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Floristics and indigenous knowledge of agro-climatically diverse Sacred groves of central Kerala

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Abstract

The study aimed to identify and document indigenous knowledge about medicinal plants in the selected sacred groves of central Kerala using the typical ethnobotanical approach and record the information. A pre-structured questionnaire survey and quantitative analysis were carried out to record the medicinal plants and to determine the ailments categories. In this study, 141 species belonging to 129 genera and 63 families were recorded from the highland sacred grove Amaran Kavu, and 198 species belonging to 176 genera and 75 families were recorded from the lowland grove Nagampoozhimana Kavu. Habit-wise analysis of the flora showed that trees are the dominant forms (37.58%) in the highland hilly grove, while herbs dominate (36.86%) in the coastal grove. The ethno-floristic survey revealed a total of 102 species of medicinal plants belonging to 90 genera and 50 families.

The significance of the plant species was quantified by using family use value, use value index, and informant consensus factor. The highest family use value index (FUV) was reported in the families Piperaceae, Caesalpiniaceae, Combretaceae, etc. and the maximum Use Value (1) was reported in *Curcuma longa* L. and *Ocimum basilicum* L., which are the high use valued species among the community and Use Value Index (UVI) ranges from 0.05-1. The Informant Consensus Factor (ICF) value ranged from 0.93 to 0 and the greatest value (0.93) was obtained for postnatal care, earache (0.92), migraine and headache (0.9). The present study reveals that the indigenous people living around the sacred groves depend on the plant species for their health care. However, proper management is required for the conservation of sacred groves through sustainable utilization of medicinal plants occurring in the groves.

Keywords

conservation; Ethnomedicine; indigenous knowledge; phyto-diversity; sacred groves

Introduction

The Western Ghat region is a repository of immense biological diversity and a traditional knowledge system (TKS) associated with indigenous communities. Among the south Indian states, Kerala also known as "God's own country" is known for its rich biological diversity, cultural heritage and pilgrimage centers. The highland and lowland regions of central Kerala are well known for their distinctive ethnic communities, each of which demonstrates a unique ethnomedicinal knowledge system.

The sacred groves of the central Kerala region are part of Western Ghat's evergreen and semi-evergreen vegetation near the Arabian Sea coast in the western side of Kerala and extend southeast by Tamil Nadu. Presently these are the areas having only certain patches or remnants of forests so-called sacred groves, which are protected under the ground of religious faith. The central Kerala sacred groves are part of the highland, midland and lowland regions of this terrain. The majority of the population uses several plants for their basic requirements like medicine, food, fodder, fibers, dyes, etc. They collect the plants from nearby groves and also grow them for some household remedies in their dooryard gardens. Primarily sacred groves are considered treasure houses of rare and endangered plant species and abode of many medicinal plants that are also facing threats due to various man-made activities. A severe threat faced is the large-scale destruction of vegetation particularly forest vegetation and the disappearance or scarcity of many valuable medicinal plants of traditional use. Hence, it is very important to protect these surviving examples of climax vegetation.

In many societies, medicinal plants form the foundation of the healthcare system. Approximately 85% of conventional medications used for basic healthcare worldwide are plant-based (1). As much as 80% of people worldwide still rely on traditional medicine today, according to the World Health Organisation (WHO). In India, 65% of the rural population uses Ayurvedic medicine and medicinal plants to aid with basic healthcare needs (2-3). Over 43% of all blooming plants in India are thought to have therapeutic use (4).

Ethnobotanical studies and documentation of data on medicinal plants and dissemination of this information to the public are highly indicative to make them aware of the relevance of maintaining and preserving these natural resources for the future. The present study was carried out to reveal the floristic diversity and ethnomedicinal wealth of the selected sacred groves to create awareness among the people about the relevance of traditional knowledge and to find new treatments. The indigenous tribal cultures prudently utilize the medicinal flora to treat diseases and infections to maintain good health. Many common household remedies are used by the native people, which are on the edge of disappearance. Hence, it is imperative to document traditional knowledge about medicinal plants and their recipes (5).

The erosion of traditional medical knowledge and resources associated with folklore medicine is a consequence of evolving lifestyles, customs and a scarcity of documentation regarding this knowledge (6). Despite the vast and varied flora of central Kerala, the biodiversity of the sacred groves concerning ethnomedicinal uses has not been explored sufficiently. The objective of the present work is to study the floristic diversity, documentation of ethnomedicinal uses and threat assessment of the medicinal plants in selected groves and discuss their importance in the conservation of regional plant diversity. Given these facts, the authors conducted a structured ethnobotanical survey to document available medicinal plants from sacred groves for traditional treatment systems.

Materials and Methods

2.1 Study area

Based on the inventory and preliminary survey during the period 2021-2023, two major sacred groves i.e. Amaram Kavu (Idukki district) and Nagampoozhimana Sarpakau (Kottayam district) were selected from agro-climatically diverse regions of central Kerala and conducted detailed studies on floristic composition, ethnobotanical importance and threatened taxa point of view. Selection of the groves was made considering their size, vegetation and location. The study area of the selected sacred groves varied in size from about 1.20 to 1.60 hectares located at high land and low land regions of central districts of the Kerala state respectively. The location of the selected sacred groves is shown on the map of Kerala (Fig. 1 and Table 1).

2.2 Climate

Central Kerala districts mostly experience variability in rainfall, with the monsoon season from June to August which is considered to be the maximum growth period for natural vegetation. Thus, in the post-monsoon season September to January, a majority of the plants bear flowers and fruits. While, the pre-monsoon season from February to May, the rainfall is minimal. Due to the continuous rise in temperature, this is the period of maturation and drying up of native floras, generally grasses and herbaceous plants. In March-April the highest mean temperature in the range 37 - 40˚C and the average annual rainfall between 2800-3130 mm were recorded.

Table 1. Location of sacred groves.

Name of the sacred grove	District	Area (ha.)	Physiographic Zone	Latitude/Longitude with Altitude	Deities
Nagampoozhimana Sarpakavu	Kottayam	1.20	Low land	9.7216°N 76.3927°E 10 m	Naga
Amaram Kavu	Idukki	1.60	High land	9.89027°N 76.69081°E 72 m	Durga

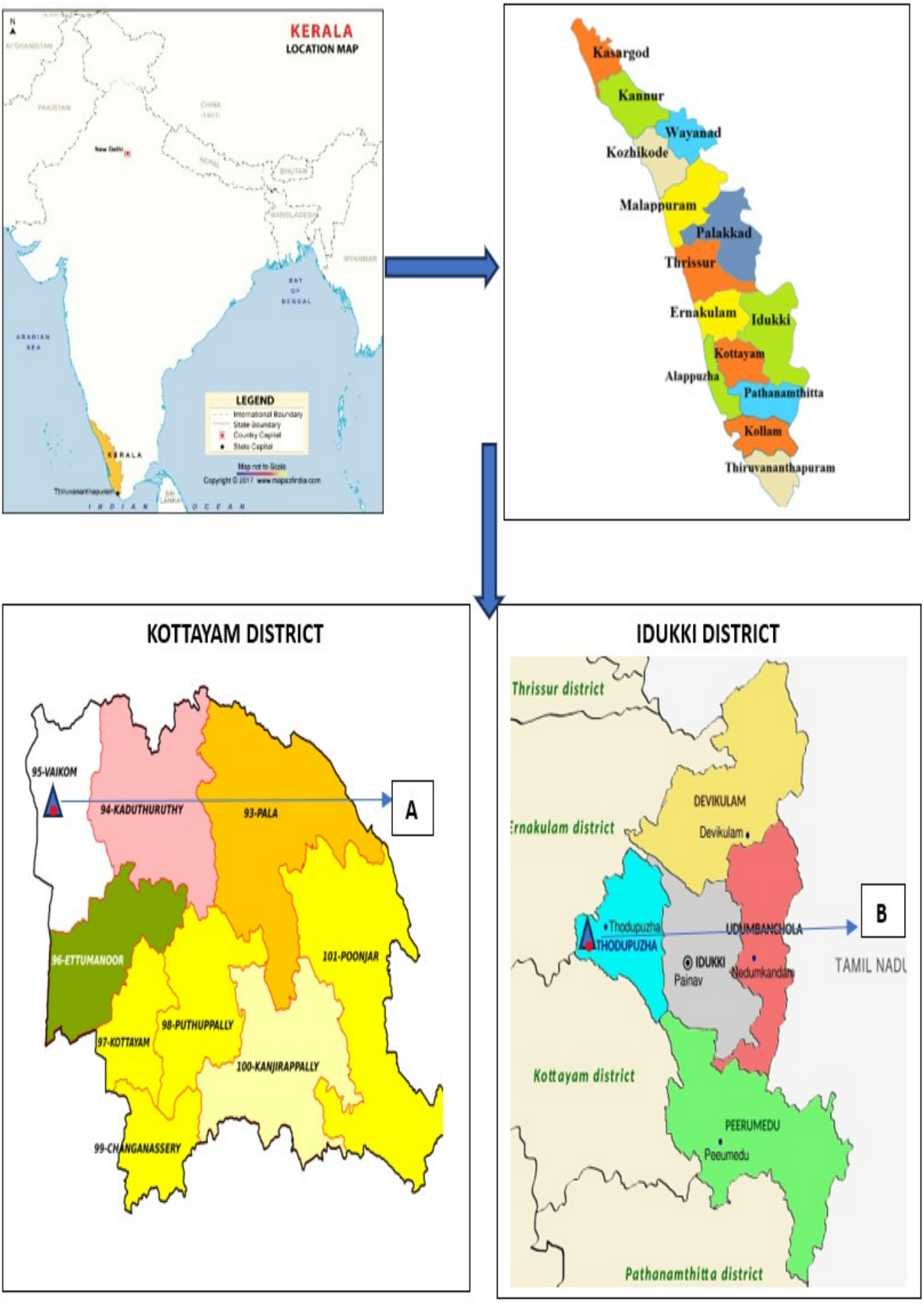

Fig. 1. Map of India shows the state Kerala with selected sacred groves at Kottayam and Idukki districts indicated; **'A'** as Nagampoozhimana Sarpakavu and **'B'** as Amaram Kavu.

Fig. 1. a. Nagampoozhimana Sarpakavu GIS Image

Fig. 1. b. Amaram Kavu GIS Image

2.3 Demography

The selected areas are the natural abode of the aboriginal tribes, whose main occupation is agriculture. The majority of residents in these districts include various Hindu, Christian, Dalit and some tribal communities, with a population ranging between 819,000-101,58,72. Tribals like Malaveda, Malayaraya, Muthuvan and Mannan inhabit the upland regions and the foothills of high-range areas almost 600 meters above mean sea level.

2.4 Analysis of the Phyto-diversity

The floristic composition of trees, shrubs, climbers and herbs was recorded from both the groves, and their identification with the voucher specimens was carried out during the flowering and fruiting (7). Specimens were verified with the herbaria of Kerala Forest Research Institute (KFRI), Peechi and Plant Science Department, Calicut University (CALI). The voucher specimens were deposited in the herbarium of the Department of Botany, St. Teresa's College (Autonomous) Ernakulam, Kerala. The taxonomic details of the flora were noted and the specimens were identified using standard floras like Flora of the Presidency of Madras (8), Flowering Plants of the Western Ghats (9), Flora of Alapuzha district (10), Computerized taxonomic identification of Flowering Plants of Kerala (11).

2.5 Analysis of the Ethnomedicinal Plant Wealth

A survey method was adopted for the assessment of ethno -medicinal plants and related information. The results presented are based on personal interviews with local people, traditional healers and informant's observations. In-depth ethnobotanical inquiry was used in the present study and compiles the traditional knowledge of plants.

Each grove was visited 4 to 5 times during different seasons to cover the selected houses of the nearby areas in the field of study. During the field investigation for plant collection and documentation of data, the informant accompanied the authors. Each use of the plant has been confirmed and verified during different visits to different localities in the region. During the survey, the recommended folklore plant specimens were collected and identified (12). The folklore descriptions regarding habit, phenology of the plant, colour, texture and smell of leaves, local names and local uses available were recorded. Other relevant information on ethnomedicinal plants was done with the help of referred books and reports (13-17).

2.6 Data analysis

1. Family Use value (FUV)

The family use value of medicinal plants was used to calculate the family-wise significance of medicinal plants using the formula **FUVs= Σ UVs/ Ns** where, UVs= the sum of the use value of all the species quoted from a family and Ns = total number of species quoted among each family.

2. Use Value Index (UVI)

The use value index was calculated to know the relative importance of an individual plant species used by the respondents, applying the formula **UV= Σ U/n** where, U = the number of respondents citing the use of a single species and *n* = the total number of participants surveyed during the study.

3. Informant consensus factor (ICF)

It is used to estimate the variability of medicinal plants and to determine the plant species that are particularly interesting in the search for bioactive compounds (18). ICF is calculated using the formula **Fic = NUR-Nt/Nur-1** where, *'NUR'* = number of use-reports in each category and *'Nt'*= the number of taxa used for a particular ailment.

4. Determination of threat status

The details of the threat status of plant species were collected with the help of International Union for Conservation of Nature and Natural Resources (IUCN) categories and criteria to evaluate and assess the RET species status (19-20), while the conservation status was checked using IUCN 2017- 3 (21).

Results and Discussion

3.1 Analysis of plant diversity in selected groves

The present study was conducted to assess the floristic diversity of two agro-climatically diverse sacred groves. It resulted in the documentation of 141 species belonging to 129 genera and 63 families in high land sacred grove (Amaran Kavu) and 198 species belonging to 176 genera and 75 families in low land grove (Nagampoozhimana Kavu).

Angiosperm flora is composed of trees to herbs. Habit-wise analysis in high land groves shows a comparatively higher percentage of trees with 53 species (37.58 %) predominant followed by climbers with 33 species (23.40 %), shrubs with 30 species (21.27%) and herbs with 25 species (17.73%). Similarly, low land sacred grove shows herbs with 73 species (36.86%) as the major group followed by trees with 51 species (25.75%), climbers with 41 species (20.70%) and shrubs with 33 species (16.66%) (Fig. 2).

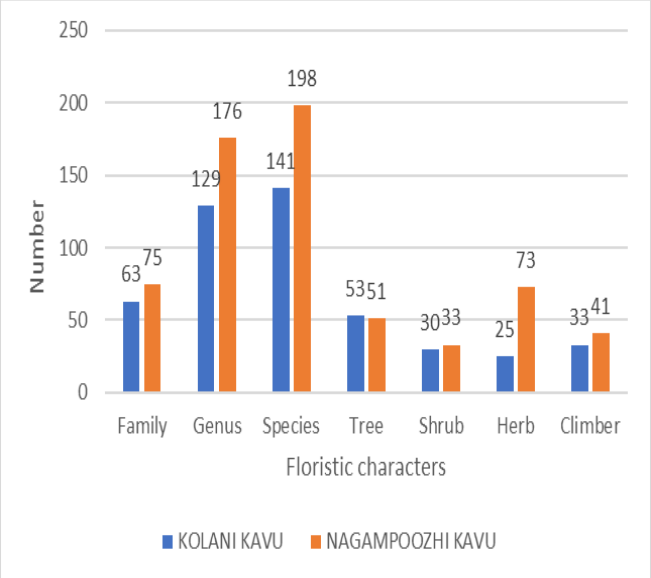

Fig. 2. Floristic analysis in selected sacred groves.

3.2 Socio-demographic profile of the respondents

A total of 36 respondents, comprising 22 females and 14 males participated in the study. For effective participation to obtain relevant data, the age of the respondents was purposively classified into six groups < 25, 25 to 40, 41 to 55, 56 to 70, 71-85 and above 85 years. The information on the percentage values for the respondent's gender, age and educational status is also provided (Table 2). The present study reported that 33.33% of elderly members (aged between 56 and 70) of the communities hold immense knowledge of traditional practices in the region, while the younger generation has limited interest in acquiring and practicing indigenous medicines.

3.3 Analysis of the ethnomedicinal plant wealth

3.3.1 Enumeration of ethnomedicinal flora

The ethnomedicinal plant species collected from the sacred groves are presented with their botanical name, distribution, family followed by genus, vernacular name, habit, part used, ailments treated, mode of administration and threat categories (Supplementary Table 3).

According to the distribution of ethnomedicinal species, the highland Amarankavu grove with 26 species, low land Nagampoozhimana grove with 45 species and both these groves comprised 31 species of common distribution. A total of 102 different taxa distributed across 90 genera and 50 families were utilized to treat several human ailments reported among various indigenous peoples and traditional healers living around the selected grove area. They utilize the grove flora for their indigenous medicinal practices, which constituted 40.42% and 38.38% of the total plant species representation of the Amarankavu and Nagampoozhimana groves respectively. Of these plants 35% are herbs, 30% trees, 19% climbers and 16% shrubs are present (Fig. 3). The frequent use of herbaceous species among the local communities could be a result of their relative abundance as compared to trees and shrubs as identified by investigators of this study. The areas selected experience Southeast and Northwest monsoons during the middle of the year creating favorable conditions for the regeneration of annuals and perennials after a dormant period.

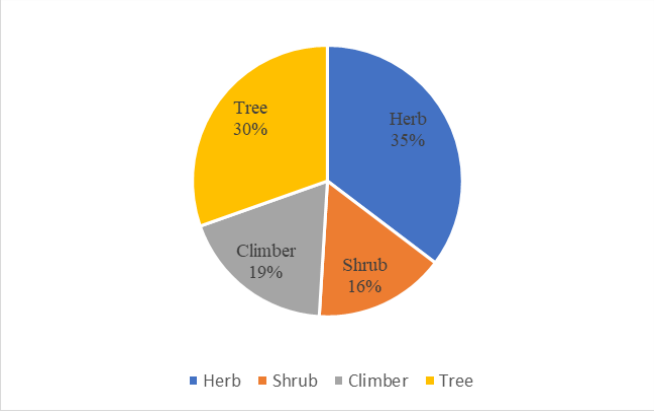

Fig. 3. Life form analysis of Ethnomedicinal flora.

The majority of the plant species recorded from Apocynaceae (8 species), followed by Rubiaceae (7 species), Fabaceae (6 species), Zingiberaceae (5 species) and 4 species as representing Acanthaceae, Asteraceae and Solanaceae (Fig. 4). It is analyzed that ethnobotanical and therapeutic knowledge is rich among the local communities of high land and low land regions of central Kerala. The present finding shows a similar distribution of ethnomedicinal species reported from the study carried out in Kerala state of India (22). Acknowledging the significance of the Traditional Knowledge System (TKS), the current study shows how villagers use phytomedicine resources to treat a variety of illnesses using diverse healing methods.

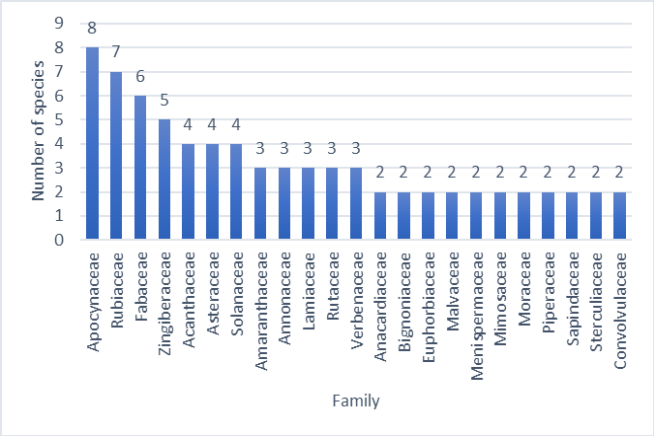

Fig. 4. Dominant families reported among highland and low-land sacred groves.

Table 2. Socio-demographic characteristics of the respondents.

Socio-economic variables	Category	Number of respondents	Percentage (%)
Gender	Male	14	38.88
	Female	22	61.11
Age	Less than 25	1	2.77
	25-40	4	11.11
	41-55	6	16.66
	56-70	12	33.33
	71-85	9	25
	Above 85	4	11.11
Educational status	Illiterate	2	5.55
	Primary	6	16.66
	High school	9	25
	Higher Secondary	12	33.33
	Graduate	7	19.44

The most dominant and abundant plant genera found in the sacred groves include *Curcuma* (3 species), *Justicia, Tabernaemonata, Wrightia, Desmodium, Ficus, Piper, Ixora, Solanum* and *Vitex* with 2 species each (Fig. 5).

The most common medicinal plant species found in the highland and lowland sacred grove sites include *Acacia caesia* (L.) Willd., *Achyranthes aspera* L., *Alstonia scholaris* (L.) R. Br., *Asparagus racemosus* Willd., *Cissus repens* Lam., *Clerodendrum infortunatum* L., *Curcuma longa, Elephantopus scaber* L., *Ficus religiosa* L., *Garcinia gummi – gutta* (L.) Robs., *Glycosmis pentaphylla* (Retz.) DC., *Hydnocarpus pentandra* (Buch. -Ham.) Oken, Allg., *Justicia adhatoda* L., *Kyllinga nemoralis* (J. R & G. Forst.) Dandy *ex* Hutch. & Dalz., *Mussaenda frondosa* L., *Piper longum* L., *Schleichera oleosa* (Lour.) Oken, Allg., *Smilax zeylanica* L., *Strychnos nux-vomica* L., *Tabernaemontana alternifolia* L. and *Zizyphus oenophila* (L.) DC., etc.

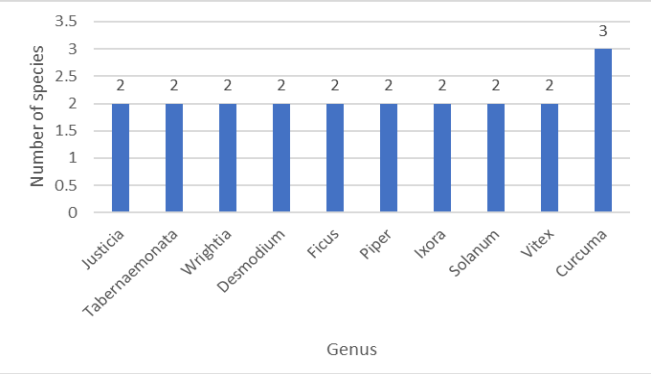

Fig. 5. Dominant genera reported among high-land and low-land sacred groves.

3.3.2 Plant parts used

The present ethnomedicinal study revealed that the local people living near the sacred groves were using all the represented species of medicinal plants to cure their ailments and various diseases (Supplementary Table 3). There are 10 types of plant parts used for the medicinal preparations, most of them reliant on leaves with 23% and roots with 20%. Whole plants have nearly 13% utility while fruits with 11%, bark with 10%, rhizome and seeds with 6%, stem and flowers with 5% (Fig. 6)

The utility of fruits was described in *Aegle marmelose* (L.) Correa, Trans., *Garcinia gummi-gutta*, *Helicteres isora* L., *Piper longum, Solanum torvum* Sw., *Syzygium cumini* (L.) Skeels, etc. for curing chronic fever, diarrhoea, dysentery, indigestion, abdominal pain and diabetes respectively.

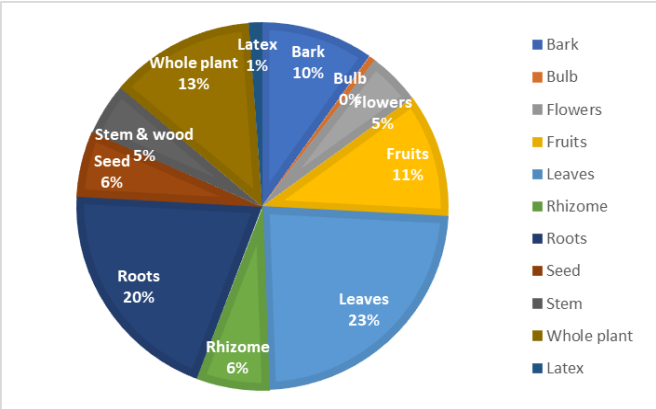

Fig. 6. Plant parts used in the preparation of traditional medicines.

Similarly root bark of *Gmelina arborea* L. and *Holarrehena pubescens* (Bunch. - Ham.) Wall *ex* G. are used in dyspepsia and dysentery and stem bark of *Lannea coromandelica* (Houtt.) Merr. and *Quassia indica* (Gaertn.) Nooteb. is used in postpartum care.

Furthermore, underground plant parts such as rhizomes and bulbs were also used as small healing remedies. Rhizomes of *Amorphophallus commutatus* (Schott) Engl. in A. & C. DC., *Ipomoea cairica* (L.) Sweet, *Asparagus racemosus, Curcuma* species, *Costus speciosus* (Koenig) J. E. Smith, Trans., *Hemidesmus indicus* (L.) R. Br., etc. are used for the treatment of piles, mineral deficiency, urinogenital and maternal postpartum care, as an antidote to poison, respiratory problems and skin diseases respectively. The seeds of *Hydnocarpus pentandra* are used for leprosy and other skin diseases, *Strychnos nux-vomica* is also used in skin diseases, controlling bleeding and as an antidote to snake bites. *Myristica malabarica* Lam. and *Terminalia bellerica* (Gaertn.) Roxb. seeds help to cure digestive problems and cardiac disorders. Seeds of *Senna tora* (L.) Roxb. is used in arthritis treatment and poisonous stings and *Wrightia arborea* (Dennst.) Mabber. seed paste for snake bites, scorpion stings and also as a dyeing agent.

Flower buds of *Evolvulus nummularis* (L.) L. is a powerful brain tonic for dementia, *Ixora coccinea* L. and *Ixora malabarica* (Dennst). Mabb. is used for postnatal care, skin problems and toothache. *Michelia champaca* (L.) Ball. *ex* Pierre oil is used for treating ophthalmia, cephalgia, and gout diseases. *Saraca asoca* (Roxb.) de Wilde. was recorded to cure piles, scabies in children and other skin diseases and *Tabernaemontana divaricata* (L.) R.Br. for various eye diseases. The latex of *Alstonia scholaris* is utilized for plantar warts diseases in the foot and fungal infections of the nail. The latex of *Tabernaemontana alternifolia* is applied to the wounds to expel the inner prickles or sands. The latex of *Vateria indica* L. was described as a good fumigant to control insects.

The ethnobotanical investigation highlighted the potential role of leaf and root parts, which were primarily employed through various methods for healthcare purposes. The majority of treatments were reported to be administered internally through oral consumption or externally by direct application on the body parts. The similar utilization of plant portions and the method of administration have been shown in several investigations conducted among various local communities (23-24).

3.3.3 Preparation approach of locals

A total of 17 types of remedial formulations were reported among the local communities in varied healing approaches. The decoction (27.02 %) and paste (22.7 %) were the most commonly used remedial formulations followed by juice (15.13 %) and boiled extracts (8.1%). Application of plant parts was extensively employed for numerous health care purposes (Fig. 7). Preparation like powder and poultice (5.94%), oil (4.32%), cooked (3.78%) were moderately employed in traditional healings.

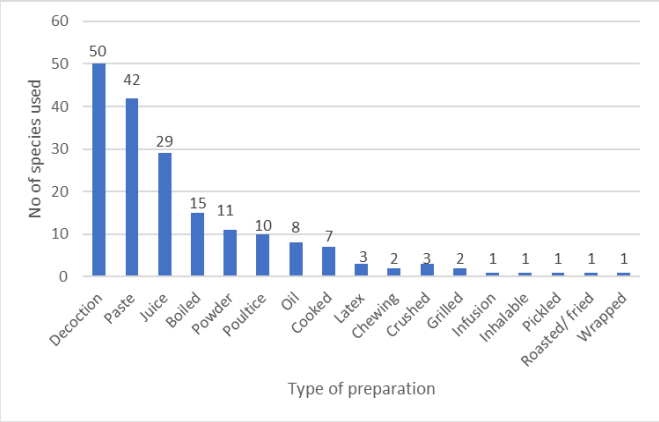

Fig.7. Forms of medication used in the herbal healthcare system.

Very few formulations including latex and crushed (3 species each), chewing and grilled (2 species each), infusion, inhalable, pickled, roasted and wrapped (1 species each) were least favoured in the drug preparation. It is interesting to observe that considering their instant benefits and extended shelf life, traditional methods of extracting medicinal plants in powder and decoction have been extensively documented in various ethnic healings worldwide (25).

3.3.4 Use of medicinal plant species in different ailments

Medicine preparations made from different parts of medicinal plants were used for the treatment of various diseases and several species were used for curing 40 types of disorders (Table 4). Based on the information collected from the respondents, medicinal plants were broadly categorized into three ailments groups including acute, chronic and maternal health disorders. In terms of acute disease, a total of 11 ailments were classified as general health issues, dental problems, dermatological, gastrointestinal diseases, respiratory system dysfunction, urological and reproductive system disorders, poisonous

Table 4. Informant consensus factors reported in the study area.

Ailment category	No. of plants	No. of use reports	ICF
Anthelmintic	7	13	0.5
Asthma	8	30	0.75
Blood pressure	2	9	0.87
Blood purifier	4	8	0.85
Cardiac disorders	4	12	0.72
Constipation	4	21	0.85
Cough and cold	21	72	0.72
Debility	2	7	0.83
Diabetes	12	74	0.84
Diarrhoea and dysentery	14	29	0.53
Dog bite	3	7	0.66
Ear ache	2	15	0.92
Eye disease	6	24	0.78
Fever	27	58	0.54
Headache and migraine	5	45	0.9
Inflammations	14	42	0.68
Insect bites	3	18	0.88
Intestinal and digestive disorders	12	29	0.6
Jaundice	5	30	0.86
Kidney disorders	2	6	0.8
Leprosy	4	5	0.25
Leucorrhoea	2	9	0.87
Liver disorders	2	4	0.66
Maternal health care	12	78	0.85
Menorrhoea	3	7	0.66
Neonatal care	3	30	0.93
Nervous disorders	4	14	0.76
Piles	11	22	0.52
Respiratory disorders	8	16	0.53
Rheumatic problems	9	36	0.77
Scorpion bite	2	8	0.85
Skin diseases	35	129	0.73
Snake bites	6	10	0.44
Stomach disorders	6	8	0.28
Syphilis	1	4	0
Toothache	5	13	0.76
Tuberculosis	3	5	0.5
Urinogenital & reproductive disorders	9	30	0.72
Uterine disorders	6	14	0.61
Wounds, cuts, and ulcers	14	68	0.8

bites, hepatic diseases, ophthalmic disease, blood-related conditions, ear and throat illness. The present study revealed that the most prevalent chronic disorders treated by local healers were asthma, arthritis, diabetes, cardiac disorders, nervous dysfunctions, tuberculosis, migraine and piles. Further, in maternal and neonatal health care several plant species were documented to resolve prenatal and postnatal health issues.

The study reveals that from the plants collected and observed, treatment of skin disorders utilized the highest number of plant taxa (35), followed by general health issues such as fever (27), cough and cold (21), diarrhoea, dysentery and inflammations (14) and gastro-intestinal problems (12) chronic diseases like asthma (8), rheumatic illness (9), diabetes (12), piles (11), migraine (5) and cardiac disorders (4). Two taxa each for the treatment of blood pressure, debility, earache, infertility, kidney and liver disorders, leucorrhoea, dog bite, scorpion bite, and only one taxa was recorded for the treatment of syphilis (Fig. 8).

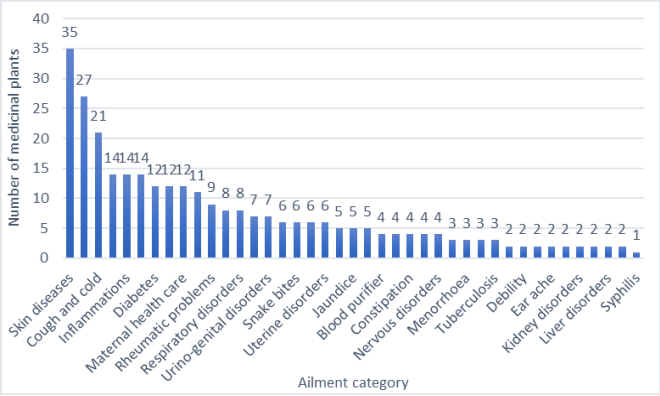

Fig. 8. Number of species used in different human ailments.

Antidote formulations for dog bites, bees sting, scorpion stings and snake bites were prepared using the herbal resources obtained by the local healers from the sacred groves. For the specific treatment of poisonous issues, complete body masking by certain herbal poultices of various combinations was used that lasted for 3 to 8 days completely. After such treatments, certain food habits should be followed for the completion and effectiveness of the medications. The type of ailment and dosage response were related to the effectiveness of the medicine. Based on the reason and efficacy of the medication, doses can vary from patient to patient and even within the same patient.

In the present study, the traditional healers also recognized numerous plant species as immuno-stimulants and attributed them to rejuvenating the human body to fight against several new pandemic disorders. Research findings revealed that during the coronavirus pandemic, the long-standing TKS of local and indigenous societies connected to plant-based immune-modulating agents played a significant role (26). Several of these medicinal plants were used as appetizers or digestive stimulants, astringents, diuretics, brain tonics, nervous stimulants, cooling agents and immune system boosters.

Traditionally plants like *Costus speciosus*, *Curcuma species, Elephantopus scaber, Garcinia gummi-gutta, Gmelina arborea, Myristica malabarica, Oroxylum indicum* (L.)*, Piper species, Sterospermum coalis* (Buch. -Ham. *ex* Dillw.) Mabb.*, Terminalia bellerica* and *Tinospora cordifolia* (Willd.) Miers. are used in several traditional "Kashayas" and "Arishtams" for digestive and bowel ailments. *Spondias pinnata* (L. f.) Kurz, Prelim. and *Syzygium cumini* as an astringent, *Achyranthes aspera, Aerva lanata* (L.) Juss. *ex* Schult. and *Eclipta prostrata* (L.) L. as a diuretic, *Evolvulus nummularis* as a brain tonic and *Morinda citrifolia* L. as an immune system booster, *Sida cordifolia* L. and *Tinospora cordifolia* are neuro stimulants and *Cissus repens*, *Costus speciosus* and *sida cordifolia* as cooling agents (antipyretic). The presence of phytochemicals such as phenols, alkaloids, flavonoids, gallic acid, lignins, tannins and terpenes in the above-mentioned medicinal plants has an effective influence on the immune system.

3.3.5 Assessment of Ethnobotanical Indices

: Family Use Value (FUV)

Of the recorded 50 families, Piperaceae had the highest (0.165) FUV score, followed by Caesalpiniaceae (0.13), Combretaceae, Loganiaceae and Poaceae (0.12 each). The values range between 0.11 and 0.07 as significantly found in the families Lamiaceae to Zingiberaceae in the following graph plotted (Fig. 9). The lowest FUV ranged from 0.04 to 0.03 in Hypoxidaceae, Lytheraceae, Rubiaceae, Apocynaceae and Sterculiaceae.

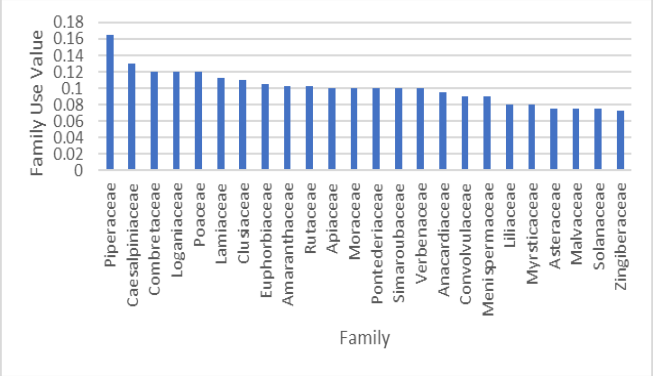

Fig. 9. FUV of the species collected from the sacred groves.

: Use Value Index (UVI)

Maximum UVI was cited (36) for *Ocimum basilicum* and *Curcuma longa* (1 each) followed by *Curcuma neilgherriensis* Wight. (0.94) and *Piper longum* (0.88) with 34 and 32 citations respectively. Fig. 10 shows that the medicinal plants with high UVI score values near1. The UVI of *Glycosmis pentaphylla* and *Garcinia gummi-gutta* was 0.86 and 0.83 respectively. The moderate range of UVI (0.7-0.6) was indicated by *Eclipta prostrata, Myrstica malabarica, Ixora coccinea, Leucas aspera* (Willd.) Link*, Quassia indica, Mimosa pudica* (L.)*, Cardiospermum halicacabum* L. and *Tamarindus indica* L. The least UVI was observed at 0.05 to 0.08 in *Smilax zeylanica, Salacia fruiticosa* Heyne *ex* Lawson in Hook. f.*, Abrus precatorius* L.*, Ichnocarpus fruitascens* (L.) W.T. Aiton*, Uvaria narum* Wall. *ex* Hook. f. & Thoms.*, Cissus repens, Ophiorrhiza mungos* L.*, Cyclea peltata* (Lam.) Hook. f. & Thomas. and *Michelia chamapaca.*

The highest UVI indicates higher popularity and use frequency, whereas the lowest value shows the least

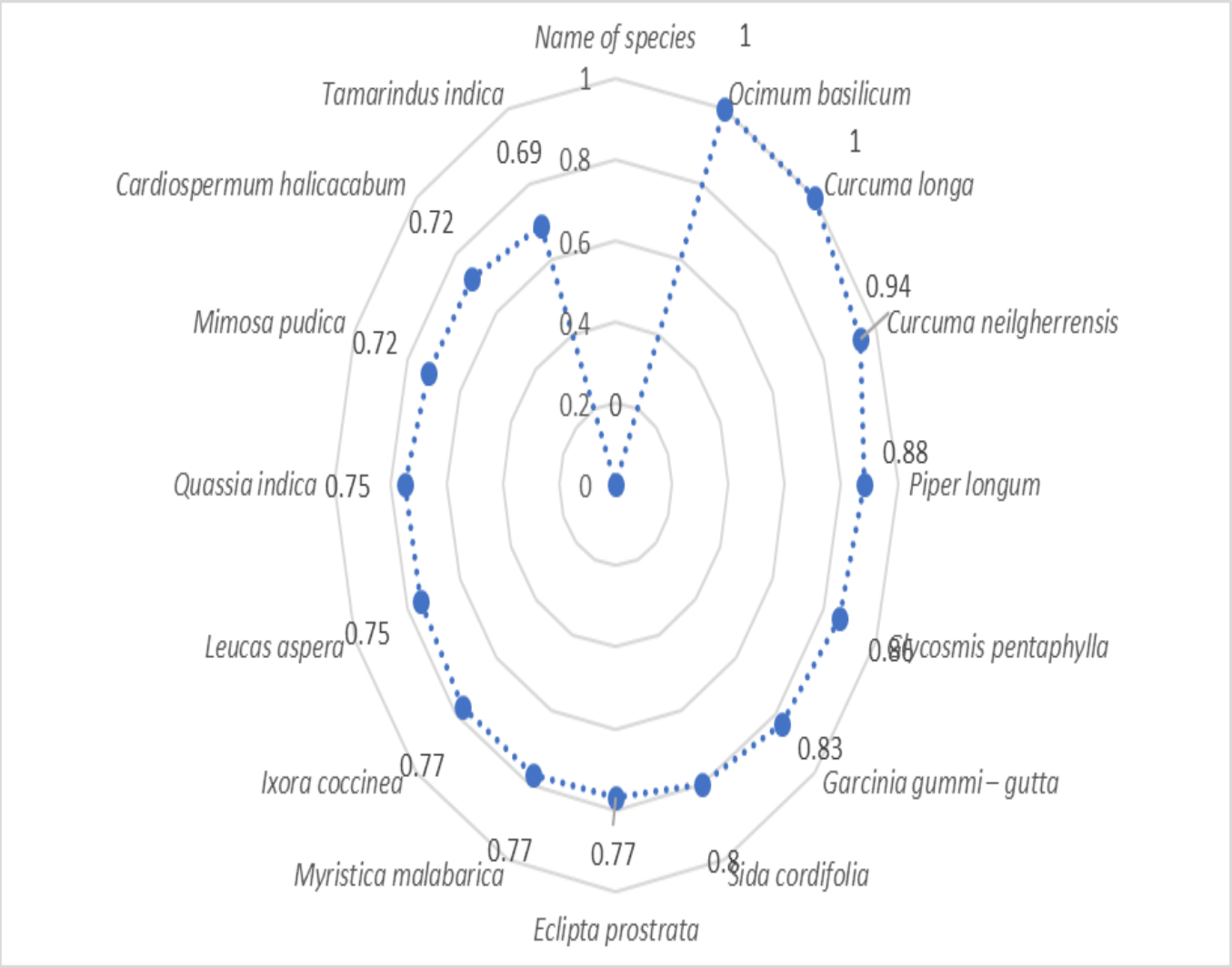

Fig. 10. Highest UVI of medicinal plant species recorded from sacred groves.

preference for traditional medicines within the community. The indigenous communities mostly utilize *O. basilicum, C. longa, C. neilgherrhensis* and *P. longum* for the treatment of bronchitis, cough and cold, fevers, all toxic infections, skin diseases, unconsciousness, chronic diarrhoea, dysentery, bleeding piles, dysuria, diabetes, ringworm infections, digestive problems in children's and adults and urinary tract infections, etc. These plants are utilized singly or in combinations based on their effectiveness, easy consumption and shelf life. Apart from that, these plants have widespread usage as medicines, spices, dyeing and cultural significance in the region (24, 27).

: *Informant Consensus Factor (ICF)*

The results showed homogeneity between informants and their ethnomedicinal knowledge of herbal treatments for various health issues. There are a total of 41 ailments found in the study area. The ICF value ranged from 0.93 to 0, with the greatest value (0.93) obtained for neonatal care treatment with 3 plants and 30 use-reports followed by earache (0.92) cured by 2 plants and 15 use-reports, migraine and headache (0.9) with 5 plants and 45 use-reports, insect bites (0.88) with 3 plants and 18 use-reports, blood pressure and leucorrhoea (0.87) with 2 plants and 9 use-reports. The lowest ICF value (0) was reported for syphilis, leprosy (0.25) and stomach disorders (0.28) category. (The high ICF values close to 1 indicated that the frequently utilized plant species among the informants to treat a specific illness, while the values near 0 showed the disagreement of informants to treat particular ailments by utilizing specific ethnomedicinal species.)

The most common ailments healed traditionally were jaundice, cuts and wounds, constipation, maternal post-partum care, diabetes, debility, kidney disorders, eye diseases and rheumatic problems. The (ICF) informant consensus factor values were more or equal to 0.80 (Table 4).

3.3.6 Determination of threat status

The floristic study helps to identify 4 vulnerable species (*Saraca asoca*, *Vateria indica, Myristica malabarica* and *Ixora malabarica*), 1 endangered (*Costus speciosus*) and 2 near threatened (*Vitex negundo* L. and *Aegle marmelose*) species. These sacred groves also possess 9 endemic species that need a microclimatic condition for survival in the specific geographic area (Supplementary Table 3).

Conclusion

Sacred groves serve as natural homes for wild, medicinal and commercially significant plants and as conservation areas for the area's natural environment. It possesses

unique characteristics compared to other species and serves as a reservoir for biodiversity. One of the biomonitoring tasks for restoration is the survey and documentation of floristic riches, which is a precondition for conserving diminishing genetic resources. An effort has been made to discover the medicinally significant plants and folklore that rural populations regularly employ in the areas surrounding the sacred groves in Kerala's central districts. These regions still need to be discovered from an ethnobotanical standpoint and thereby documentation of a thorough record of the traditional knowledge of the area.

The present investigation confirms that several medicinal plant species are used by the local population in the study area to treat a wide range of illnesses. The indigenous community emphasizes the value of plant-based traditional recipes while practicing conventional healthcare despite the widespread availability of contemporary health facilities. These results provide a platform for connecting the scientific communities looking into the biopotential of druggable compounds with users of folklore.

Aboriginal people in the Western Ghats who practice folk medicine are the primary keepers of this wealth of knowledge regarding the ecology and applications of the local flora. Furthermore, the younger generation has either lost about ethnomedicine or has become enmeshed in the modern world of education and lifestyle, leaving the knowledge of ethnomedicine to the elders and traditional healers. In recent times, sacred groves in the central Kerala districts have come under threat of exploitation, encroachment of forest resources and modernization.

It is crucial to gather information and take action to create a framework for protecting medicinally valuable plants in these sacred groves because there is currently very little knowledge about the species composition and traditional knowledge (TK) of medicinal plants within groves. The documentation of unknown medicinal plants can be used to produce pharmaceutical medications and methods for their protection through ethnobotanical studies. Hence, the recording of their knowledge of plants for medicinal and other economic purposes is becoming increasingly important.

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Authors' contributions

HN carried out the survey, sampling studies, floristic studies, ethnobotanical index studies and drafted the manuscript. LM participated in the design of the study and coordination of the overall study. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interest to declare.

Ethical issues: None.

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