

**ECO-DISTRIBUTION MAPPING OF MEDICINAL PLANTS USING GIS****Harathi P.B<sup>1</sup> , Kiruthika K<sup>2</sup>, Sulaiman M<sup>3</sup>**<sup>1</sup>Department of Zoology, PSGR Krishnammal College for Women, Coimbatore, Tamil Nadu<sup>2</sup>Department of Botany, Karpagam Academy of Higher Education, Coimbatore, Tamil Nadu<sup>3</sup>Botanical Survey of India, Southern Regional Centre, Coimbatore, Tamil Nadu**Abstract:**

Indigenous people of different parts of the world have a vast knowledge of, and capacity for, developing innovative practices and products from their environment. Indigenous knowledge grows from close interdependence between knowledge, land, environment and culture. The oral transmission of knowledge in accordance with cultural principles and rules regarding secrecy and sacredness needs to be documented in the proposed geographical area. Fortunately, there were a few in many of these tribes who remembered the traditional ways, or remembered what their ancestors told them, and were able to bring back some of the traditional knowledge and revive their culture through education and native plant food. The wealth of traditional medicinal knowledge needs to be collected, documented and preserved for development of novel herbal medicines.

Though, series of works have been done on ethno-botany work and ethno-ecology, more data is needed to quantify the effects of medicinal values at the ecosystem level. However, the data collected from these resources are sometimes neither comparable nor aggregated at national level as their concepts and values vary from region to region. An interdisciplinary approach by integrating ethno-medicinal findings with GIS tools is essential.

Study area: Nilgiris is a unique biosphere in the Western Ghats and part of Tamil Nadu, India, characterized at higher altitudes by grass lands and evergreen forests, has number of tribal groups which includes Paniyans, Kattunayakans, Kurumbas, Thodas, Kotas and Irulas.

**Methodology:**

- i. Database Preparation: Survey and documentation of medicinal plants their uses corresponding to their natural distribution from tribal (local) population
- ii. Integrating in GIS environment: Using ArcGIS 10.2 for visualizing, analyzing, creating, and

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managing data with a geographic component  
Results: Spatial distribution using GIS defines plants of a given region. Based on the parameters, like the recorded uses of medicinal plants, rarity, threat factors to plant species and area can be identified. GIS based mappings will indicate not only the availability of medicinal plant species in a given forest compartment, but also will show the density classes for plant species. These maps will help in sustainable collection of medicinal plants, avoiding overexploitation of commercialized species. It will also help in streamlining the conservation measures such as germplasm collection and implementing suitable regeneration methods.

## Introduction

Globally, the flowering plants are represented by ca 3, 69,000 species belonging to 416 families, among which 28,187 species are being recorded as medicinally important (Willis, 2017). More than 2,000 medicinal plants are estimated to be present in southern Indian states of Kerala, Karnataka and Tami Nadu (Ved *et al.*, 1998). Exploring and exploiting the medicinal plants are common in practice and according to CITES it has been recorded that ca 1,280 species are under protection out of 28,187 species. An insitu conservation of wild medicinal plants in varied strand of vegetations, topography and altitude is established through Conservation scheme *viz.*, Medicinal Plants Conservation Areas (MPCA) recognized by the State Forest Departments of India (Karnataka, Kerala & Tamil Nadu). About thirty two sites have been declared as MPCA's which function as Living Germplasm of medicinal plants in the former mentioned states.

Indigenous plants are still been in practice from rural to urban on the primary health care. With the next step, highly potential medicinal plants place its role on the synthesis of pharmaceutical drugs for healing the diseases. Increasing interest in the study of traditional uses of medicinal plants has been witnessed in different parts of the world, mainly due to several problems associated with synthetic drugs and emergence of multi-drug resistant Pathogens (Chellaiah *et al.*, 2006). This wealth of traditional knowledge needs to be collected and preserved which may help to understand remedial plant metabolites for development of novel herbal medicines (Singh *et al.*, 2012).

Though, series of works have been done on ethno-botany work and ethno-ecology, more data is needed to quantify the effects of medicinal values at the ecosystem level. However, the data collected from these resources are sometimes neither comparable nor aggregated at national level as their concepts and values vary from region to region. Absence of basic data often set limitation to the planning process. However, Geographic Information System (GIS) based mapping is indeed a novice idea. An inter-disciplinary approach by integrating ethno-medicinal findings with GIS tools is essential.

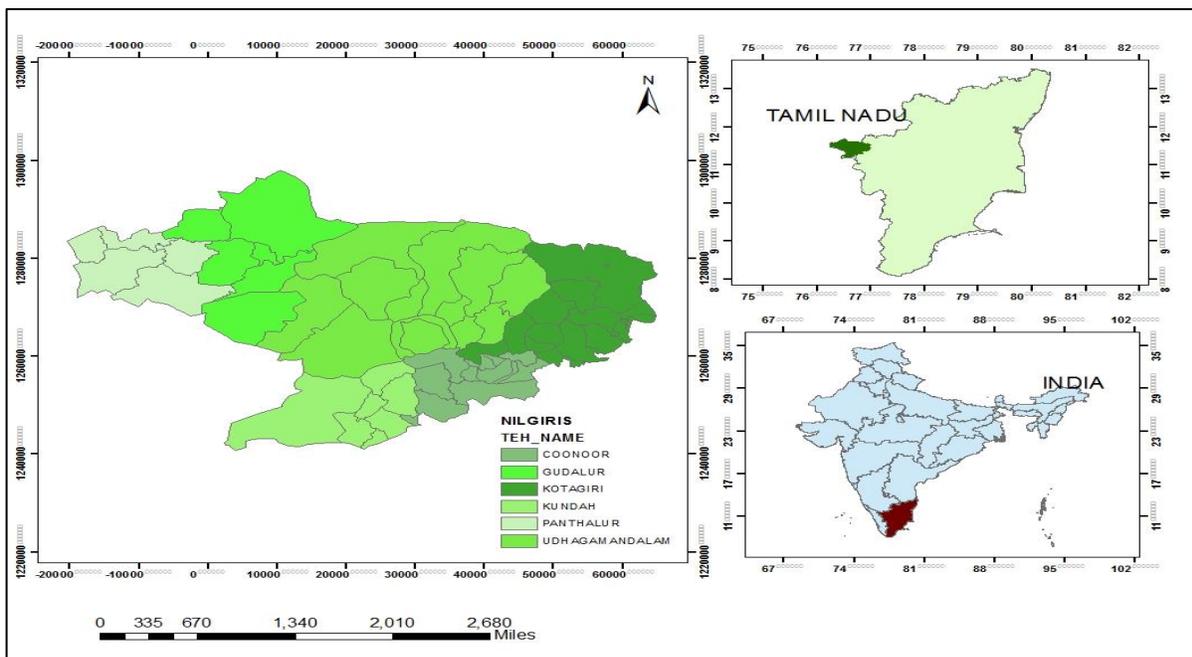
Spatial distribution using GIS happens to be new field of research and can be used in defining plants of a given region. GIS could be a tool to address all these complexities using extrapolation techniques. Based on the parameters, like the recorded uses of medicinal plants, rarity and threat factors plant species and area can be identified to develop GIS based mapping using available software for visualizing, analyzing, creating, and managing data with a geographic component. The geographical distribution of medicinal plants provide the distribution pattern and conservation measures. The approach would be usually based on integrating different data of vegetation, botanical surveys, pharmacognosy and ethnobotany through user specified-criteria (Al-Bakri *et al.*, 2011).

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The proposed study makes an inventory, diversity of the medicinal plants and documentation of their uses corresponding to their natural distribution from tribal population of Nilgiri district through survey and to develop spatial maps using GIS.

## Study Area

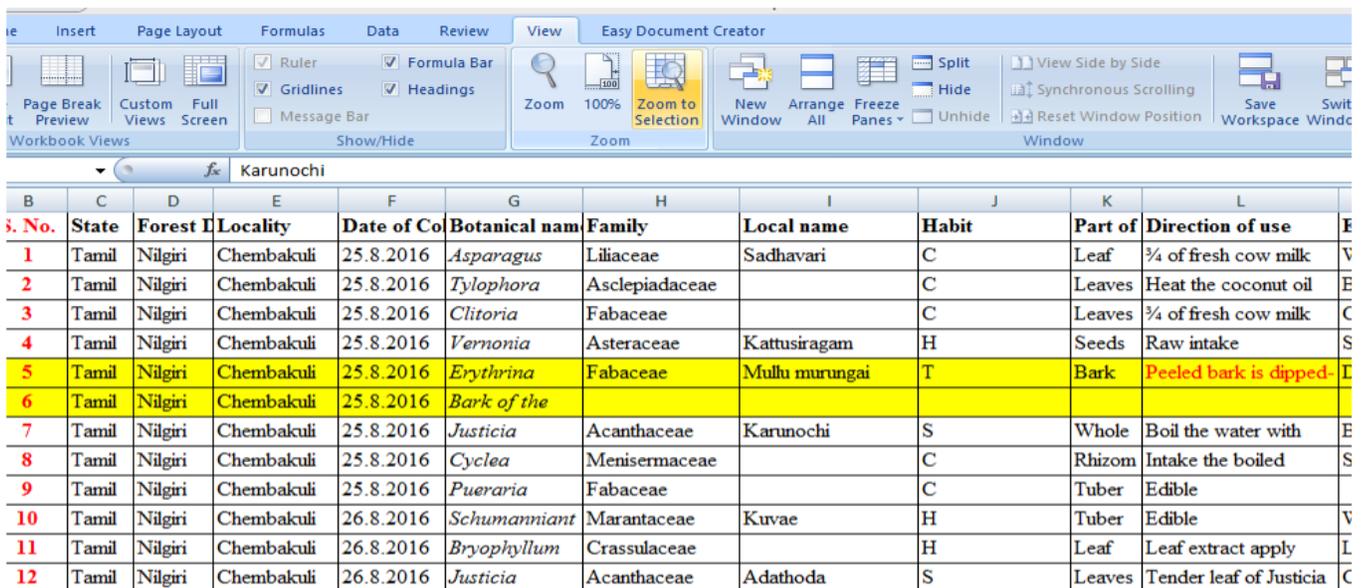
Nilgiri District is inhabited with the Primitive Tribal Groups viz., Irulars, Kattunaikars, Kurumbar, Kotas, Paniyars and Todas in the taluks of Coonoor, Gudalur, Kotagiri, Kundah, Pandalur and Udagamandalam. It is located in the state of Tamil Nadu, India and part of Western Ghats; covering an area about 2,551 km<sup>2</sup> and bounded on the north by Karnataka State, north-west by Kerala State, south-east by Coimbatore District and north-east by Erode District of Tamil Nadu. It is extended from 11° 12' to 11° 37' North latitude and 76° 45' to 77° 00' East longitudes (**Fig:1**); while the highest altitude is observed at 2,634 m at Doddabetta. The physiographic factors viz., average annual rainfall of the district is 1920.8 mm; the climate is temperate and salubrious throughout the year with the annual temperature of summer is maximum between 21°C to 25 °C and the minimum of 10°C to 12°C; and winter is maximum 16°C to 21°C and minimum of 2°C (Lakshumanan *et al.*, 2012). The area is wide spread with various types of vegetations namely: Tropical Thorn Forests, Tropical Dry Deciduous Forests, Tropical Moist Deciduous Forests, Tropical Semi-evergreen Forests, Tropical Wet Evergreen Forests, and Southern Montane Wet Temperate Forests.



**Fig: 1 – Study Area – Nilgiri District**

## Methodology

**Database Preparation:** Field survey is the prime feature of database preparation. It includes the documentation of indigenous knowledge of medicinal plants from the aboriginals of Nilgiri District, Tamil Nadu. Information related to local name of medicinal plant, plant part used for curing, method of dosage and administration of the crude drug were recorded in the field note book. Subsequently, the geo co-ordinates of the plant (point and line vectors) were recorded using GPS-Trimble Juno 3B and digital photo of the plant was captured (Nikon D5300) for future reference. The plants were also collected for identification and herbarium preparation. The database is prepared comprising the taxonomic details of the plant, and the information recorded in the field note book in MS- Excel sheet (**Fig: 2**).

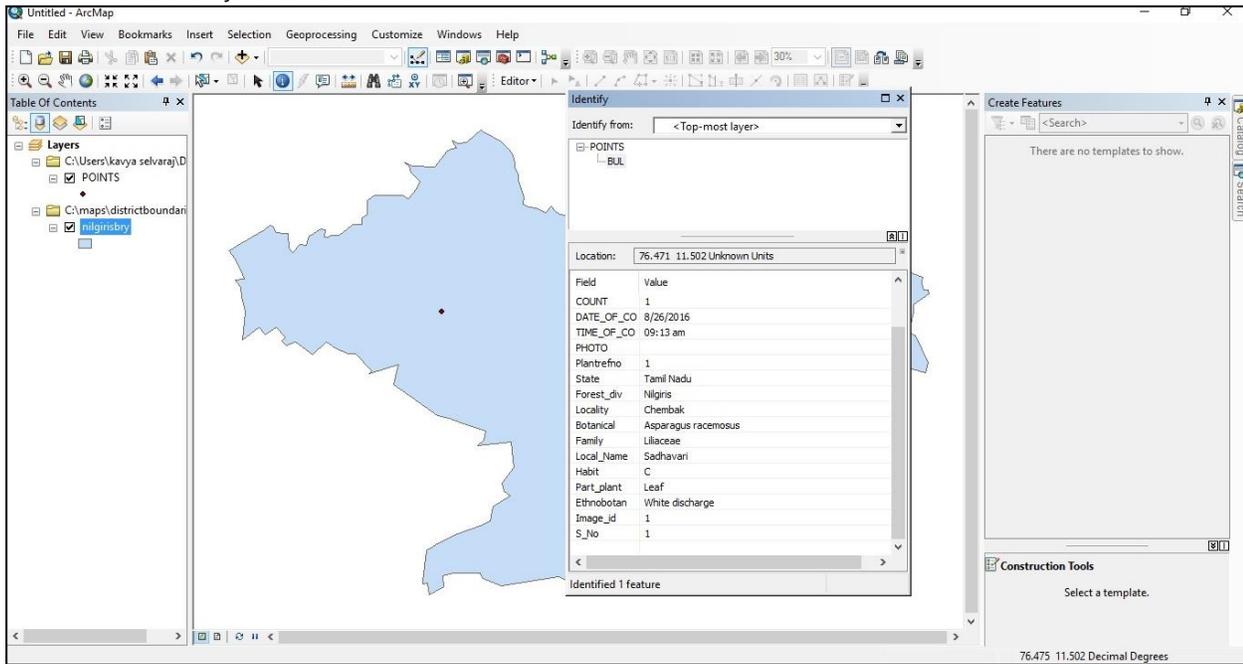


| S. No. | State | Forest  | Locality   | Date of Collection | Botanical name      | Family         | Local name     | Habit | Part of plant | Direction of use        |
|--------|-------|---------|------------|--------------------|---------------------|----------------|----------------|-------|---------------|-------------------------|
| 1      | Tamil | Nilgiri | Chembakuli | 25.8.2016          | <i>Asparagus</i>    | Liliaceae      | Sadhavari      | C     | Leaf          | ¼ of fresh cow milk     |
| 2      | Tamil | Nilgiri | Chembakuli | 25.8.2016          | <i>Tylophora</i>    | Asclepiadaceae |                | C     | Leaves        | Heat the coconut oil    |
| 3      | Tamil | Nilgiri | Chembakuli | 25.8.2016          | <i>Clitoria</i>     | Fabaceae       |                | C     | Leaves        | ¾ of fresh cow milk     |
| 4      | Tamil | Nilgiri | Chembakuli | 25.8.2016          | <i>Vernonia</i>     | Asteraceae     | Kattusiragam   | H     | Seeds         | Raw intake              |
| 5      | Tamil | Nilgiri | Chembakuli | 25.8.2016          | <i>Erythrina</i>    | Fabaceae       | Mullu murungai | T     | Bark          | Peeled bark is dipped-  |
| 6      | Tamil | Nilgiri | Chembakuli | 25.8.2016          | <i>Bark of the</i>  |                |                |       |               |                         |
| 7      | Tamil | Nilgiri | Chembakuli | 25.8.2016          | <i>Justicia</i>     | Acanthaceae    | Karunochi      | S     | Whole         | Boil the water with     |
| 8      | Tamil | Nilgiri | Chembakuli | 25.8.2016          | <i>Cyclea</i>       | Menispermaceae |                | C     | Rhizom        | Intake the boiled       |
| 9      | Tamil | Nilgiri | Chembakuli | 25.8.2016          | <i>Pueraria</i>     | Fabaceae       |                | C     | Tuber         | Edible                  |
| 10     | Tamil | Nilgiri | Chembakuli | 26.8.2016          | <i>Schumanniant</i> | Marantaceae    | Kuvae          | H     | Tuber         | Edible                  |
| 11     | Tamil | Nilgiri | Chembakuli | 26.8.2016          | <i>Bryophyllum</i>  | Crassulaceae   |                | H     | Leaf          | Leaf extract apply      |
| 12     | Tamil | Nilgiri | Chembakuli | 26.8.2016          | <i>Justicia</i>     | Acanthaceae    | Adathoda       | S     | Leaves        | Tender leaf of Justicia |

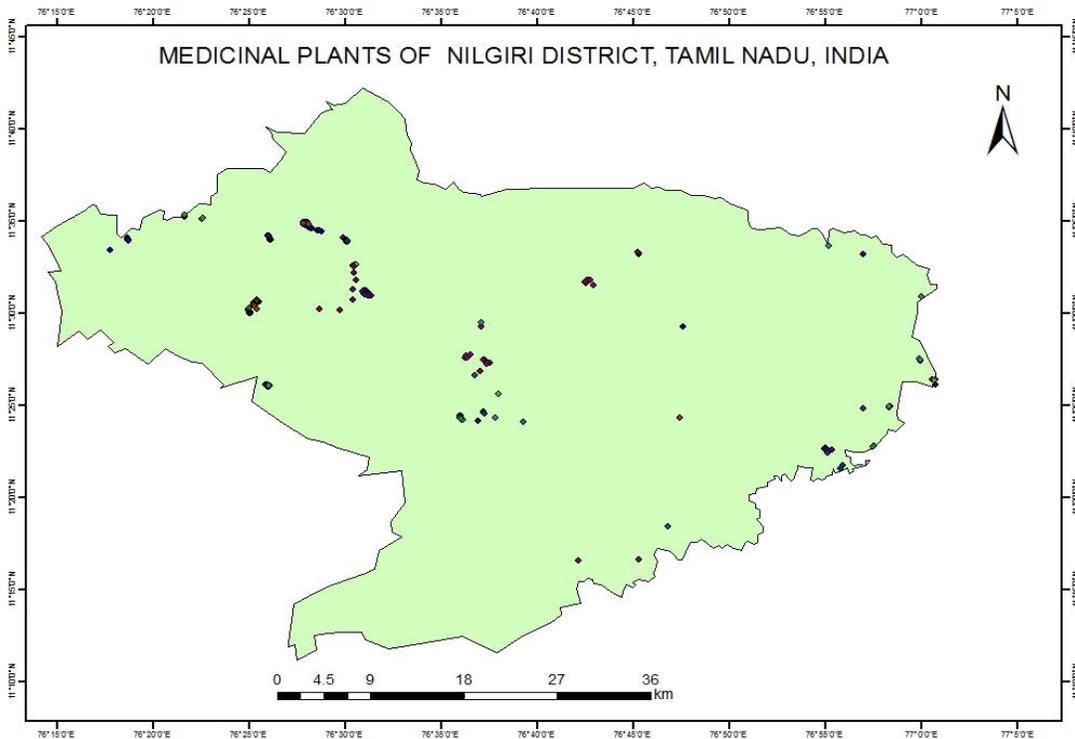
**Fig: 2 - Database (Details of the medicinal plants) in the form of Excel Sheet**

**Integrating in GIS environment:** Importing GPS Coordinates into ArcMap by converting the data into SHP Files and linking the recorded information from excel data to ArcMap (Attributes include – Reference no, Botanical name, Common Name, Part of the plant to be used, Mode of intake/administration, Method of harvesting, Time of availability). Preparation of GIS based mapping (ArcGIS 10.2) of medicinal plants using for visualizing, analyzing, creating, and managing data with a geographic component (**Fig: 3 & 4**).

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**Fig: 3 - Integration in GIS**



**Fig: 4 – Mapping of medicinal Plants**

## Results & Discussion

Indigenous people of different parts of the world have a vast knowledge of, and capacity for, developing innovative practices and products from their environment. Indigenous knowledge grows from close interdependence between knowledge, land, environment and other aspects of culture in indigenous societies. The oral transmission of knowledge in accordance with well understood cultural principles and rules regarding secrecy and sacredness that govern the management of knowledge (Tripathi *et al.*, 2000) needs to be documented in the proposed geographical area. Tribes who remembered the traditional ways, or remembered what their ancestors told them were very few in numbers and it is essential to document the traditional knowledge and revive their culture.

The documentation of indigenous plants from the various group of tribes made a broad circumstance on understanding the ethnic knowledge on plants and its medicinal practices. It has been recorded with 38 species of 35 genera represented from 29 families among which varied life forms are distributed with Herbs 16 species, Trees 9 species, Twiners 5 species, Shrubs 4 species, Climbing Shrubs 3 species and Liana 1 species (**Fig: 5**). Indigenous plants used to cure various ailments were listed in **Table. 1**. From the collection of 38 species; among 8 species *viz.*, *Anaphalis neelgerryana*, *Berberis tinctoria*, *Bulbophyllum fimbriatum*, *B. neilgherensis*, *Cycas circinalis*, *Decalepis hamiltonii*, *Leucas lamiifolia* and *Rhododendron arboreum* subsp. *nilagiricum* are endemic to Western Ghats and 2 species *viz.*, *Decalepis hamiltonii* and *Cycas circinalis* are categorized as endangered. The mapping of species would able to ascertain the distribution pattern of the species over different period of time. These maps would generate the conservation schemes on the endangered medicinal plant species.

Documentation of indigenous knowledge needs to be protected and incorporated into national polygon. Development of the database and spatial distribution using GIS on medicinal plants will enhance resource sustenance. In future, this would provide base information on developing novel drugs for the diseases. Geodatabase would serve as a repository in future on comparison statistics of the distribution of plants. Systematic mapping of the occurrence of the species provides distribution pattern, availability of the species and insight into the regions where conservation has to be initiated for recommending the policy and decision makers. The maps will indicate not only the availability of medicinal plant species in a given forest compartment, but also will show the density classes for plant species. These maps will help in sustainable collection of medicinal plants, avoiding overexploitation of commercialized species. It will also help in streamlining the conservation measures such as germplasm collection and implementing suitable regeneration methods. Later, plant density can also be calculated using image analysis algorithm applied on satellite data, and it can be cross validated with the available data from Department of Forest, Government of Tamil Nadu

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**Fig: 5 – a - *Anaphalis subdecurrens*; b- *Bulbophyllum neilgherensis*; c- *Capparis grandis*; d- *Gnetum ula*; e- *Leucas lamiifolia*; f- *Leucas vestita*; g- *Litsea deccanensis*; h- *Rhododendron arboretum* subsp. *nilagiricum*; h- *Rhynchosstylis retusa* & j,k,l – Interaction with tribals on recording the ethnobotanical use of plants**

**Table 1: List of Medicinal Plants used by Tribals in Nilgiri District, Tamil Nadu**

| S.No | Botanical name                                  | Family        | Local name     | Habit* | Part of the plant | Direction of use   | Ethnobotanical Uses               |
|------|---|---------------|----------------|--------|-------------------|--|-----------------------------------|
| 1.   | <i>Asparagus racemosus Willd.</i>               | Liliaceae     | Sadhavari      | CS     | Leaves            | ¾ of fresh cow milk with leaf paste is mixed and intaken                                     | Cures White discharge for women   |
| 2.   | <i>Actiniopteris radiata</i> (Sw.) Link         | Pteridaceae   | Mayilviri      | H      | Whole plant       | Whole plant is shade dried and powdered; mixed with milk and in taken                        | Removes stones from Urinary tract |
| 3.   | <i>Anaphalis neelgerryana</i> (DC.) DC.         | Asteraceae    | Katel          | H      | Leaves            | Leaves with coconut oil is heated and applied on swelled area                                | Cures swelling                    |
| 4.   | <i>Anaphalis subdecurrens</i> Gamble            | Asteraceae    | Kodayars       | H      | Stem              | Sap of the stem is applied on wounds   | Wound healer                      |
| 5.   | <i>Basella alba</i> L.                          | Basellaceae   | Vasala dahu    | TW     | Leaves            | Sap of the leaves are heated with castor oil; applied on bones and tied tightly with a cloth | Recovers from bone fracture       |
| 6.   | <i>Berberis tinctoria</i> Lesch.                | Berberidaceae | Oosipalam      | S      | Leaves            | Leaves rawly in taken daily  | Used as food supplement           |
| 7.   | <i>Bulbophyllum fimbriatum</i> (Lindl.) Rchb.f. | Orchidaceae   | Maramalli      | H      | Bulb              | A dried and powdered pseudobulb is applied on body before the bath.                          | Recover sfrom hypothermia         |
| 8.   | <i>Bulbophyllum neilgherensis</i> Wight         | Orchidaceae   | Marakaai       | H      | Bulb              | Powdered bulb is heated with oil; applied on legs and hands                                  | Recovers from sprain              |
| 9.   | <i>Capparis grandis</i> L.f.                    | Capparaceae   | Thoratti maram | T      | Leaves            | Leaves paste with jaggery is in taken  | Cures cough                       |

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|     |  |                |                   |    |                |   |   |
|-----|--|----------------|-------------------|----|----------------|---|---|
| 10. | <i>Crotalaria biflora</i> L.                   | Fabaceae       | Odambuvali chedi  | H  | Leaves         | Leaves are crushed and its extract is applied on the body at evening only                                       | Recovers from body pain and fever                             |
| 11. | <i>Cycas circinalis</i> L.                     | Cycadaceae     | Eendhu            | S  | Seeds          | Seeds soaked into water for 15 days and added with rice flour on dosa and idli preparation                      | Edible – Food supplement                                      |
| 12. | <i>Cyclea peltata</i> (Lam.) Hook.f. & Thomson | Menispermaceae | Pavatta           | TW | Tuber          | Tubers are crushed; mixed with honey and in taken   | Cures Stomach pain/disorders                                  |
| 13. | <i>Decalepis hamiltonii</i> Wight & Arn.       | Asclepiadaceae | Mahaali Kizhanku  | TW | Tuber          | Tuber is rawly in taken   | Appetizer   |
| 14. | <i>Dichrostachys cinerea</i> (L.) Wight & Arn. | Mimosaceae     | Vedathalai        | T  | Bark           | Bark is crushed, made into paste with lemon and in taken  | Recovers from snake bite                                      |
| 15. | <i>Dioscorea oppositifolia</i> L.              | Dioscoreaceae  | Riyang kesanku    | TW | Tuber          | Tuber is stream cooked, mixed with honey and in takens  | Removes stones from Urinary tract and used as food supplement |
| 16. | <i>Eupatorium adenophorum</i> Spreng.          | Asteraceae     | Sarmanthor        | H  | Leaves         | Leaves are crushed and its extract applied on cut wounds  | Wound healers   |
| 17. | <i>Galium asperifolium</i> Wall.               | Rubiaceae      | Kuributhur        | H  | Leaves         | Leaves with <i>Rubus ellipticus</i> leaves, a pinch of mud and buffalo dung are crushed and in taken with water | Recovers from fever   |
| 18. | <i>Gloriosa superba</i> L.                     | Liliaceae      | Kanivili kizhangu | H  | Flowers/Tubers | Flowers or tubers crushed and   | Cures eye pain  |

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|     |   |             |                 |    |           |  |  |
|-----|---|-------------|-----------------|----|-----------|--|--|
|     |   |             |                 |    |           | its extract are given in drops for eye   |  |
| 19. | <i>Gnetum ula</i> Brogn.                            | Gnetaceae   | Oolai kai       | L  | Fruit     | The fruit heated in the fire and eaten   | Edible   |
| 20. | <i>Justicia gendarussa</i> Burm.f.                  | Acanthaceae | Karunochi       | S  | Leaves    | Leaves are boiled the water and bath it  | Recovers body pain                             |
| 21. | <i>Leucas lamiifolia</i> Desf.                      | Lamiaceae   | Thumbai         | H  | Leaves    | Leaves are crushed and its extract are applied on body                               | Recover from fever                             |
| 22. | <i>Leucas vestita</i> Benth.                        | Lamiaceae   | Thumbai         | H  | Leaves    | Leaf paste   | Removes wartz                                  |
| 23. | <i>Litsea deccanensis</i> Gamble                    | Lauraceae   | Jakkatha maram  | T  | Root      | Roots are grinded and its extract are in taken                                       | Cures stomach pain                             |
| 24. | <i>Neonotonia wightii</i> (Wight & Arn.) J.A.Lackey | Fabaceae    | Kattusolu chedi | TW | Roots     | Roots are crushed with few cumin seeds and its extract are in taken in empty stomach | Recovers from stomach lumps                    |
| 25. | <i>Nothapodytes nimmoniana</i> (J.Graham) Mabb.     | Icacinaceae | Kokud           | T  | Bark      | Bark is dried, powdered and boiled, extract is in taken                              | Recovers from stomach lumps                    |
| 26. | <i>Piper umbellatum</i> L.                          | Piperaceae  | Kapya illai     | CS | Leaves    | Leaf extract with milk   | Cures from any stomach disorders               |
| 27. | <i>Rapanea wightiana</i> (Wall. ex A. DC.) Mez      | Myrsinaceae | Kallumaram      | T  | Stem bark | Bark's sap is mixed with water and kept overnight; washed the mouth and teeth        | Recovers from tooth pain                       |
| 28. | <i>Remusatia vivipara</i> (Roxb.) Schott            | Araceae     | Para chembu     | H  | Stem      | Cooked and in taken  | Edible and removes hair or thread from stomach |

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|     |   |                  |               |    |        |  |                                    |
|-----|---|------------------|---------------|----|--------|--|------------------------------------|
| 29. | <i>Rhododendron arboreum</i> subsp. <i>nilagiricum</i> (Zenker) Tagg, J. B. Stevenson | Ericaceae        | Katturoja     | T  | Wood   | The fresh woods are carved                                     | Handle for cooking                 |
| 30. | <i>Rhodomyrtus tomentosa</i> (Aiton) Hassk.   | Myrtaceae        | Thavutu palam | T  | Leaves | Tender leaves are crushed and its extract is in taken          | Recover from dysentery             |
| 31. | <i>Rhynchostylis retusa</i> (L.) Blume  | Orchidaceae      | Sevuttu olai  | H  | Leaves | Sap of leaves are used as ear drops                            | Cures from ear pain                |
| 32. | <i>Rubia cordifolia</i> L.  | Rubiaceae        | Karappa chedi | CS | Leaves | Leaf extract and breast milk is used as eye drops              | Cures from eye infections          |
| 33. | <i>Sansevieria roxburghiana</i> Schult. & Schult.f.                                   | Asparagaceae     | Manji         | H  | Leaves | Leaf paste are applied on leg                                  | Recover from filariasis            |
| 34. | <i>Sida acuta</i> L.  | Malvaceae        | Kurnthotti    | H  | Leaves | Leaves are crushed and its extract is in taken                 | Cure sever stomach pain            |
| 35. | <i>Scoparia dulcis</i> L.   | Scrophulariaceae |               | H  | Leaves | Leaves are finely made into paste and in taken with buttermilk | Removes stones from Urinary tract  |
| 36. | <i>Syzygium cumini</i> (L.) Skeels  | Myrtaceae        | Navaal        | T  | Bark   | Bark is boiled and its steamed in taken orally                 | Cures tooth pain                   |
| 37. | <i>Thottea siliquosa</i> Lam.   | Aristolochiaceae | Murthikai     | S  | Fruit  | Dried fruit is made into paste and mixed with luke warm water  | Recover stomach aches for children |
| 38. | <i>Zanthoxylum ovalifolium</i> Tutcher  | Rutaceae         | Machiyakodi   | T  | Bark   | Root is crushed and applied over painful area                  | Cures swelling or pain             |

Habit\*: H- Herbs, T- Trees; L-Liana; S- Shrubs; CS- Climbing Shrubs & TW- Twiners

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