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Hepatoprotective ethnomedicinal plants of Mavilan and Koraga tribes of the Western Ghats region of Kerala, India

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Liver diseases have steadily increased to become one of the major causes of death globally for the past few decades, causing roughly two million deaths per year worldwide. Since ancient times, people have used medicinal plants to cure various liver disorders, and there are many plants and herbal preparations available in the market that can act as liver-protecting agents. As part of our ethnomedicinal survey, we have enumerated a variety of plants that the Mavilan and Koraga tribes of the southern Western Ghats region used to cure liver disorders. Face-to-face interviews with the tribal practitioners were conducted using a questionnaire after obtaining prior informed consent from each informant. The survey revealed 27 ethnomedicinal information for the treatment of liver diseases, of which 12 are single drug preparations and 15 are formulations. The survey documented 34 plant species belonging to 32 genera and 23 families for the treatment of liver diseases. This is the first study of its kind conducted in the Mavilan and Koraga tribal hamlets with the aim to document and conserve the ethnomedicinal knowledge of plants used to cure liver diseases. The detailed literature search revealed that the single drug plants *Biophytum reinwardtii*, *Cycas circinalis*, *Lepidagathis keralensis* and *Memecylon randerianum* are reported first time for their ethnomedicinal use against liver diseases.

Keywords: Ethnomedicine, Herbal drug formulations, Liver disease, Medicinal plants, Tribal knowledge

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The liver has a great capacity for eliminating pathogens, clearing immunological reactions, and detoxifying toxic substances. Furthermore, despite recent advances in pharmaceutical sciences, liver illnesses continue to be a major global health problem, causing about two million fatalities annually[1]. Since ancient times, people have used medicinal plants to cure various liver diseases, and there are many plants and herbal preparations available on the market that can act as liver-protecting agents[2]. There are more than 300 preparations comprising of 87 medicinal plants used in different combinations in AYUSH system for the treatment of liver and associated diseases[3-6]. The development of scientifically validated, standardized drugs and formulations based on traditional medicinal knowledge could be a valuable addition to the current medications for the treatment of liver diseases[7]. Thus, a stringent regulatory framework is required for research and development in traditional medicines, including their safety and efficacy[8].

Traditional medicines have already grown into a multibillion-dollar global business, and the pharmaceutical sector is increasingly looking into the potential of genetic resources and associated traditional knowledge (TK). Many modern drugs are derived from plants that were initially identified via ethnobotanical and ethnopharmacological research[8-10]. Besides classical systems of medicine, modern medicinal chemists consider ethnobotany as an affordable alternative for discovering novel and valuable molecules with high therapeutic value. Thus, documenting and safeguarding of these traditional medicine systems is becoming a greater priority. As part of our ethnomedical survey conducted from August 2012 to September 2013, we have enumerated

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a variety of plants that the Mavilan and Koraga tribes of the southern Western Ghats region used to cure liver problems. These researches not only provide TK about medicinal plants used for specific therapeutic objectives, but also ensure the preservation of cultural heritage.

Methodology

Study area

The present ethnobotanical survey was conducted in 15 villages of Kasaragod district (12.5°N, 75°E), namely Ananthapura, Badiyadka, Bekal, Kumbadaje, Mangalpady, Manjeswar, Mogral, Nattakallu, Neeleswaram, Neerchal, Panathady, Panathur, Periya, Sungathagutta and West Eleri, and 3 villages of Kannur district (11.9°N, 75.4°E), namely Alakode, Chemperi and Peringome of the Western Ghats regions of Kerala, India (Fig. 1). These villages are rich in naturally occurring medicinal plants used by the tribes and locals for treating various ailments. All the informants of the surveyed areas belong to Mavilan and Koraga tribal communities. Mavilan communities are mainly located in the Kannur and Kasaragod districts of Kerala state, while Koraga tribe are spread over the borders of Kerala and Karnataka states, India.

Methods

The surveys were carried out from August, 2012 to September, 2013. Totally three field visits of 3 to 5 days duration were conducted in the study areas. The information on ethnomedicinal plants were gathered through a questionnaire and in-depth interviews with the tribal practitioners in their own language with the help of tribal promoters[11-13]. Prior Informed Consent (PIC) was obtained from all the informants as per the NBA/CBD guidelines. The questionnaire permitted descriptive responses on the ethnomedicinal plants mentioned[14], such as local name, plant part used, method of preparation (*i.e.*, decoction, paste, juice etc.), route of administration (oral, external etc.) and dosage.

The plant materials collected were identified with the help of plant taxonomist of the Jawaharlal Nehru Tropical Botanic Garden and Research Institute (JNTBGRI), India and were further compared with The Plant List (http://www.theplantlist.org/). The voucher specimens were placed in the herbarium repository of the Institute. The inventory of plant species beginning with binomial nomenclature, family, habit, local name, locality, voucher specimen number, part used, method of preparation, route of administration, dosage and name of the informant tribal group are presented in Table 1.

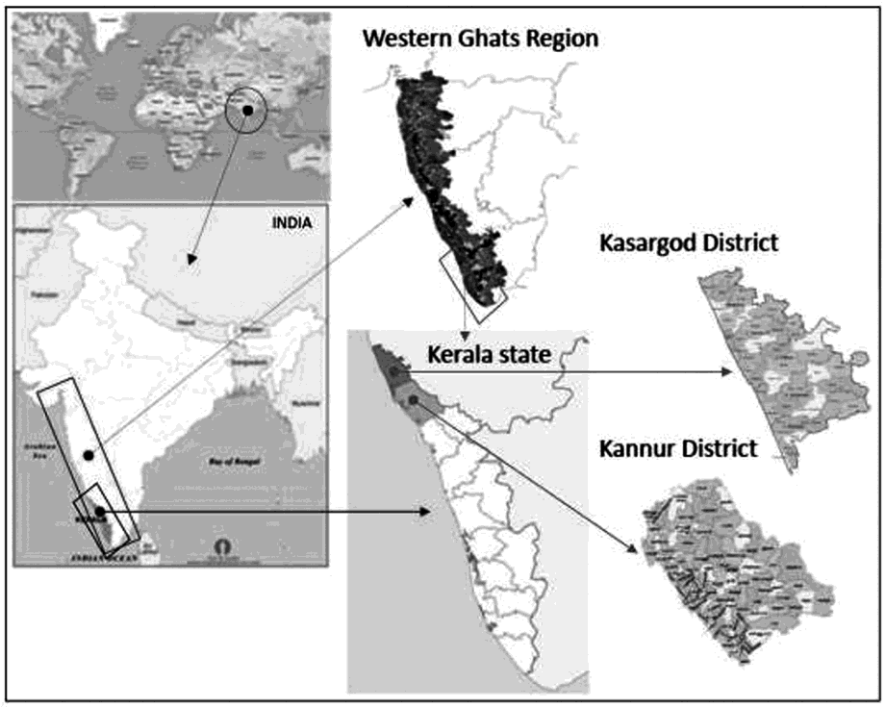

Fig. 1 — Geographical location of the ethnomedicinal survey area in the Western Ghats region of Kerala state, India (www.mapsofindia.com)

Table 1 — List of documented plants used for the treatment of liver diseases by Mavilan and Koraga tribes of Kerala, India

Single drug

Sl. No.	Binomial nomenclature	Family and habit	Local name(s)	Locality	Voucher specimen number	Part used	Preparation, route of administration and dosage	Informant tribe
1	*Andrographis paniculata* (Burm. f.) Nees	Acanthaceae Herb	*Nilaveppu*	Badiyadka	TBGT 57063 22.11.2013	Whole plant	15 mL of whole plant decoction, thrice daily for 7 days orally.	Mavilan
2.	*Azadirachta indica* A. Juss.	Meliaceae Tree	*Veppu*	Kumbadaje	TBGT 56944 24.02.2013	Leaves	10 g of leaf paste, twice daily for 7 days orally.	Mavilan
3.	*Blepharis maderaspatensis* (L.) B. Heyne ex Roth	Acanthaceae Herb	*Kodali soppu*	Badiyadka and Chemperi	TBGT 57083 03.12.2013	Whole plant	5-10 g of whole plant paste cooked with rice (gruel), twice daily for 7 days orally.	Mavilan and Koraga
4.	*Drynaria quercifolia* (L.) J. Sm.	Polypodiaceae Herb	*Bandhanika*	Neerchal	TBGT 57048 12.10.2013	Whole plant	5-10 g of whole plant paste cooked with rice (porridge), once daily for 7 days orally.	Koraga
5.	*Lagenaria siceraria* (Molina) Standl.	Cucurbitaceae Herb	*Churaykka*	Sungathagutta	TBGT 56941 24.02.2013	Fruits	One fresh fruit is sliced and cooked in water, taken orally without adding salt, once daily for 14 days.	Mavilan
6.	*Lepidagathis keralensis* Madhus. & N. P. Singh	Acanthaceae Herb	*Paramullu*	Ananthapura	TBGT 57061 22.11.2013	Whole plant	10 mL of fresh whole plant juice, twice daily for 7 days orally.	Mavilan and Koraga
7.	*Memecylon randerianum* S. M. Almeida & M. R. Almeida	Melastomataceae Shrub	*Vollekodi*	Sungathagutta	TBGT 56933 21.02.2013	Tender leaves	10 mL of fresh tender leaf juice, twice daily for 7 days orally.	Mavilan
8.	*Morinda citrifolia* L.	Rubiaceae Tree	*Chayamaram*	Bekal	TBGT 56902 15.01.2013	Stem bark	Fresh stem bark (100 g) is crushed and expressed juice is cooked with rice (porridge), twice daily for 7 days orally.	Koraga
9.	*Naregamia alata* Wight & Arn.	Meliaceae Shrub	*Nelanaragam, Nelakanchi*	Panathady	TBGT 57024 15.09.2013	Whole plant	Two fresh whole plants made to decoction, half glass thrice daily for 7 days, orally.	Mavilan
10.	*Phyllanthus amarus* Schumach. & Thonn.	Phyllanthaceae Herb	*Kirunelli, Nelanelli*	Nattakallu	TBGT 56943 24.02.2013	Whole plant	One fresh whole plant paste orally in empty stomach along with cow milk, once daily morning for 7 days.	Mavilan and Koraga
11.	*Syzygium cumini* (L.) Skeels	Myrtaceae Tree	*Nerale mara*	Neerchal	TBGT 56917 16.01.2013	Seeds	Expressed juice from fresh seeds, two tea spoon twice daily for 7 days orally.	Koraga

…*Contd*.

Table 1 — List of documented plants used for the treatment of liver diseases by Mavilan and Koraga tribes of Kerala, India (Contd.)

Sl. No.	Binomial nomenclature	Family and habit	Local name(s)	Locality	Voucher specimen number	Part used	Preparation, route of administration and dosage	Informant tribe
Single drug								
12.	*Thespesia populnea* (L.) Sol. ex Corrêa	Malvaceae Tree	*Poovarashu*	Neeleswaram	TBGT 57019 13.09.2013	Leaves	Fresh leaves boiled in water and bath once daily for 28 days.	Mavilan
13. Formulation 1								
	Thespesia populnea (L.) Sol. ex Corrêa	Malvaceae Tree	*Poovarashu*	Neeleswaram	TBGT 57019 13.09.2013	Leaves	7 fresh leaves of *Thespesia*, 21 seeds of cumin and a small piece of turmeric are ground and made to paste. This mixture concentrated in 250 mL of coconut oil by heating. Apply externally and take bath after 1 h.	Mavilan
	Cuminum cyminum L.	Apiaceae Herb	*Jeerakam*	Market sample		Seeds		
	Curcuma longa L.	Zingiberaceae Herb	*Manjal*	Periya	TBGT 57017 13.09.2013	Rhizome		
14. Formulation 2								
	Leucas aspera (Willd.) Link	Lamiaceae Herb	*Thumba*	Mogral	TBGT 56888 13.01.2013	Whole plant	Equal quantities (5-10 g) of all ingredients are crushed and expressed juice is taken orally for 7 days. Also apply 2-3 drops of juice in each eye twice daily for 7 days.	Mavilan
	Cuminum cyminum L.	Apiaceae Herb	*Jeerakam*	Market sample		Seeds		
	Cassia fistula L.	Fabaceae Tree	*Konna*	Mangalpady	TBGT 56909 15.01.2013	Stem bark		
	Vitex negundo L.	Lamiaceae Shrub	*Vellanochi*	Mangalpady	TBGT 56972 04.03.2013	Tender leaves		
15. Formulation 3								
	Syzygium cumini (L.) Skeels	Myrtaceae Tree	*Njaval*	Neerchal	TBGT 56917 16.01.2013	Root	Equal quantities (5-10 g) of all ingredients are ground to paste and taken orally with cow milk. Once daily for 7 days in empty stomach.	Mavilan
	Curcuma longa L.	Zingiberaceae Herb	*Manjal*	Panathur	TBGT 57017 13.09.2013	Rhizome		
	Ricinus communis L.	Euphorbiaceae Shrub	*Chittavanakku*	Panathur	TBGT 56964 03.03.2013	Root		
16. Formulation 4								
	Euphorbia hirta L.	Euphorbiaceae Herb	*Nelapala*	Panathur	TBGT 56970 04.03.2013	Whole plant	Equal quantities (5-10 g) of fresh whole plants are ground to paste and taken orally with cow milk. Once daily for 7 days in empty stomach.	Mavilan
	Phyllanthus amarus Schumach. & Thonn.	Phyllanthaceae Herb	*Keezharnelli*	Nattakallu	TBGT 56943 24.02.2013	Whole plant		

…*Contd*.

Table 1 — List of documented plants used for the treatment of liver diseases by Mavilan and Koraga tribes of Kerala, India (Contd.)

Sl. No.	Binomial nomenclature	Family and habit	Local name(s)	Locality	Voucher specimen number	Part used	Preparation, route of administration and dosage	Informant tribe
17. Formulation 5								
	Biophytum reinwardtii (Zucc.) Klotzsch	Oxalidaceae Herb	*Mukkutti*	Alakode	TBGT 56911 16.01.2013	Whole plant	Equal quantities (5 g) of fresh whole plant pastes mixed with 20 mL of water and taken orally 10 ml twice daily for 7 days.	Mavilan
	Phyllanthus amarus Schumach. & Thonn.	Phyllanthaceae Herb	*Keezharnelli*	Peringome	TBGT 56943 24.02.2013	Whole plant		
18. Formulation 6								
	Leucas aspera (Willd.) Link	Lamiaceae Herb	*Thumba*	Mogral	TBGT 56888 13.01.2013	Whole plant	Equal quantities of all ingredients are crushed and 2 drops of expressed juice apply in each eye thrice daily for 7 days.	Mavilan
	Erythrina variegata L.	Fabaceae Tree	*Murukku*	Badiyadka	TBGT 56864 29.12.2012	Root		
	Vitex negundo L.	Lamiaceae Shrub	*Vellanochi*	Mangalpady	TBGT 56972 04.03.2013	Tender leaves		
	Cassia fistula L.	Fabaceae Tree	*Konna*	Mangalpady	TBGT 56909 15.01.2013	Stem bark		
19. Formulation 7								
	Phyllanthus amarus Schumach. & Thonn.	Phyllanthaceae Herb	*Kirunelli, Nelanelli*	Nattakallu	TBGT 56943 24.02.2013	Whole plant	Equal quantities (100 g) of both ingredients made to decoction (concentrated 1 L to 100 mL). 10 mL of the decoction taken orally with cow milk, twice daily for 7 days.	Koraga
	Andrographis paniculata (Burm. f.) Nees	Acanthaceae Herb	*Kirathagaddi*	Badiyadka	TBGT 57063 22.11.2013	Whole plant		
20. Formulation 8								
	Jatropha curcas L.	Euphorbiaceae Shrub	*Kadalavanakku*	Badiyadka	TBGT 56969 04.03.2013	Tender leaves	Two fresh tender leaves of *Jatropha* and 1 g of cumin seeds are ground and made to paste. Taken orally once daily for 8 days with cow milk.	Koraga
	Cuminum cyminum L.	Apiaceae Herb	*Jeerike*	Market sample		Seeds		
21. Formulation 9								
	Phyllanthus emblica L.	Phyllanthaceae Tree	*Nellikai*	Manjeswar	TBGT 56943 24.02.2013	Fruits	Equal quantities of all the fresh ingredients are crushed and expressed juice (20-30 mL) is boiled with 1 L of water and concentrated to 200 mL. 15 mL of decoction taken orally, twice daily for 12 days.	Koraga
	Ficus benghalensis L.	Moraceae Tree	*Goli*	West Eleri	TBGT 56718 28.06.2012	Stem bark		
	Ficus racemosa L.	Moraceae Tree	*Athi*	Badiyadka	TBGT 56743 02.07.2012	Stem bark		
	Garcinia indica (Thouars) Choisy	Clusiaceae Tree	*Pinampuli*	Badiyadka	TBGT 56831 21.12.2012	Stem bark		

…*Contd*.

Table 1 — List of documented plants used for the treatment of liver diseases by Mavilan and Koraga tribes of Kerala, India (Contd.)

Sl. No.	Binomial nomenclature	Family and habit	Local name(s)	Locality	Voucher specimen number	Part used	Preparation, route of administration and dosage	Informant tribe
22. Formulation 10								
	Phyllanthus amarus Schumach. & Thonn.	Phyllanthaceae Herb	*Kirunelli, Nelanelli*	Nattakallu	TBGT 56943 24.02.2013	Whole plant	Fresh ingredients (10 g each) are crushed, boiled with water and made to decoction. Taken orally once daily for 7 days.	Koraga
	Justicia adhatoda L.	Acanthaceae Shrub	*Adaska*	Badiyadka	TBGT 56841 23.12.2012	Leaves		
23. Formulation 11								
	Ficus benghalensis L.	Moraceae Tree	*Goli*	West Eleri	TBGT 56718 28.06.2012	Stem bark	All the fresh ingredients (100 g each) are crushed, boiled with 1 L of water and concentrated to 100 mL. 15 mL of decoction taken orally, twice daily for 7 days.	Koraga
	Morinda citrifolia L.	Rubiaceae Tree	*Chayamaram*	Bekal	TBGT 56902 15.01.2013	Stem bark		
	Ixora coccinea L.	Rubiaceae Shrub	*Ckokki, Kepla*	West Eleri	TBGT 56843 24.12.2012	Flower		
24. Formulation 12								
	Andrographis paniculata (Burm. f.) Nees	Acanthaceae Herb	*Kirathagaddi*	Badiyadka	TBGT 57063 22.11.2013	Whole plant	Equal quantities of fresh *Andrographis* and *Phyllanthus* (10 g each), and 1 g of Cumin is crushed and the expressed juice is taken orally along with tender coconut water, once daily for 7 days.	Koraga
	Phyllanthus amarus Schumach. & Thonn.	Phyllanthaceae Herb	*Kirunelli, Nelanelli*	Nattakallu	TBGT 56943 24.02.2013	Whole plant		
	Cuminum cyminum L.	Apiaceae Herb	*Jeerake*	Market sample		Seeds		
25. Formulation 13								
	Aloe vera (L.) Burm.f.	Asphodelaceae Herb	*Kalabanda*	West Eleri	TBGT 56968 04.03.2013	Leaves	Equal quantity of all the fresh ingredients are crushed and expressed juice (10 mL) is taken orally twice daily for 7 days.	Koraga
	Phyllanthus emblica L.	Phyllanthaceae Tree	*Nellikai*	Manjeswar	TBGT 56943 24.02.2013	Stem bark		
	Phyllanthus amarus Schumach. & Thonn.	Phyllanthaceae Herb	*Kirunelli, Nelanelli*	Nattakallu	TBGT 56943 24.02.2013	Whole plant		
	Chrysopogon zizanioides (L.) Roberty	Poaceae Herb	*Lopanam*	Nattakallu	TBGT 56849 24.12.2012	Root		
26. Formulation 14								
	Oroxylum indicum (L.) Kurz	Bignoniaceae Tree	Payyani	West Eleri	TBGT 56851 26.12.2012	Stem bark	All the fresh ingredients (100 g each) are crushed, boiled with 1 L of water and concentrated to 100 mL. 10 mL of decoction taken orally, once daily for 7 days.	Koraga
	Careya arborea Roxb.	Lecythidaceae Tree	Daddala	West Eleri	TBGT 56893 13.01.2013	Tender leaves		
	Aegle marmelos (L.) Corrêa	Rutaceae Tree	Bellapatre	West Eleri	TBGT 56858 26.12.2012	Stem bark		

…*Contd*.

Table 1 — List of documented plants used for the treatment of liver diseases by Mavilan and Koraga tribes of Kerala, India (Contd.)

Sl. No.	Binomial nomenclature	Family and habit	Local name(s)	Locality	Voucher specimen number	Part used	Preparation, route of administration and dosage	Informant tribe
27. Formulation 15								
	Cycas circinalis L.	Cycadaceae Tree	*Eenthu*	West Eleri	TBGT 56882 12.01.2013	Root	All the fresh ingredients are crushed and 10 mL of expressed juice is taken orally once daily for 7 days.	Koraga
	Morinda citrifolia L.	Rubiaceae Tree	*Nonni*	Bekal	TBGT 56902 15.01.2013	Fruits		
	Phyllanthus emblica L.	Phyllanthaceae Tree	*Nellikkai*	Manjeswar	TBGT 56943 24.02.2013	Fruits		
	Syzygium cumini (L.) Skeels	Myrtaceae Tree	*Neralam*	Neerchal	TBGT 56917 16.01.2013	Stem bark		

Statistical analysis

All the statistical calculations were done using Microsoft Office software. The reported data were evaluated by comparing several parameters, including the number of plant species, family, habit, part used, method of preparation, and route of administration.

Results and Discussion

Majority of the Mavilan tribal settlements are in the hilly areas of Kannur and Kasaragod districts of Kerala, India. The chief of a settlement is called *Kiragan*, who oversees all social, religious, and agricultural activities in the settlements. In the past, Mavilans were hunter-gatherers; later they became shifting cultivators. They have very rich knowledge in indigenous traditional medicinal practices, farming and seed storage. Nowadays, the changing land use pattern, introduction of mono-crops / cash crops and intrusion of land by other communities, alienated their indigenous practices. Presently majority of the Mavilans are agriculture or wage labourers and few are marginal farmers. Koraga tribes are one of the most primitive tribal groups in Kerala state, and they speak a language close to *Tulu* and *Kannada*. The head of a settlement is called *Gurukara*, who oversees all social, religious, and indigenous activities in the settlements. The major sources of income in the Koraga community are the manufacture of baskets, laterite stone cutting, beedi rolling, and agricultural labour.

In the present ethnomedicinal survey, face-to-face interviews with 16 informants (7 Mavilan and 9 Koraga tribes) whose age ranged from 50-90 were carried out with the help of a questionnaire after obtaining PIC from each informant. Of these, 11 are male and 5 are female informants. The survey revealed 27 ethnomedicinal informations for the treatment of liver diseases (Table 1), of which 12 are single drug preparations (Mavilan 6 informations, Koraga 4 informations and 2 Koraga and Mavilan informations) and 15 are formulations (Mavilan 6 informations, Koraga 9 informations). All the informants interviewed inherited these indigenous knowledge and practices from their ancestors.

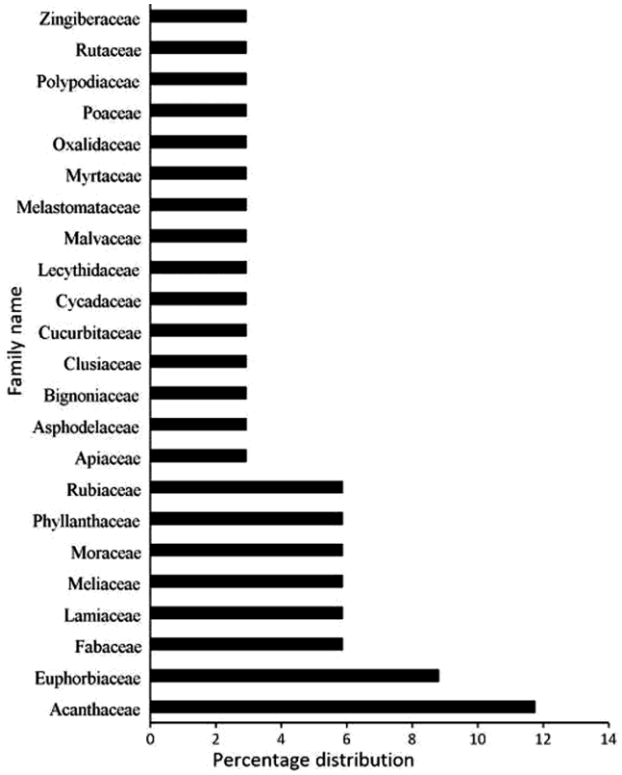

Fig. 2 — Family wise percentage of distribution of documented ethnomedicinal plants

The survey documented 34 plant species belonging to 32 genera and 23 families for the treatment of liver diseases. The family Acanthaceae (4 plants, 11.76%) represented maximum number of species followed by Euphorbiaceae (3 plants, 8.82%), Fabaceae, Lamiaceae, Meliaceae, Moraceae, Phyllanthaceae and Rubiaceae (2 plants each, 5.88%). The remaining 15 species belonged to 15 families, contributing to 2.94% each (Fig. 2). Out of the 34 species listed, 14 were

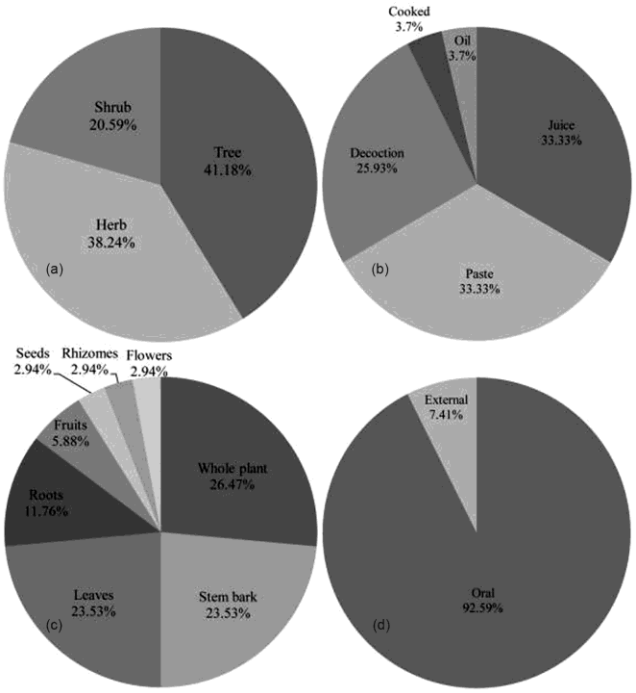

Fig. 3 — (a) Percentage of distribution of plant life forms present in the documented list of ethnomedicinal plants, (b) Percentage of distribution of method of preparation of ethnomedicines, (c) Percentage of distribution of plant parts used for ethnomedicinal purposes and (d) Percentage of distribution of route of administration of ethnomedicines

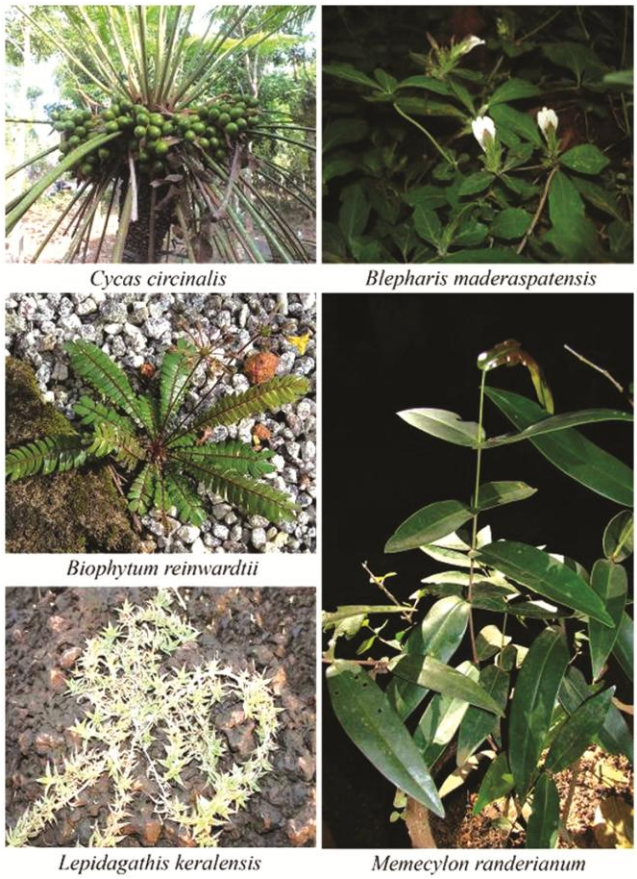

Fig. 4 — Newly reported hepatoprotective ethnomedicinal plants used by Mavilan and Koraga tribes

trees (41.18%), 13 were herbs (38.24%) and 7 were shrubs (20.59%). In case of plant parts used for the preparation of ethnomedicines, 9 species were used as whole plant (26.47%), bark from 8 species (23.53%), leaves from 8 species (23.53%), roots from 4 species (11.76%), fruits from 2 species (5.88%), seeds, rhizomes and flowers were used from 1 species each (2.94% each). The drugs were mainly prepared as juice (33.33%), paste (33.33%) and decoction (25.93%). The other preparations were in the form of cooked raw fruit, and medicated oil for external application (Fig. 3a-d). The major ingredients in 15 drug combinations are *Phyllanthus amarus* (in 6 combinations), *Cuminum cyminum* (4 combinations), *Phyllanthus emblica* (3 combinations), *Andrographis paniculata*, *Cassia fistula*, *Curcuma longa*, *Ficus benghalensis*, *Leucas aspera*, *Morinda citrifolia*, *Syzygium cumini* and *Vitex negundo* (2 combinations each), and *Thespesia populnea* (1 combination). The plants *Andrographis paniculata*, *Morinda citrifolia*, *Phyllanthus amarus*, *Syzygium cumini* and *Thespesia populnea* are used as both single and in combination drugs. Of these 92.59% were oral preparations. The detailed literature search revealed that the single drug plants *Biophytum reinwardtii*, *Cycas circinalis*, *Lepidagathis keralensis* and *Memecylon randerianum* (Fig. 4) are reported first time for their ethnomedicinal use in treatment of liver diseases. Recently, we have experimentally established the tribal claim on the liver-protective action of *Blepharis maderaspatensis*[15].

Conclusion

Findings of the present ethnobotanical survey revealed the rich trove of TK associated with the Mavilan and Koraga tribes residing in the southern Western Ghats region of Kerala state, India. Five plants are reported for the first time for their ethnomedicinal use in the treatment of liver diseases. Scientific validation of these hitherto uninvestigated plants is warranted. Conservation, sustainable utilization, fair and equitable sharing of benefits should be applied when these TK are applied in research and development.

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Conflict of Interest

The authors have no conflict of interest.

Author Contributions

TPI, NPR, VG and PP designed the study; PP and VG supervised the study; TPI, NPR, NA and MN conducted the field work; TPI wrote the manuscript in consultation with NPR and VG; NPR, MN and NA helped in the identification of species, TPI done the data analysis; VG and PP helped in the manuscript correction.

Prior Informed Consent

Prior Informed Consent (PIC) was obtained from all the informants as per the NBA/CBD guidelines.

Data Availability

The data will be made available by the corresponding author upon reasonable request.

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