
Dioscorea oppositifolia L. (Dioscoriaceae)—Climber SPCH- 62	fx1	8	0.40	0.4	1.0	Tuber	SMSD: 8 (Swelling)	100	Paste	Topical
Dioscorea pentaphylla L. (Dioscoriaceae)—Climber SPCH- 63	fx1	13	0.65	1.05	0.91	Tuber	RSD: 9 (Asthma)	42.9	Juice	Oral
							GH: 12 (Body stimulant)	57.1	Juice	Oral
Eclipta prostrata L. (Asteraceae)—Herb SPCH- 64	fx1	17	0.85	1.15	0.94	Leaf Root	HC: 16 (Hair growth)	69.6	Powder	Topical
							GH: 7 (To reduce burning sensation in body)	30.4	Paste	Topical
Ficus benghalensis L. (Moraceae)—Tree SPCH- 88	fx1	18	0.90	2.6	0.82	Leaf Young stem Whole ripe fruit Latex	GUA: 5 (To increase sperm count)	9.6	Paste	Oral
							DC: 17 (Teeth strength)	32.7	Raw	Tooth brush
							GUA: 13 (To increase sperm count)	25	Raw	Oral
							GUA: 17 (To stimulate sexual power in men)	32.7	Raw	Oral
Ficus reacemosa L. (Moraceae)—Tree SPCH- 89	fx1	18	0.90	1.8	0.88	Latex Whole ripe fruit	GUA: 18 (To increase sperm count)	50	Raw	Oral
							ONC: 2 (Cancer)	5.6	Raw	Oral
							GIA: 16 (Indigestion)	44.4	Raw	Oral
Ficus reliogiosa L. (Moraceae)—Tree SPCH- 60	fx1	16	0.80	1.7	0.86	Leaf Stem bark Whole ripe fruit	GUA: 13 (To stimulate sexual power in men)	38.2	Paste	Oral
							GD: 5 (White discharge in female)	14.7	Decoction	Oral
							GUA: 16 (Increase sperm count)	47.1	Raw	Oral
Glycyrrhiza glabra L. (Leguminosae)—Shrub, SPCH- 40	fx1	17	0.85	0.85	1.0	Rhizome	RSD: 17 (Cold, cough)	100	Raw	Oral
Heliotropium indicum L. (Boraginaceae)—Herb, SPCH- 28	fx1	15	0.75	0.8	0.93	Aerial part Whole plant	DC: 12 (Mouth ulcer)	75	Raw	Oral
							DID: 4 (Leprosy)	25	Paste	Topical
Hibiscus rosa-sinensis L. (Malvaceae)—Shrub, SPCH- 95	fx1	15	0.75	1.35	0.93	Flower	HC: 15 (Hair growth)	55.6	Paste	Oral
							CSCD: 12 (Heart strength)	44.4	Decoction	Oral
Hygrophila auriculata (Schumach.) Heine (Malvaceae)—Herb, SPCH- 77	fx1	12	0.60	0.6	1.0	Seed	GUA: 12 (Increase sperm count)	100	Powder	Oral
Hyptis suaveolens (L.) Poit. (Lamiaceae)—Herb, SPCH- 16	fx1	5	0.25	0.25	1.0	Leaf	GIA: 5 (Stomach ache)	100	Juice	Oral
Indigofera tinctoria L. (Leguminosae)—Herb SPCH- 42	fx1	15	0.75	1	0.86	Whole plant Root Leaf	RSD: 4(Cold, cough)	20	Powder	Oral
							DID: 3 (Leprosy)	15	Powder	Topical
							PB: 13 (Snake bite)	65	Paste	Topical
Ipomoea aquatica Forssk. (Convolvulaceae)—Climber SPCH- 53	fx1	8	0.40	0.75	0.86	Leaf	LP: 7 (Jaundice)	46.7	Soup	Oral
							DID: 8 (Skin disease)	53.3	Paste	Topical
Ipomoea batatas (L.) Poir. (Convolvulaceae)—Climber SPCH- 189	fx1	15	0.75	1.8	0.93	Tuber	RSD: 13 (Cough)	36.1	Paste	Oral
							FVR: 12 (Fever)	33.3	Raw	Oral
							GH: 11 (Body strength)	30.6	Raw	oral
Ipomoea obscura (L.) Ker Gawl. (Convolvulaceae)—Climber SPCH- 72	fx1	8	0.40	0.4	1.0	Leaf	DID: 8 (Leprosy)	100	Paste	Topical
Kedrostis foetidissima (Jacq.) Cogn. (Cucurbitaceae)—Climber SPCH- 51	fx1	4	0.20	0.3	0.66	Root	RSD: 2 (Asthma)	33.3	Paste	Oral
							HEM: 4 (Piles)	66.7	Paste	Topical
Lagenaria siceraria (Molina) Standl. (Cucurbitaceae)—Climber SPCH- 47	fx1	6	0.30	0.3	1.0	Whole ripe fruit	ED: 6 (Diabetes)	100	Raw	Oral
Lepidium sativum L. (Brassicaceae)—Herb, SPCH- 52	fx1	11	0.55	0.55	1.0	Seed	GUA: 11 (Delivery pain)	100	Powder	Oral
Leucas aspera (Willd.) Link. (Lamiaceae)—Herb SPCH- 65	fx1	16	0.80	1.6	0.87	Leaf	DID: 13 (White patches in skin)	40.6	Juice	Oral
							RSD: 8 (Cold, cough)	25	Juice	Oral
							SMSD: 11 (Headache)	35.4	Raw	Oral
Limonia acidissima L. (Rutaceae)—Tree, SPCH- 73	fx1	9	0.45	0.7	0.87	Whole ripe fruit	GH: 8 (Body refreshment)	57.1	Paste	Oral
							GIA: 6 (Indigestion)	42.9	Paste	Oral
Mangifera indica L. (Anacardiaceae)—Tree SPCH- 54	fx1	9	0.45	0.55	0.75	Leaf Whole ripe fruit	ED: 4 (Diabetes)	36.4	Juice	Oral
							RSD: 2 (Cough)	18.2	Juice	Oral
							ENT: 5 (Eye pain)	45.5	Raw	Oral
Macrotyloma uniflorum (Lam.) Verdc. (Leguminosae)—Herb, SPCH- 75	fx1	15	0.75	0.75	1.0	Seed	KP: 15 (Stone problem)	100	Soup	Oral
Momordica charantia L. (Cucurbitaceae)—Climber SPCH- 76	fx1	18	0.90	1.75	0.88	Leaf Whole ripe fruit	ED: 2 (Diabetes)	5.9	Juice	Oral
							GIA:18 (To kill worms in stomach)	52.9	Raw	Oral
							ED: 14 (Diabetes)	41.2	Raw	Oral

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Morinda citrifolia L. (Rubiaceae)—Tree SPCH- 78	fx1	17	0.85	2	0.81	Whole ripe fruit Whole unripe fruit Leaf	RSD: 13 (Cough)	32.5	Decoction	Oral
							GIA: 15 (Stomach ulcer)	37.5	Decoction	Oral
							DC: 4 (Tooth ache)	10	Raw	Chewing
							DID: 8 (Wounds)	20	Paste	Topical
Moringa oleifera Lam. (Moringaceae)—Tree SPCH- 92	fx1	20	1.00	3.9	0.68	Leaf Stem bark Flower Whole ripe fruit Resin	ENT: 4 (Eye pain)	5.1	Decoction	Oral
							RSD: 14 (Cold, cough)	17.9	Juice	Oral
							GD: 10 (Uterine disorder)	12.8	Decoction	Oral
							GUA: 17 (To stimulate sexual power in men)	21.8	Raw	Oral
							GH: 1 (Body strength)	1.3	Raw	Oral
							GUA: 18 (To stimulate sexual power in men)	23.1	Raw	Oral
							GUA: 14 (To increase sperm count)	17.9	Powder	Oral
Nelumbo nucifera Gaertn. (Nelumbonaceae)—Herb SPCH- 106	fx1	15	0.75	1.4	0.85	Petals Rhizome	CSCD: 11 (Heart strength)	39.3	Decoction	Oral
							GIA: 12 (Stomach ache)	42.9	Paste	Oral
							GUA: 5 (Abortion)	17.9	Juice	Oral
Nerium oleander L. (Apocynaceae)—Herb, SPCH- 84	fx1	13	0.65	0.65	1.0	Stem bark	ENT: 13 (Ear ache)	100	Decoction	Topical
Nigella sativa L. (Ranunculaceae)—Herb SPCH- 126	fx1	12	0.60	0.6	1.0	Seed	GH: 12 (Body refreshment)	100	Raw	Oral
Ocimum basilicum L. (Lamiaceae)—Herb SPCH- 87	fx1	15	0.75	1	0.86	Leaf Seed	KP: 5 (Cold, cough)	25	Juice	Oral and
							GH: 15 (To reduce burning sensation in body)	75	Maceration	Inhalation
										Oral
Ocimum tenuiflorum L. (Lamiaceae)—Herb SPCH- 03	fx1	18	0.90	2.05	0.82	Leaf Seed	RSD: 18 (Cold, cough)	43.9	Juice	Oral
							SMSD: 7 (Head ache)	17.1	Paste	Topical
							DID: 12 (Leprosy)	29.3	Paste	Topical
							GIA: 4 (Stomach ache)	9.8	Maceration	Oral
Pedalium murex L. (Pedaliaceae)—Herb SPCH- 57	fx1	8	0.40	0.4	1.0	Whole ripe fruit	KP: 8 (Stone formation)	100	Powder	Oral
Pergularia daemia (Forssk.) Chiov. (Apocynaceae)—(Climber) SPCH- 59	fx1	12	0.60	0.6	1.0	Leaf	SMSD: 12 (Head ache)	100	Paste	Topical
Phyllanthus amarus Schum. &Thonn. (Euphorbiaceae)—Herb, SPCH- .2	fx1	14	0.70	0.7	1.0	Aerial part	LP: 14 (Jaundice)	100	Powder	Oral
Phyllanthus emblica L. (Euphorbiaceae)—Tree SPCH- 146	fx1	12	0.60	1.2	0.82	Fruit rind	RSD: 12 (Cold, cough)	50	Juice	Oral
							HC: 4 (Hair growth)	16.7	Powder	Topical
							GIA: 8 (Gastric problem)	33.3	Decoction	Oral
Picrorhiza kurroa Royle ex Benth. (Scrophulariaceae)—Herb SPCH- 94	fx1	7	0.35	0.55	0.83	Rhizome	LP: 6 (Jaundice)	54.5	Paste	Oral
							ED: 5 (Diabetes)	45.5	Powder	Oral
Polyalthia longifolia (Sonn.) Thwaites (Annonaceae)—Tree, SPCH- 08	fx1	3	0.15	0.15	1.0	Stem bark, flower	GIA: 3 (Indigestion, Dysentery)	100	Decoction	Oral
Psidium guajava L. (Myrtaceae)—Tree, SPCH- 50	fx1	16	0.80	1.75	0.93	Leaf Whole ripe fruit	DC: 6 (Worms in teeth)	28.6	Raw	Oral
							GIA: 15 (Indigestion)	71.4	Raw	Oral
Pterolobium hexapetalum (Roth.) Santapau & Wagh. (Leguminosae)—Climber SPCH- 111	fx1	4	0.20	0. 2	1.0	Leaf	GUA: 4 (Pregnancy pain)	100	Decoction	Oral
Punica granatum L. (Punicaceae)—Shrub SPCH- 56	fx1	18	0.90	1.65	0.88	Seed Fruit rind Root	CSCD: 12 (Blood circulation)	36.4	Raw	Oral
							GD: 17 (Uterine problem)	51.5	Powder	Oral
							GIA: 4 (Intestinal worms)	12.1	Infusion	Oral
Rosa indica L. (Rosaceae)—Shrub, SPCH- 71	fx1	12	0.60	0.6	1.0	Petal	CSCD: 12 (Heart strength)	100	Decoction	Oral
Senna alexandrina Mill. (Leguminosae)—Shrub, SPCH- 80	fx1	6	0.30	0.3	1.0	Leaf	GIA: 6 (Indigestion)	100	Decoction	Oral
Senna auriculata (L.) Roxb. (Leguminosae)—Shrub SPCH- 70	fx1	18	0.90	1.9	0.88	Flower Whole ripe fruit	ED: 14 (Diabetes)	36.8	Powder	Oral
							GH: 17 (Body shining)	44.7	Decoction	Oral
							GIA: 7 (Stomach ache)	18.4	Powder	Oral
Senna occidentalis (L.) Link (Leguminosae)—Shrub SPCH- 91	fx1	13	0.65	0.95	0.91	Leaf Whole ripe fruit	FVR: 8 (Fever)	42.1	Decoction	Oral
							SMSD: 11 (Bone setting)	57.9	Paste	Topical
Senna tora (L.) Roxb. (Leguminosae)—Herb, SPCH- 93	fx1	12	0.60	0.6	1.0	Seed	GIA: 12 (Stomach ache)	100	Powder	Oral
Sesamum indicum L. (Pedaliaceae)—Herb SPCH- 96	fx1	14	0.70	0.85	0.92	Seed	GH: 13 (To reduce burning sensation in body)	76.5	Raw	Oral
							GIA: 4 (Stomach ache)	23.5	Oil	Oral and Topical
Sida acuta Burm. f. (Malvaceae)—Herb, SPCH- 82	fx1	5	0.25	0.25	1.0	Aerial part	DID: 5 (Cut and wounds)	100	Paste	Topical
Sida cordifolia L. (Malvaceae)—Herb SPCH- 98	fx1	19	0.95	1.6	0.89	Whole plant Seed Root bark	GUA: 4 (To stimulate sexual power in men)	12.5	Powder	Oral
							GUA: 16 (To stimulate sexual power in men)	50	Powder	Oral
							SMSD: 12 (Rheumatism)	37.5	Decoction	Oral
Sphaeranthus indicus L. (Asteraceae)—Herb, SPCH- 123	fx1	12	0.60	0.6	1.0	Flower head	GIA: 12 (Indigestion)	100	Paste	Oral

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Table 4 (*continued*)

Botanical name, Family, Habit and Voucher number	Local name	FC	RFC	UV	IAR	Parts used	Ailment category: No. of use reports (ailments treated)	FL	Preparation	Application
Spilanthes acmella (L.) L. (Asteraceae)—Herb SPCH- 124	fx1	13	0.65	0.65	1.0	Flower head	DC: 13 (Tooth ache)	100	Raw	Oral
Stereospermum tetragonum DC. (Bignoniaceae)—Tree, SPCH- 171	fx1	14	0.70	0.7	1.0	Stem bark	DID: 14 (Leprosy)	100	Paste	Topical
Syzygium cumini (L.) Skeels (Myrtaceae)—Tree SPCH- 90	fx1	18	0.90	2.2	0.82	Stem bark Whole ripe fruit Seed	GH: 3 (To reduce burning sensation in body)	6.8	Decoction	Oral
							ED: 11 (Diabetes)	25	Raw	Oral
							CSCD: 18 (Blood formation)	40.9	Raw	Oral
							ED: 12 (Diabetes)	27.3	Powder	Oral
Tectona grandis L. f. (Lamiaceae)—Tree, SPCH-97	fx1	4	0.20	0.2	1.0	Seed	ED: 4 (Dandruff)	100	Powder	Topical
Terminalia arjuna (Roxb. ex DC.) Wight & Arn. (Combretaceae)—Tree SPCH- 99	fx1	15	0.75	0.75	1.0	Stem bark	CSCD: 15 (Heart strength)	100	Decoction	Oral
Terminalia bellirica (Gaertn.) Roxb. (Combretaceae)—Tree SPCH- 100	fx1	7	0.35	0.5	0.83	Stem bark Fruit rind	GUA: 3 (Urinary problem)	30	Decoction	Oral
							GIA: 7 (Indigestion)	70	Powder	Oral
Terminalia chebula Retz. (Combretaceae)—Tree SPCH- 103	fx1	12	0.60	0.6	1.0	Fruit rind	GIA: 12 (Indigestion)	100	Powder	Oral
Tinospora cordifolia (Willd.) Miers (Menispermaceae)—Climber SPCH- 10	fx1	15	0.75	0.75	1.0	Stem	FVR: 15 (Fever)	100	Decoction	Oral
Trianthema portulacastrum L. (Portulacaceae)—Herb SPCH- 105	fx1	12	0.60	0.6	1.0	Root	RSD: 12 (Asthma)	100	Juice	Oral
Tribulus terrestris L. (Zygophyllaceae)—Herb SPCH- 100	fx1	18	0.90	0.9	1.0	Whole ripe fruit	KP: 18 (Stone problem)	100	Powder	Oral
Tridax procumbens (L.) L. (Asteraceae)—Herb SPCH- 101	fx1	17	0.85	0.85	1.0	Whole plant	DID: 17 (Wounds)	100	Paste	Topical
Vitex negundo L. (Lamiaceae)—Tree, SPCH- 131	fx1	13	0.65	1.2	0.91	Aerial part Leaf	RSD: 13 (Cold, Cough)	54.2	Juice	Oral
							SMSD: 11 (Rheumatism)	45.8	Decoction	Oral
Vitex negundo var. purpurescens Sivar. & Moldenke (Lamiaceae)—Tree SPCH- 132	fx1	19	0.95	1.7	0.94	Aerial part Leaf	RSD: 18(Cold, cough)	52.9	Juice	Oral
							SMSD: 16 (Rheumatism)	47.1	Decoction	Oral
Withania somnifera (L.) Dunal. (Solanaceae)—Herb SPCH- 104	fx1	18	0.90	1.65	0.94	Root	GUA: 18 (To stimulate sexual power in men)	54.5	Powder	Oral
								45.5	Powder	Oral
Zingiber officinale Roscoe (Zingiberaceae)—Herb SPCH- 108	fx1	16	0.80	1.35	0.93	Rhizome	ONC: 14 (Cancer)	51.9	Juice	Oral
							GIA: 13 (Indigestion)	48.1	Decoction	Oral
Ziziphus mauritiana Lam. (Rhamnaceae)—Tree SPCH- 107	fx1	15	0.75	1.3	0.93	Leaf Whole ripe fruit	SMSD: 11 (Body pain)	42.3	Juice	Oral
							GIA: 15 (Indigestion)	57.7	Raw	Oral

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plants like *Borassus flabellifer* L., *Leucas aspera* (Willd.) Link. and *Sida cordifolia* L. were recorded with moderate UV of 1.6.

Use value for a plant species will be high or low based on the availability of the certain plant in a region, its uses, accessibility and informant's knowledge of the particular area. For instance, *Tridax procumbens* (L.) L. was used for cuts and wounds with an UV of 0.85 (17 use reports) and *Sida acuta* Burm. f. also used to treat cuts and wounds with a low UV of 0.25 (5 use reports). It indicates that *T. procumbens* (L.) L. was reported with more number of use reports than *S. acuta* Burm.f. by the informants.

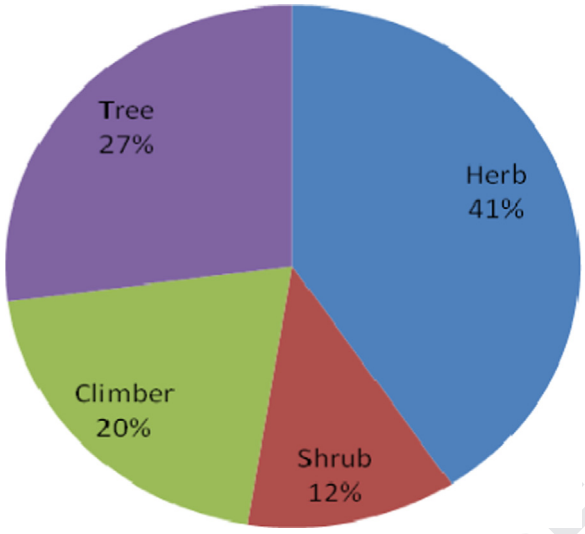

Fig. 2. Life forms of collected ethnomedicinal plants in the study area.

3.5.2. Family use value

The most frequently used family of the present study was Moringaceae with highest FUV (3.9 with 78 use reports) followed by Moraceae (2.18 with 174 use reports), Rubiaceae (2.01 with 40 use reports), Myrtaceae (1.97 with 79 use reports), Nyctaginaceae (1.95 with 39 use reports), Zingiberaceae (1.8 with 72 use reports), Palmaceae (1.75 with 70 use reports) Solanaceae and Punicaceae (each with 1.65 and 33 use reports), Rutaceae (1.5 with 124 use reports), Amaryllidaceae (1.36 with 61 use reports),

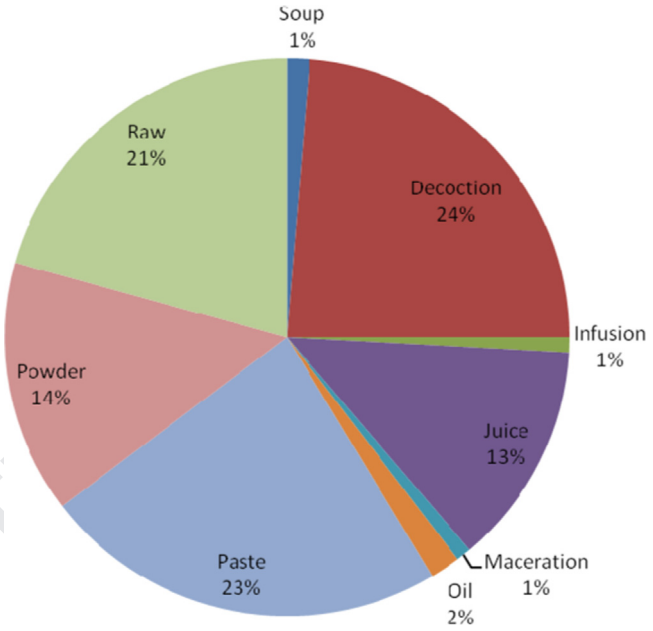

Fig. 4. Method of preparation of herbal medicines by the studied tribal people.

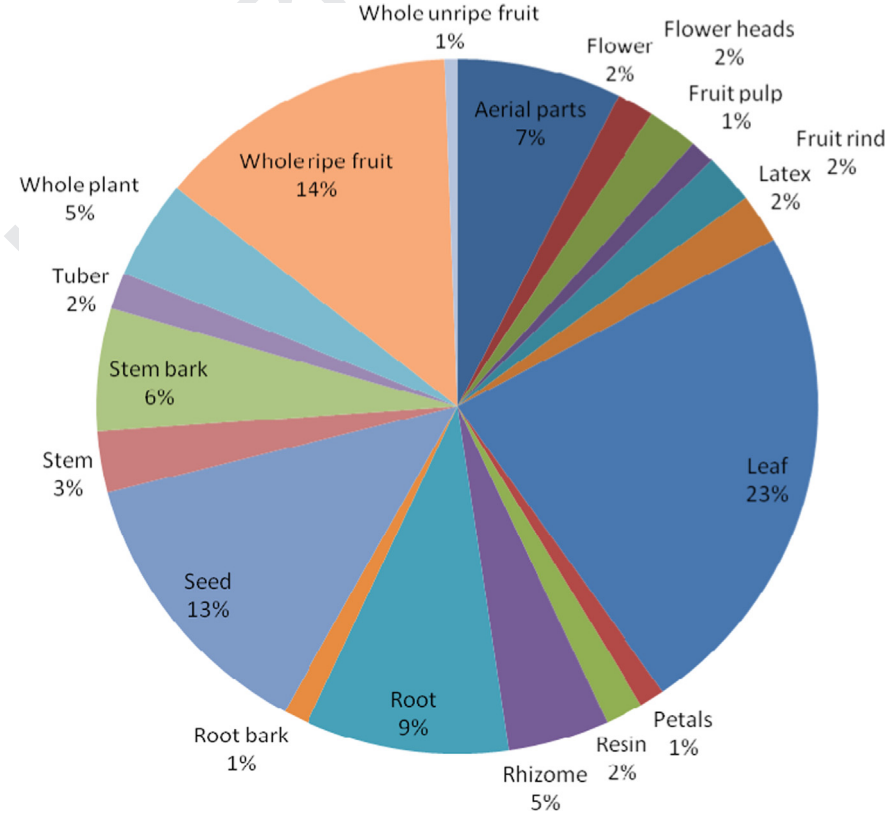

Fig. 3. Plant parts used for the preparation of herbal medicines by Malayali tribal people.

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Nelumbonaceae (1.4 with 28 use reports), Rhamnaceae and Euphorbiaceae (1.3 with 26 and 78 use reports respectively) and remaining families are reported with 1.25 to 0.35 FUV (Table 5).

3.5.3. Fidelity level

In the present study 53 species of plants were recorded with 100% fidelity level for different type of illness category (Table 4). The plant species having highest fidelity level constitutes those are most preferred plants among the informants in the treatment of particular illness category (Friedman et al., 1986) and plants which are used in some repetitive manner are more likely to be biologically active (Trotter and Logan, 1986). Hence the plants with highest FL might be an indication of their good healing potential for a specific ailment (Ayyanar and Ignacimuthu, 2011). The plants with highest FL values were also reported to have number of pharmacological effects which were proven scientifically. Some important plants with highest FL in the study were *Bacopa monnieri* (L.) Wettst., *Centella asiatica* (L.) Urban. and *Terminalia arjuna* Roxb. ex DC. (for CSCD), *Spilanthes acmella* (L.) L. (for DC), *Cocculus hirsutus* (L.) W. Theob., *Stereospermum tetragonum* DC. and *T. procumbens* (L.) L. (for DID) *Caralluma umbellata* Haw. and *Decalepis hamiltonii* Wight. (for ED), *Nerium oleander* L. (for ENT), *Tinospora cordifolia* (Willd.) Miers. (for FVR), *C. verum* J. Presland and *N. sativa* L.(for GH), *Abutilon indicum* (L). Sweet., *Senna tora* (L.) Roxb., *Cissus quadrangularis* L., *Sesamum indicum* L. and *Terminalia chebula* Retz. (for GIA), *Aaparagus racemosus* Willd., *Hygrophila auriculata* (Schumach.) Heine. and *Lepidium sativum* L. (for GUA), *Macrotyloma uniflorum* (Lam.) Verdc. and *Tribulus terrestris* L. (for KP), *Phyllanthus amarus* Schum. & Thonn. (for LP), *Andrographis echioides* (L. f.) Nees. (for PB), *G. glabra* L. and *Trianthema portulacastrum* L. (for RSD), *Anisomeles malabarica* (L.) R. Br. ex Sims., *Bambusa bambos* (L.) Voss., *Canarium strictum* Roxb. and *Pergularia daemia* (Forssk.) Chiov. (for SMSD).

The plant with lowest FL indicates these plants were less preferred species for treating specific ailments. In contrast, one of the highly reported plants (*M. oleifera* Lam.) of the present study has been widely used against various type of diseases and in fact attained very low FL values as ENT (5.1), RSD (17.9), GD (12.8), GH (1.3), GUA (21.8 and 23.1 for men and women diseases respectively) GUA (17.9 for resin). Abe and Ohtani (2013) also observed that *M. oleifera* Lam. was used for a wide range of ailments such as

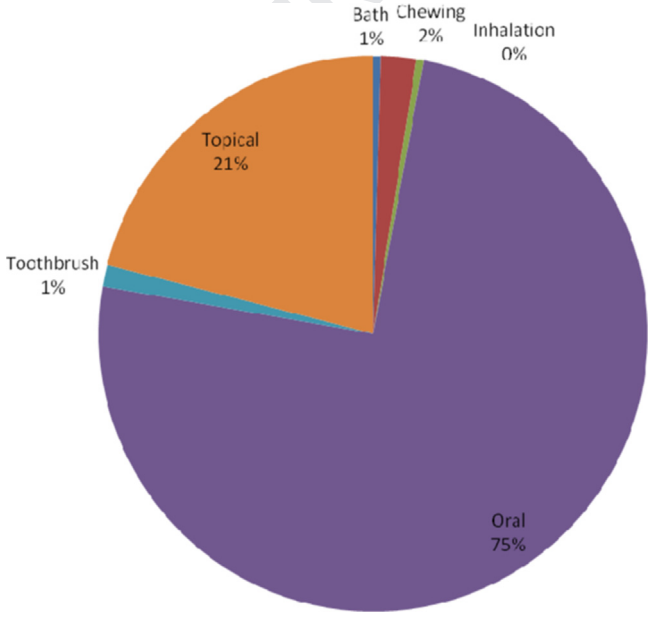

Fig. 5. Mode of application of herbal preparations by the informants.

diabetes, body strength, anemia, to lower blood pressure, constipation, ulcer, scabies, skin eruption, cuts and wounds by the local people in Philippines with varied low FL values resembling to the present study.

3.5.4. Informant consensus factor

The ailment categories with highest ICF value indicate the degree of knowledge sharing among the informants of the study area to treat particular ailment by particular plant species. The ICF values of 18 ailment categories were computed using the recorded use reports by informants in the study area and number of taxa employs. The ICF value of different ailment categories were ranged from 0.89 to 0.93 (Table 6). The highest ICF value was recorded for CSCD and GD with 0.93 followed by FVR, GH, GUA, HEM and PB (each with 0.92), DID, HC, KP, ONC and SMSD (each with 0.91). Most of the ailment categories in the present study were recorded with highest ICF; similarly, Abe and Ohtani (2013) reported that ring-worm infection (*Senna alata* (L.) Roxb.), sore eye (*Calophyllum inophyllum* L.) and toothache (*Ormocarpum cochinchinense* (Lour.) Merr.) were highest ICF of 1.00 among the indigenous people of Batan Island in the Philippines.

The ailment categories with high ICF is a result of several use reports for a single species or a few species, for example 32 use reports corresponding to only 3 species gives the ICF of 0.93 for GD. The ailment categories like GIA, GUA, RSD, DID and SMSD were reported with 34, 24, 21, 19 and 17 species of plants, respectively. The high ICF occurring ailment category reflects a high level of homogeneity among the informants in different villages of the study area regarding the medicinal use of a species (Tuttolomondo et al., 2014). The informant consensus factor was abbreviated as "FIC" and "ICF" in the previous articles (Al-Quran, 2009; Rokaya et al., 2010; Upadhyay et al., 2011; Kaval et al., 2014; Polat et al., 2015).

3.5.5. Frequency citation and relative frequency citation

The FC and RFC values were used to determine the local importance of each plant species of study area. In the present study, *M. oleifera* Lam. was recorded with highest RFC (1) which tend to show that it was locally important among all the interviewed informants for the treatment of variety of diseases like male and female fertility, cold, cough, eye pain and to improve body strength (Table 4). It was followed by *Vitex negundo var.* purpurescens Sivar. & Moldenke, *S. cordifolia* L., *C. longa* L., *C. halicacabum* L. and *A. paniculata* (Burm. f.) Nees (0.95 each), *Adhatoda vasica* Nees, *Anacardium occidentale* L., *A. heterophyllus* Lam., *B. flabellifer* L., *S. auriculata* (L.) Roxb., *Curculigo orchioides* Gaertn., *F. benghalensis* L., *Ficus reacemosa* L., *Momordica charantia* L., *Ocimum tenuiflorum* L., *Punica granatum* L., *S. cumini* (L.) Skeels, *T. terrestris* L. and *Withania somnifera* (L.) Dunal. (0.90 each). The low RFC value was reported for the plants *A. paniculata* (Burm. f.) Nees (0.10), *Aristolochia bracteolata* Lam. and *Kedrostis foetidissima* (Jacq.) Cogn. (0.20 each), *Hyptis suaveolens* L. and *S. acuta* Burm. f. (0.20 each). If the number of datasets is very small, it is not possible to determine the best strategy for evaluating the relative importance of species as shown by high correlation coefficient between RFC and UV and between the number of citations and informants (Vitalini et al., 2013).

3.5.6. Informants agreement ratio

The plants with higher IAR values observed in the present study were those plants suggested by all the informants for treating same disease especially in case of single disease (Table 4). *A. indicum* (L.) Sweet (dysentery), *A. echioides* (L. f.) Nees. (snake bite), *A. malabarica* (L.) R. Br. ex Sims. (rheumatism), *Asparagus racemosus* Willd. (fertility problems), *B. monnieri* (L.)

Table 5
Family use value of plants collected in the present study.

Family	Total UV of the family	No. of species	FUV	% of family
Moringaceae	3.90	1	3.90	0.8
Moraceae	8.70	4	2.18	3.4
Rubiaceae	2.00	1	2.00	0.8
Myrtaceae	3.95	2	1.98	1.7
Nyctaginaceae	1.95	1	1.95	0.8
Zingiberaceae	3.60	2	1.80	1.7
Palmaceae	3.50	2	1.75	1.7
Solanaceae	1.65	1	1.65	0.8
Punicaceae	1.65	1	1.65	0.8
Rutaceae	6.20	3	1.55	2.5
Rhamnaceae	1.30	1	1.30	0.8
Euphorbiaceae	3.90	3	1.30	2.5
Sapindaceae	2.50	2	1.25	1.7
Cucurbitaceae	6.15	5	1.23	4.2
Acanthaceae	5.65	4	1.13	3.3
Amaryllidaceae	4.10	3	1.36	2.5
Lamiaceae	8.65	8	1.08	6.7
Anacardiaceae	2.20	2	1.10	1.7
Cyperaceae	1.05	1	1.05	0.8
Lauraceae	2.00	2	1.00	1.7
Malvaceae	3.95	5	0.99	4.2
Convolvulaceae	2.95	3	0.98	2.5
Combretaceae	1.85	3	0.98	2.5
Zygophyllaceae	0.90	1	0.90	0.8
Poaceae	1.75	2	0.88	1.7
Plantaginaceae	0.85	1	0.85	0.8
Boraginaceae	0.80	1	0.80	0.8
Leguminosae	10.45	13	0.80	11.0
Aristolochiaceae	1.55	2	0.78	1.7
Apiaceae	2.30	3	0.77	2.5
Menispermaceae	3.00	4	0.75	3.4
Asparagaceae	0.75	1	0.75	0.8
Dioscoriaceae	1.45	2	0.73	1.7
Annonaceae	1.45	2	0.73	1.7
Burseraceae	0.70	1	0.70	0.8
Bignoniaceae	0.70	1	0.70	0.8
Vitaceae	0.65	1	0.65	0.8
Apocynaceae	3.80	6	0.63	5.1
Pedaliaceae	1.25	2	0.63	1.7
Rosaceae	0.60	1	0.60	0.8
Ranunculaceae	0.60	1	0.60	0.8
Portulacaceae	0.60	1	0.60	0.8
Scrophulariaceae	0.55	1	0.55	0.8
Brasssicaceae	0.55	1	0.55	0.8
Asteraceae	4.10	7	0.51	6.8
Celastraceae	0.35	1	0.35	0.8

Table 6
Informant consensus factor (ICF) values of ailment categories.

Ailment category	Number of use reports (N_{ur})	Number of taxa (N_t)	Informant consensus factor (F_{ic})
Circulatory system and Cardiovascular diseases (CSCD)	178	13	0.93
Gynaecological disorders (GD)	32	3	0.93
Fever (FVR)	121	10	0.92
General health (GH)	244	21	0.92
Genito-urinary ailments (GUA)	296	24	0.92
Haemorrhoids (HEM)	27	3	0.92
Poisonous bites (PB)	121	11	0.92
Dermatological infection and diseases (DID)	194	19	0.91
Hair care (HC)	85	8	0.91
Kidney problem (KP)	75	7	0.91
Oncology (ONC)	50	5	0.91
Skeleton-Muscular system diseases (SMSD)	179	17	0.91
Dental care (DC)	92	10	0.90
Endocrine disorders (ED)	124	13	0.90
Ear, Nose and Throat infections (ENT)	22	3	0.90
Liver problem (LP)	72	8	0.90
Respiratory system diseases (RSD)	204	21	0.90
Gastro intestinal ailments (GIA)	315	34	0.89
Total	2431	230	

Wettst. (memory power), *C. strictum* Roxb. (rheumatism), *C. asiatica* (L.) Urban. (memory power), *G. glabra* L. (cold and cough), *P. amarus* Schum. & Thonn. (jaundice), *Cullen corylifolium* (L.) Medik. (leprosy), *T. terrestris* L. (stone formation) and *T. procumbens* (L.) L. (cuts and wounds) were reported with high IAR values. Lowest IAR was recorded for *K. foetidissima* (Jacq.) Cogn. and *M. oleifera* Lam. as 0.66 and 0.68, respectively. The reported plants with significantly high IAR of easily available plants in an ethnobotanical survey indicated the importance of availability of resources on maintenance of knowledge over their usage on medicinal preparations (Mutheeswaran et al., 2011).

4. Conclusion

The present investigation revealed that, the study area has vast diversity of medicinal plants which were used for the primary healthcare system by tribal people. This is the first ethnobotanical research in the study area and present exploration quantifies the use of medicinal plants by herbalists and local people. They provide medical practice among themselves and the patients approaching them with their knowledge of medicinal flora in their environs for the treatment of different type of diseases. But very less number of professional healers was identified in the study area revealed preserving this traditional knowledge before it vanishing from this generation, since the present day young generation of this community is not interested to learn and follow these traditional practices. The efficacy and safety of commonly used ethnomedicinal plants need to be evaluated for detailed phytochemical and pharmacological studies especially the plants with high trade value should be given priority to carry out bioassay and toxicity studies. As a result of present study we are suggesting the plants *A. indicum* (L.) Sweet., *A. echioides* (L.f.) Nees., *B. monnieri* (L.) Wettst., *C. strictum* Roxb., *C. asiatica* (L.) Urban., *S. auriculata* (L.) Roxb. and *T. terrestris* (L.) for further ethnopharmacological studies which are reported with high UV, IAR, RFC and FL values.

Uncited references

Girach et al. (1999), Kapur et al. (1992), Sargin et al. (2013).

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