Ethnomedicinal plants used by Kani tribals to treat Rheumatism in Kalakad Mundanthurai Tiger Reserve, Tamil Nadu, India

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Research

Abstract

Background: The search for safe and alternative remedy for rheumatic disorders from herbal resources is increasing nowadays hence the medicinal plants constitute a promising role in modern medication system due to the presence of several bioactive compounds. The people inhabiting in the forest areas are often affected with several skeleton-muscular disorders especially with rhematic problems, hence the present study was undertaken to document the plants used to treat such diseases.

Methods: The present study was carried out to document the traditional knowledge of medicinal plants used in treating rheumatism by Kani tribes who live in the KMTR region in the Southern Western Ghats of Tamil Nadu, India. Extensive field studies were conducted in five hamlets of Kani tribes focusing on the plants used in treating rheumatism. The data was collected using questionnaires, interviews and discussions among the traditional practitioners and other people of the hamlet.

Results: The present ethnobotanical survey has led to the documentation of 59 species of medicinal plants belonging to 33 families. Of these, 26 species are the major utilized plants while 33 plant species are used in least quantity. Leaves are widely utilized against rheumatic problems. The medicinal formulations are prepared in the form of decoction, paste and powder which are administered topically or orally based on the disease condition.

Conclusion: The medicinal plants were documented with the focus on conserving the ethnic knowledge of Kani tribes as documentary evidence for plant-based natural product research. Among the documented plants, *Cardiospermum halicacabum*, *Elettaria cardamomum, Elephantopus scaber*, *Cymbopogon citratus*, *Allium cepa*, *Sida acuta*, *Pergularia daemia,* and *Lawsonia inermis* were frequently cited and requires further pharmacological studies to develop an effective drug against chronic illnesses.

Keywords: Ethnic community, Folk medicine, Rheumatism, Western Ghats

Background

Ethnobotanical research has gained much importance in recent days as it helps in the discovery of effective drugs. Based on the ethnobotanical inventories, numerous bioactive compounds and drugs were developed and about 35 to 50% of modern drugs are developed from natural products for a wide range of health issues (Sureshkumar

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et al. 2021). The traditional knowledge of ethnic people can be implemented in conventional healthcare system. According to World Health Organization, plant extracts are widely utilized in the traditional treatments against diseases. Medicinal plants are beneficial to mankind as they are the economical source of medicines (Rahman *et al*. 2019). Plants and the plant-based medications are the frontline remedy for a variety of ailments since the beginning. Pharmacological studies on plants can be carried out by having ethnobotanical data as a lead (Ayyanar *et al*. 2013). In earlier days, medicines were prepared from plants, either in simple or in complex form of crude extracts and mixtures with one or more plants. It was well documented that, about 7500 plant species are used by tribal communities in India in the traditional medical practices (Silambarasan *et al*. 2017a).

Chronic pain is one of the global health issues faced by 25% of population throughout the world (Espinoza *et al*. 2022). Rheumatism is considered as the dominant pain syndrome throughout the world and is one of the classical auto-immune disease (Wu *et al*. 2021). The primary medicines available for treating rheumatism poorly controls the pain and carries numerous side effects. Hence, effective pain management therapies are required for alleviating the rheumatic pain through various treatment methods (Sadler *et al*. 2022). Medicinal plants can be used in treating rheumatism as it has wide range of phytochemicals. Tribal people are known for their folk medicines as they are highly associated with nature. There are 36 ethnic groups of tribes in Tamil Nadu and most of them are living in the forest and adjoining areas who have great ethnomedicinal knowledge (Ayyanar & Ignacimuthu 2011).

Kani tribes are one among them who practice ethnic medicine and live along the South-Western Ghats of Tamil Nadu and Kerala, India. There are several reports about the traditional medical practices of Kani tribes during the past three decades (Ayyanar & Ignacimuthu 2005a, 2011, Ignacimuthu *et al*. 1998, Sukumaran *et al*. 2020). The reports on particular diseases which are commonly practiced by the Kani tribes is scanty except a few (skin diseases and poisonous bites by Ayyanar and Ignacimuthu (2005b); rheumatism by Sutha *et al*. (2010). So, the present study was planned to undertake survey among the traditional healers and local ethnic people residing in KMTR to document their ethnomedicinal knowledge in treating rheumatic problems and the data obtained was validated with ethnobotanical tools.

Methods

Study area

The present study was carried out in Kalakad Mundanthurai Tiger Reserve (KMTR) situated in the southern district of Tirunelveli and Kanyakumari, Tamil Nadu (Fig. 1). It is a valuable repository of biodiversity in Tirunelveli hills with diversified flora and fauna, known for its species richness and endemism, it is one among the three mega centres of endemism in India. Out of 5000 vascular plant species occurring in southern Peninsular India, KMTR harbours over 2000 plants (Henry *et al*. 1984). KMTR has core area of about 895 km^2 in Tirunelveli district including Mundanthurai Tiger Sanctuary, Kalakad Wildlife Sanctuary and portion of Veerapuli and Kilamalai Reserve Forests in Kanyakumari District. KMTR has its buffer zone is in the south of Kanyakumari Wildlife Sanctuary (201.36 Km^2) and in the north of Nellai Wildlife Sanctuary (35.28 Km^2). While the eco zone is present in the east (469.90 Km^2). KMTR was the first declared Tiger Reserve in Tamil Nadu and 17th Tiger Reserve in the country. KMTR is the place of origin of Thamirabarani river. The reserve includes areas such as Kothayar, Servalar, Mayilaru, Manimuthar and Karaiyar with human settllements.

Studied Tribal Community

The ethnic people inhabiting the study area are Kanikaran or Kani. The Kani tribes speak dialect of Tamil and Malayalam. They are the traditional forest dwellers of Tirunelveli hills who led nomadic life, but now they lead a settled life. Kani tribes live in eastern part of the Thiruvananthapuram district in Kerala and western part of the Kanyakumari and Tirunelveli districts along the Western Ghats in Tamil Nadu. They are regarded as the migrants from Thiruvananthapuram district, Kerala and might have entered into Tamil Nadu through the Courtallam pass (Ignacimuthu *et al*. 1998). These people live in tribal hamlets consisting about 5-20 families in and around the forest area. Kani tribes are considered as the live repository of medicinal plants. They are well versed in treating fever, cough, cold, headache, poisonous bites and some other ailments. These people depend widely on medicinal plants for their primary healthcare system and collect non-timber forest produce for their livelihood. They cultivate staple food crops and cash crops such as tapioca, millets, areca nut, cashew nut, coconut and pepper.

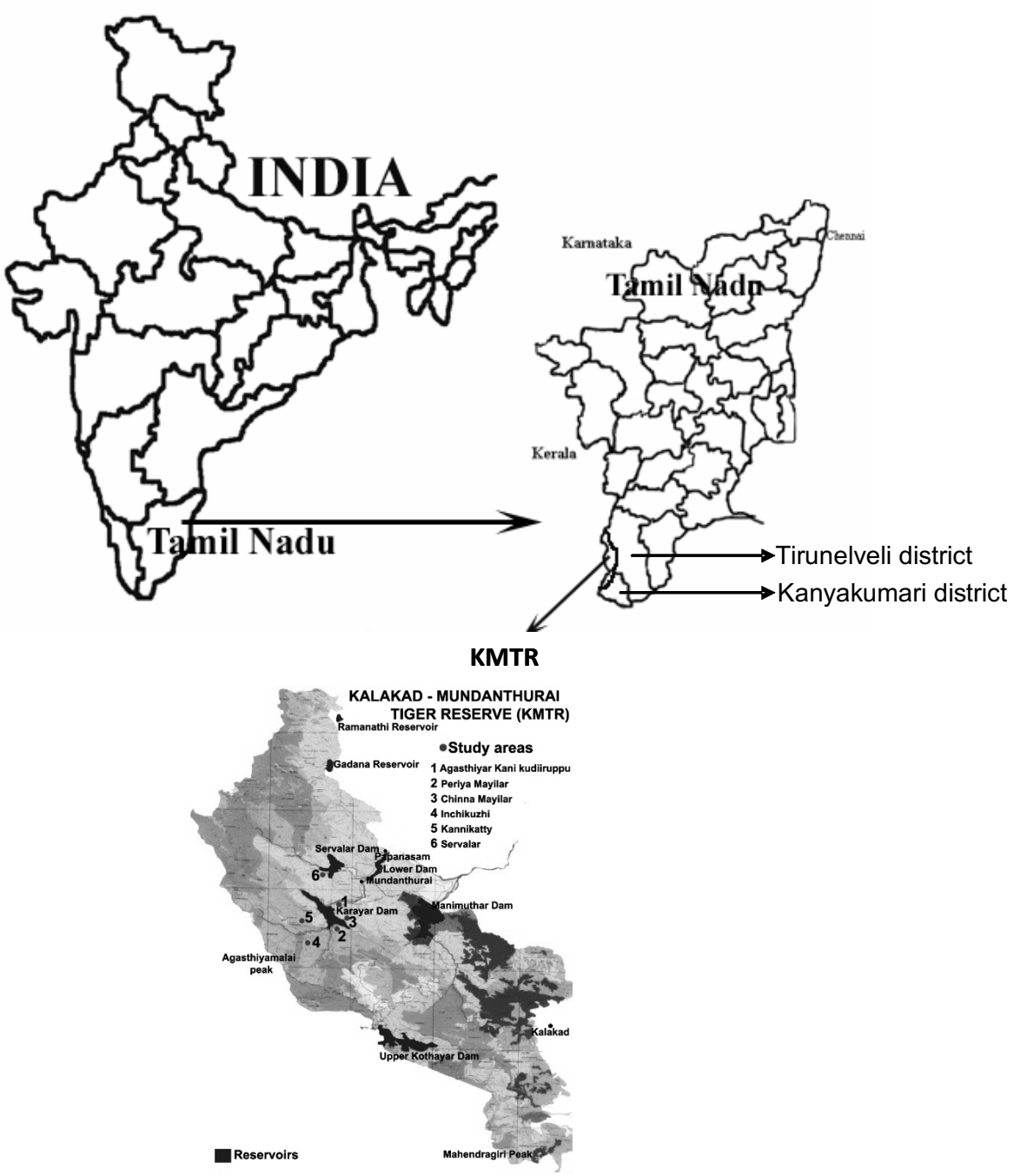
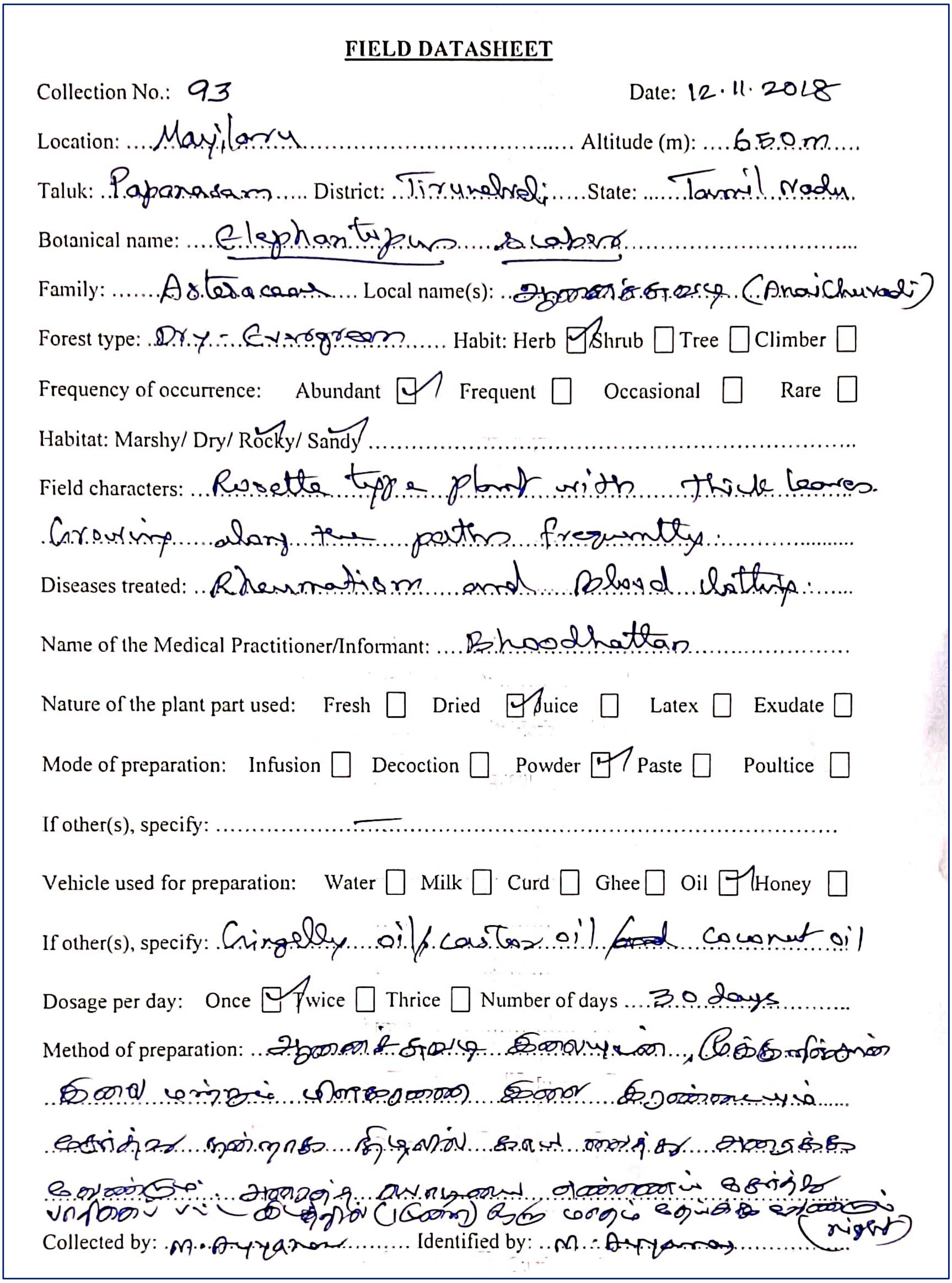


Figure 1. Location map of Kalakad Mundanthurai Tiger Reserve with tribal inhabited villages in Tamil Nadu, India

Data collection

The ethnobotanical survey on medicinal plants used by Kani tribes of KMTR was carried out between October 2018 and December 2019. The settlements of Kani tribes were located with 10 field surveys. Five tribal hamlets were chosen for the study in the selected area. The informants were chosen based on the experience in preparation of medicines, readiness to share their traditional knowledge, way of acquiring knowledge on the medicinal plants and ability to treat a specific disease. The information on medicinal use of plant, plant part used, mode of preparation and administration, dosage, other plants or ingredients used were collected with the help of semi structured questionnaire (Fig. 2), discussions and interviews. The ethnobotanical study was undertaken as directed by Haq *et al.* (2022). The medicinal use of plants utilized by Kani tribes were gathered from traditional healers or herbal practitioners who are referred as 'Vaidhyar' and other people belonging to the settlements. Fresh plant specimens were displayed to the traditional healers for acquiring the medicinal use and was validated by showing the same material to other healers of the hamlet. The informants were also taken to field for obtaining medicinal uses. Regional (vernacular names) names of plants, and field characters were noted in field data sheets.



FIELD DATASHEET

Collection No.: 93 Date: 12.11.2018

Location: Mayilaru Altitude (m): 650 m

Taluk: Papanasam District: Tirunelveli State: Tamil Nadu

Botanical name: Elephantopus scaber

Family: Asteraceae Local name(s): ஆனைச்சுவடி (Anaichuvadi)

Forest type: Dry - Evergreen Habit: Herb ☑ Shrub ☐ Tree ☐ Climber ☐

Frequency of occurrence: Abundant ☑ Frequent ☐ Occasional ☐ Rare ☐

Habitat: Marshy/ Dry/ Rocky/ Sandy

Field characters: Rosette type plant with thick leaves. Growing along the paths frequently.

Diseases treated: Rheumatism and blood clotting.

Name of the Medical Practitioner/Informant: Bhoodhattan

Nature of the plant part used: Fresh ☐ Dried ☑ Juice ☐ Latex ☐ Exudate ☐

Mode of preparation: Infusion ☐ Decoction ☐ Powder ☑ Paste ☐ Poultice ☐

If other(s), specify: —

Vehicle used for preparation: Water ☐ Milk ☐ Curd ☐ Ghee ☐ Oil ☑ Honey ☐

If other(s), specify: Gingelly oil/castor oil/ coconut oil

Dosage per day: Once ☑ Twice ☐ Thrice ☐ Number of days 30 days

Method of preparation: ஆனைச்சுவடி இலையுடன், [illegible]

[illegible]

[illegible]

[illegible] (night)

Collected by: M. Ayyanar Identified by: M. Ayyanar

Figure 2. Field datasheet used to collect the ethnomedicinal information from Kani tribes of Kalakad Mundanthurai Tiger Reserve, India

Analysis of ethnomedicinal data

Use Value (UV)

The ethnomedicinal plants documented to be used in treating rheumatism were validated with Use Value (ethnobotanical index). This helps to understand the prevalence of ethnic knowledge among the informants. The use value of plants was calculated with the following formula (Silambarasan *et al.* 2017b).

$$UV = \sum U/n$$

Where, 'U' is the total number of use reports cited by informants for a plant and, 'n' is the total number of informants Use value is generally high when there are more use reports, and it is helpful in determining the medicinal plants with high use reports in the treatment of disease.

Frequency of Citation (FC)

Frequency of Citation of a plant is recorded by number of use reports cited by the informants in the study area for a plant species in treating a particular ailment.

Plant collection and identification

The collected plants were identified using the Flora of Presidency of Madras (Gamble 1935), Flora of Tamil Nadu Carnatic (Matthew 1983), and Check list of the Flora of Tirunelveli hills, Southern Western Ghats, India (Manickam *et al.* 2004). The binomials were verified from Plants of the World Online (POWO, 2022). The specimens were deposited in the herbarium of Department of Botany, A.V.V.M Sri Pushpam College, Thanjavur, Tamil Nadu.

Results

Demographic data of informants

Twenty-one informants between the age 30 and 65 were chosen for the present study in five hamlets of KMTR. Out of 21 informants, 13 are folk medicine practitioners and 8 are local ethnic people who practice folk medicine for their needs and neighbours (Table 1).

Table 1. Demographic data of informants of the study area

Features	Category	Number of informants		Total	Percentage
		Male	Female		
Age	30-35	1	0	1	04.76
	35-40	2	1	3	14.28
	40-45	2	2	4	19.04
	45-50	3	1	4	19.04
	50-55	4	2	6	28.57
	55-60	1	1	2	09.52
	60-65	1	0	1	04.76
Occupation	Medicine practitioners	11	2	13	61.90
	Others	7	1	8	38.09
Education	Illiterate	11	5	16	76.19
	Primary education	3	1	4	19.04
	Higher education	1	0	1	04.76

Enumeration of medicinal plants

The ethnomedicinal plants used against rheumatic problems were enumerated with binomial name, local name, family, life form, parts used, use value, other plants and ingredients used, dosage, mode of preparation and administration. The information about the life form, number of use reports and use value for documented species are provided in Table 2.

Table 2. List of medicinal plants used by Kani tribes to treat rheumatism

Binomial Name, voucher specimen number	Life form	Parts used	Frequency of citation (FC)	Use value (UV)
Allium cepa L. (ERIH 48)	Herb	Bulb	20	0.95
Bambusa bambos (L.) Voss (ERIH 394)	Shrub	Seeds	16	0.76
Bauhinia tomentosa L. (ERIH 113)	Shrub	Leaf	11	0.52
Blachia umbellata (Willd.) Baill. (ERIH 137)	Shrub	Leaf	04	0.19
Blepharispermum petiolare DC. (ERIH 102)	Shrub	Leaf, stem bark	06	0.29
Cardiospermum halicacabum L. (ERIH 361)	Herb	Leaf	21	1.0
Cayratia pedata (Lam.) Gagnep. (ERIH 76)	Shrub	Leaf	12	0.57
Cyphostemma trilobata (Lam.) M.R. Almeida (ERIH 167)	Climber	Leaf, root	10	0.48
Cryptolepis buchananii R.Br. ex Roem. & Schult. (ERIH 112)	Climber	Leaf	15	0.71
Cymbopogon citratus (DC.) Stapf (ERIH 160)	Herb	Whole plant	20	0.95
Dorstenia indica Wight (ERIH 191)	Herb	Whole plant	04	0.19
Elephantopus scaber L. (ERIH 143)	Herb	Leaf	20	0.95
Elettaria cardamomum (L.) Maton (ERIH 129)	Herb	Dried fruit	20	0.95
Hugonia mystax L. (ERIH 213)	Shrub	Leaf, root bark	13	0.62
Lawsonia inermis L. (ERIH 155)	Shrub	Leaf	17	0.81
Mallotus resinosus (Blanco) Merr. (ERIH 91)	Shrub	Leaf, unripe fruit and root	03	0.14
Miliusa indica Lesch. ex A. DC. (ERIH 225)	Shrub	Stem bark, leaf	04	0.19
Morinda coreia Buch.-Ham. (ERIH 100)	Tree	Leaf	06	0.29
Neanotis indica (DC.) W.H. Lewis (ERIH 73)	Herb	Leaf	08	0.38
Osbeckia aspera (Meerb. ex Walp.) Blume (ERIH 432)	Shrub	Leaf, stem	12	0.57
Pergularia daemia (Forssk.) Chiov. (ERIH 429)	Shrub	Leaf	17	0.81
Plumbago zeylanica L. (ERIH 434)	Shrub	Root	12	0.57
Pterocarpus marsupium Roxb. (ERIH 436)	Tree	Stem bark	15	0.71
Sida acuta Burm. f. (ERIH 426)	Herb	Root	17	0.81
Strychnos nux-vomica L. (ERIH 420)	Tree	Leaf	12	0.57
Tylophora tenuis Blume (ERIH 41)	Climber	Leaf	02	0.10

Allium cepa L., Amaryllidaceae, Local Name: **siru vulli**. Uses: Bulb of this plant, bulb of *Drimia indica*, leaf and stem bark of *Santalum album* are shade dried, powdered and heated with gingelly oil. The mixture is applied topically on affected places once a day for a month to treat rheumatic pain in legs.

Bambusa bambos (L.) Voss., Poaceae, Local Name: **moongil**. Uses: Paste made from the dried seeds of this plant is mixed with the rhizome powder of *Begonia malabarica*, seeds of *Syzygium cumini*, leaves of *Abutilon indicum*, *Withania somnifera*, *Clitoria ternatea* and *Justicia adhatoda*. About 25 gm of mixture is taken orally once a day for a month before going to bed to treat rheumatism.

Bauhinia tomentosa L., Fabaceae, Local Name: **kutthuvarai / kanchini**. Uses: Leaf of this plant, leaf of *Dunbaria ferruginea*, stem barks of *Ficus benghalensis, Ficus racemosa*, *Pongamia pinnata* and unripe fruits of *Terminalia chebula* are ground into a paste. About 25 gm of paste is taken orally once a day for a month before going to bed to treat rheumatism.

Blachia umbellata (Willd.) Baill., Euphorbiaceae, Local Name: **aatthu maanthai**. Uses: Leaf of this plant is mixed with the leaves of *Euphorbia hirta* and *Clematis zeylanica*. The mixture is ground into a paste and applied topically on affected places twice a day for 41 days to treat rheumatism.

Blepharispermum petiolare DC., Asteraceae, Local Name: **kaattu pudhar**. Uses: Leaf and stem bark of this plant is shade dried and made into a powder. One teaspoon of fine powder is taken orally along with cow's milk twice a day for 5-14 days to treat rheumatism.

Cardiospermum halicacabum L., Sapindaceae, Local Name: **mudakkatthan**. Uses: Leaf decoction is used to take bath to get relief from rheumatism. And about 25 ml of decoction is taken twice a day after food for a month to treat rheumatism.

Cayratia pedata (Lam.) Gagnep., Vitaceae, Local Name: **siruvalli kodi**. Uses: Leaf of this plant, leaves of *Ocimum basilicum*, *Cardiospermum halicacabum*, *Alpinia calcarata*, *Withania somnifera* and root of *Clematis zeylanica* are mixed and ground into a paste. The paste thus obtained is applied topically twice a day for a week to treat rheumatism.

Cyphostemma trilobata (Lam.) M.R. Almeida, Vitaceae, Local Name: **moovilai kodi**. Uses: Leaf and root of this plant are mixed with the stem barks of *Crateva adansonii, Coscinium fenestratum*, *Clematis zeylanica* and seeds of *Abrus precatorius*. The mixture thus obtained is heated with castor, coconut and gingelly oils, applied topically to treat rheumatism.

Cryptolepis buchananii R.Br. ex Roem. & Schult., Apocynaceae, Local Name: **paal kodi**. Uses: Leaf powder is mixed with water and applied topically once a day for 41 days on affected places to get relief from rheumatic pain.

Cymbopogon citratus (DC.) Stapf, Poaceae, Local Name: **sukku narip-pullu**. Uses: Whole parts of this plant, stem barks of *Ficus religiosa*, *Ficus benghalensis* and leaf of *Pandanus odorifer* are shade dried and powdered. The fine powder thus obtained is mixed with gingelly oil and applied topically once a day for a month on affected places to treat rheumatism.

Dorstenia indica Wight, Moraceae, Local Name: **kutthu urinji**. Uses: Whole parts of this plant, leaves of *Vitex altissima* and *Clematis zeylanica* are boiled in water. About 100 ml of decoction is taken orally once a day before breakfast for a month to treat rheumatism.

Elephantopus scaber L., Asteraceae, Local Name: **aanai chuvadi**. Uses: Leaf of this plant, leaves of *Zanthoxylum asiaticum* and *Clematis zeylanica* are shade dried and powdered. The powder thus obtained is heated with castor, coconut and gingelly oil and applied topically on affected places once a day for a month before going to bed to treat rheumatism.

Elettaria cardamomum (L.) Maton, Zingiberaceae, Local Name: **elak-kai / elam**. Uses: Dried fruits of this plant, rhizomes of *Alpinia galanga*, *Zingiber officinale* and fruits of *Piper nigrum* are ground into a powder. Two teaspoon of fine powder is taken once a day before going to bed for a month along with sugar to get relief from rheumatic pain.

Hugonia mystax L., Linaceae, Local Name: **mothira kanni**. Uses: Leaf and root bark of this plant, leaf of *Begonia malabarica*, stem of *Clematis zeylanica* and whole plant parts of *Cymbopogon citratus* are shade dried and powdered. About 2 teaspoon of powder is mixed with water and taken orally twice a day for 41 days early in the morning and before going to bed to treat rheumatism.

Lawsonia inermis L., Lythraceae, Local Name: **maruthani**. Uses: Leaf is ground into fine paste and applied topically on affected places to treat rheumatic pain in legs.

Mallotus resinosus (Blanco) Merr., Euphorbiaceae, Local Name: **siru thuvarai**. Uses: Leaf, unripe fruit and root of this plant, root of *Zanthoxylum asiaticum* and leaf of V*itex altissima* are mixed and ground into a paste and applied topically on affected places to treat rheumatism.

Miliusa indica Lesch. ex A. DC., Annonaceae, Local Name: **karunaarai**. Uses: Stem bark and leaf of this plant, stem bark of *Bergera koenigii*, leaves of *Chloroxylon swietenia*, *Terminalia bellirica* and *Sphaeranthus indicus* are ground into a paste and applied topically on affected places to treat rheumatism.

Morinda coreia Buch.-Ham., Rubiaceae, Local Name: **manjanatthi maram / nuna maram**. Uses: Juice extracted from the leaf is mixed with the leaf juice of *Justicia adhatoda* and the mixture is heated with gingelly oil and applied topically once a day for 41 days on affected places to get relief from rheumatic pain.

Neanotis indica (DC.) W.H. Lewis, Rubiaceae, Local Name: **kodi-urinchi**. Uses: Leaf of this plant is ground into a paste and applied topically on affected places once a day for 41 days to get relief from rheumatic pain.

Osbeckia aspera (Meerb. ex Walp.) Blume, Melastomataceae, Local Name: **pavazha chedi**. Uses: Leaf paste is applied topically on affected places to treat rheumatism. Leaf and stem are boiled in water and about 25-30 ml of decoction is taken orally once a day for two months to treat rheumatism.

Pergularia daemia (Forssk.) Chiov., Apocynaceae, Local Name: **velip-parutthi**. Uses: Leaf of this plant and seeds of *Piper nigrum* are shade dried and made into powder. The fine powder thus obtained is mixed with Eucalyptus oil and made into a paste. This paste is applied topically once a day for 41 days to get relief from rheumatism.

Plumbago zeylanica L., Plumbaginaceae, Local Name: **chitthira moolam**. Uses: Root of this plant, leaf of *Clematis zeylanica*, stem barks of *Ficus benghalensis*, *Ficus racemosa* and root of *Elephantopus scaber* are shade dried and powdered. The powder thus obtained is mixed with coconut oil and applied topically once a day for 41 days on affected places to treat rheumatism.

Pterocarpus marsupium Roxb., Fabaceae, Local Name: **vengai maram**. Uses: Stem bark of this plant, leaf of *Clematis zeylanica*, stem barks of *Ficus benghalensis*, *Ficus racemosa* and root of *Elephantopus scaber* are mixed and ground into a paste. This is applied topically once a day for 2 months on affected places to treat rheumatism.
Sida acuta Burm.f., Malvaceae, Local Name: **kurunthotti**. Uses: Root powder of this plant is mixed with the root of *Strobilanthes sps* and ground into paste. About two teaspoon of paste is taken orally twice a day after food for 14 days to treat rheumatism.
Strychnos nux-vomica L., Loganiaceae, Local Name: **etti / kanchiram**. Uses: Leaf is ground into a paste and applied topically once a day for a month on affected places to treat rheumatism.
Tylophora tenuis Blume, Apocynaceae, Local Name: **kodi neeli**. Uses: Leaf of this plant, stem bark of *Melia azedarach,* leaf of *Clematis zeylanica* and whole plant parts of *Elephantopus scaber* are mixed and ground into a paste. This is applied topically on affected places once a day for two months to treat rheumatism.

Plant diversity and family dominance
In the present study, 59 species of plants belonging to 33 families were reported to be used in treating rheumatism. The most abundantly utilized plants are belonged to Fabaceae (6 species), followed by Zingiberaceae (4 species), Moraceae (4 species), Rutaceae, Poaceae, Euphorbiaceae, Asteraceae and Apocynaceae each with 3 species. Herbs and shrubs were predominantly used in the medicine formulation as they are abundant in the studied region.

Plant parts used
The plant parts like leaf, stem, root, seeds, bulb, rhizome, stem bark, root bark and fruits were utilized in the medicinal preparation (Fig. 3). Leaves (35 species) are widely used in preparing folk medicine, followed by stem bark (13 species), root (7 species), fruit (4 species), rhizome (3 species), seeds (3 species), bulb (2 species), root bark (2 species) and stem (2 species). In some medicine preparation, whole plants were also used (3 species).

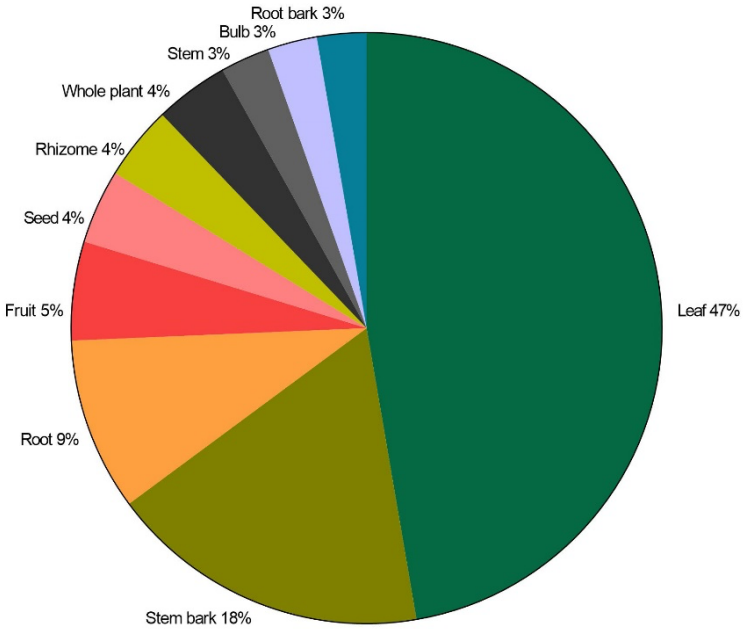


Figure 3. Percentage of plant parts used for the preparation of medicine in treating rheumatism

Preparation and administration of herbal medicine
Fifty-nine species of plants are used in the preparation of medicine, of which 26 species are the major plants used in higher quantity and 33 species are used in least quantity (Table 3). The medicinal plants were formulated into 26 medicines in the form of paste, decoction and powder. Most of the formulations were applied externally on the painful region as a paste, and powder and decoction are taken internally. Other mode of administration involved is bathing with the obtained decoction. Apart from plants, some common ingredients like water, gingelly oil, coconut oil, castor oil, cow's milk, sugar and *Eucalyptus* oil were also commonly employed in the medicinal preparation.

Table 3. List of plants used in least quantity for medicine formulation in the treatment of rheumatism among the Kani tribes in KMTR

Binomial Name	Family	Local Name	Parts Used
Abrus precatorius L.	Fabaceae	Kundumani	Seeds
Abutilon indicum (L.) Sweet	Malvaceae	Thutthi	Leaf
Alpinia calcarata (Andrews) Roscoe	Zingiberaceae		Leaf
Alpinia galanga (L.) Willd.	Zingiberaceae	Chittharatthai	Rhizome
Begonia malabarica Lam.	Begoniaceae	Narayana sanjeevi	Rhizome, leaf
Bergera koenigii L.	Rutaceae	Karuveppilai	Stem bark
Cardiospermum halicacabum L.	Sapindaceae	Mudakkatthan	Leaf
Chloroxylon swietenia DC.	Rutaceae		Leaf
Clematis zeylanica (L.) Poir.	Ranunculaceae	Mookkurinjaan	Leaf, stem, stem bark, root
Clitoria ternatea L.	Fabaceae	Shanku pushpam	Leaf
Coscinium fenestratum (Gaertn.) Colebr.	Menispermaceae	Manjal kodi	Stem bark
Crateva adansonii DC.	Capparaceae		Stem bark
Cymbopogon citratus (DC.) Stapf	Poaceae	Sukku narip-pullu	Whole plant
Drimia indica (Roxb.) Jessop	Asparagaceae		Bulb
Dunbaria ferruginea Wight & Arn.	Fabaceae	Esal avarai	Leaf
Elephantopus scaber L.	Asteraceae	Aanai chuvadi	Root, whole plant
Euphorbia hirta L.	Euphorbiaceae	Paal chedi	Leaf
Ficus benghalensis L.	Moraceae		Stem bark
Ficus racemosa L.	Moraceae	Atthimaram	Stem bark
Ficus religiosa L.	Moraceae	Arasamaram	Stem bark
Justicia adhatoda L.	Acanthaceae	Adathodai	Leaf
Melia azedarach L.	Meliaceae	Malai vembu	Stem bark
Ocimum basilicum L.	Lamiaceae	Nalla thulasi	Leaf
Pandanus odorifer (Forssk.) Kuntze	Pandanaceae	Thaalai	Leaf
Piper nigrum L.	Piperaceae	Milagu	Fruit
Pongamia pinnata (L.) Pierre	Fabaceae	Punga maram	Stem bark
Santalum album L.	Santalaceae	Santhana maram	Leaf, stem bark
Sphaeranthus indicus L.	Asteraceae	Kottai karandai	Leaf
Strobilanthes sps	Acanthaceae		Root
Syzygium cumini (L.) Skeels	Myrtaceae	Naaval maram	Seeds
Terminalia bellirica (Gaertn.) Roxb.	Combretaceae	Thandri maram	Leaf
Terminalia chebula Retz.	Combretaceae	Kadukkai maram	Unripe fruit
Vitex altissima L.f.	Lamiaceae	Mayilai maram	Leaf
Withania somnifera (L.) Dunal	Solanaceae		Leaf
Zanthoxylum asiaticum (L.) Appelhans, Groppo & J.Wen	Rutaceae	Milagaranai	Leaf, root
Zingiber officinale Roscoe	Zingiberaceae		Rhizome

Discussion

The present study has documented the ethnomedicinal uses of 59 plant species distributed in 55 genera belonging to 33 families. The traditional knowledge of these medicinal plants is limited to few members of the community. In the study, Fabaceae is considered as the dominant family with 6 species used in folk medicine preparation in treating rheumatic problems and it may due to the abundant presence of these family members in the environs of kanis as they are the diversified flora of these region. In many ethnomedicinal surveys it is reported that members belonging to Fabaceae is extensively used (Ayyanar & Ignacimuthu 2011, Sukumaran *et al.* 2020). It is also a diverse family with multitudinous pharmacological importance, and it is known for the bioactive metabolites such as alkaloids, flavonoids and coumarins (Macêdo *et al.* 2018). The aerial parts of plants were known to be widely used as they are easily collected and involve in the production of different classes of secondary metabolites (Forestrania *et al.* 2022). Of the 59 plant species reported, leaves and stem barks are widely utilized for herbal preparation. Plants contain phytochemicals in almost every part which makes them suitable to be used against varying ailments (Sukumaran *et al.* 2020).

In our study, whole plant parts of *Cymbopogon citratus* are mixed with the stem barks of *Ficus religiosa*, *Ficus benghalensis* and leaf of *Pandanus odorifer* and the powdered extract was used to treat rheumatism. Whereas Adiyan community in Wayanad district of Kerala, India uses the leaves of this plant as mouthwash to get relief from toothache (Sureshkumar et al., 2017). Likewise, paste made from the leaves of *Pterocarpus marsupium* was used to treat skin diseases and decoction obtained from the gums of the plant was used in treating urinary problems, bronchitis and leprosy by Adiyan community. But Kani tribals in Kanyakumari district use the pasted stem bark of *P. marsupium* in treating rheumatic problems after mixing with the leaf of *Clematis zeylanica*, stem bark of *Ficus benghalensis*, *F. racemosa* and root of *Elephantopus scaber*. Kani people use the powdered root of *Sida acuta* in treating rheumatism as like Adiyan community in Kerala (Sureshkumar et al., 2017), where the ethnic people use the leaves of the plant to get relief from rheumatic problems.

In the medicinal preparation with other plant parts, stem bark of *Ficus benghalensis,* root and whole plant of *Elephantopus scaber,* and leaves of *Clematis zeylanica* are used in most of the formulations (Table 3). It was reported that, stem latex of *Ficus benghalensis* is reported to be used in curing heel crack and dental issues (Muthu *et al*. 2006). *Elephantopus scaber* is known to possess triterpenoids, flavonoids and sesquiterpene lactones and is used in treating cardiovascular diseases and liver problems (Hiradeve *et al*. 2014). *Clematis zeylanica* belonging to family Ranunculaceae is most frequently used ingredient as least quantity in folk medicine preparations in treating rheumatism and commonly used in treating skin allergy and itching (Harsha *et al*. 2002). This plant is traditionally used by Ahom tribes of Assam in preparing a traditional drink called Haj and is reported to cure toothache (Bhuyan *et al*. 2013).

Out of the 59 plant species reported in the present study, *Abrus precatorius*, *Begonia malabarica*, *Cardiospermum halicacabum*, *Cymbopogon citratus*, *Elephantopus scaber*, *Hugonia mystax*, *Justicia adhatoda*, *Pergularia daemia*, *Piper nigrum*, *Plumbago zeylanica* and *Pterocarpus marsupium* were previously stated to be used in treating rheumatism by Kani tribes of KMTR (Sutha *et al*. 2010). The ethnic people in Bordj Bou Arreridj in Northeast Algeria use nine species of ethnomedicinal plants with 56 use reports in the treatment of rheumatism (Miara et al., 2019). The seeds of *Abrus precatorius* is also used in treating worm infection and bone fracture in animals (Garaniya & Bapodra 2014). The whole plant of *Begonia malabarica* is reported to be used in joint pain and arthritis treatment by Irula tribals of Walayar valley (Venkatachalapathi *et al*. 2018). The leaves of *Cardiospermum halicacabum* is treated as a prime medicine in treating joint inflammation and rheumatic pain (Elangovan *et al*. 2022). The whole plant of *Elephantopus scaber* is used by Kani tribes of Thoduhills in curing blood clot (Xavier *et al*. 2014). Leaves of *Pergularia daemia* and *Justicia adhatoda* is reported to possess anti-inflammatory activity and is used against musculoskeletal ailments (Esakkimuthu *et al*. 2021). Fruits of *Piper nigrum* is utilized as a major ingredient in medicine formulation for leg swellings (Shanmugam *et al*. 2012). Root paste of *Plumbago zeylanica* is used to cure oedema and leaf paste is used to get relief from muscular pain (Mallik *et al*. 2012).

The current study has documented 48 species of plants used by Kani tribes apart from the previously reported 50 plants by Sutha *et al*. (2010). This study has also found numerous middle-aged people practicing folk medicine apart from elderly people as reported by earlier researchers. Ranking of plants in the present study are performed based on frequency of citation and use reports specified by the informants of a given area. The use value of ethnomedicinal plant species documented in the present study ranges from 0.10 to 1.0 (Table 2). The frequently used plant species in the treatment of rheumatism as cited by the Kani tribals were *Cardiospermum halicacabum* (1.0), *Elettaria cardamomum* (0.95), *Elephantopus scaber* (0.95), *Cymbopogon citratus* (0.95), *Allium cepa* (0.95), *Sida acuta* (0.81), *Pergularia daemia* (0.81) and *Lawsonia inermis* (0.81) and the plants such as *Mallotus resinosus* and *Tylophora tenuis* were recorded with lowest use value of 0.14 and 0.10, respectively. The use value and frequency of citation are considered as quantitative methods for the analysis of ethnomedicinal information to measure which species are frequently used by the traditional healers/informants in the study area and their knowledge sharing aptitude among themselves in treating various diseases (Sureshkumar et al., 2021).

Conclusions

The present study has reported the medicinal use of 59 species of plants, most of the claims are not previously reported by other researchers. KMTR is a supreme area to carry out ethnobotanical surveys as it is rich in biodiversity with significant number of endemic plants and ethnic people who are utilizing it. The Kani tribes dwelling in the forest of KMTR are still depending on the natural resources, they involve in collecting Non-Timber Forest Produces for their economic upliftment and medicinal plants for their basic health care needs. The Kani tribes have great knowledge on the plants available and they are aware of the ingredients, plants required in least quantity and vehicle used for the preparation of medicines. The use of medicinal plants in treating rheumatic problems on the

basis of traditional knowledge acquired from the ethnic people is progressing nowadays because they are effective in treating such problems and have lesser side effects and also available at low cost. The plants such as *C. halicacabum*, *E. cardamomum*, *E. scaber*, *C. citratus*, and *A. cepa* possess the higher use value which indicates traditional knowledge of Kani tribals on these plants almost unique and these plants are further exploited for their associated pharmacological properties for developing an effective drug against chronic illness.

Declarations

List of abbreviations: **KMTR-** Kalakad Mundanthurai Tiger Reserve

Ethics approval and consent to participate: For the studies on experimental animal models, the researchers need to obtain ethical approval. For undertaking surveys for documenting ethno-medicinal knowledge from ethnic people, the college doesn't need ethical approval according to norms of our state. While before conducting the field survey with informants in the study area, individual prior informed consent was obtained from the participants who involved in the survey. To undertake surveys within forest boundaries, it is necessary to obtain permission from forest department. So, prior to starting the field work, proper permission was obtained from the Chief Wildlife Warden, Tamil Nadu to undertake field surveys. The right to use and authorship of any traditional knowledge of all participants is maintained, and any use of this information, other than for scientific publication, does require the additional prior consent of the traditional owners, as well as a consensus on access to benefits resulting from subsequent use.

Consent for publication: *Not Applicable*

Availability of data and materials: All the collected data regarding the ethnomedicinal information are given in the manuscript itself. The names of informants who participated in the survey are available with the authors.

Competing interest: The authors declare that they have no conflict of interest.

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