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Ethnopharmacological Survey on Medicinal Plants for the Dengue Hemolytic Infections in Selected Regions in Sri Lanka

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Authors' contributions

This work was carried out in collaboration among all authors. Author MAS owns the hypothesis of the study, designed the study, performed literature searches, statistical analysis, wrote the protocol, supervised the other authors during the conduct of the study and wrote the manuscript. Authors DDA and WP collected the data, managed the analyses and perform literature searches of the study. Authors VS and DB managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To conduct an Ethnopharmacological survey on medicinal plants and, to make an inventory of plant species used in the treatment of Dengue Hemolytic Infection in *Deshiya Chikithsa* (an autochthonous traditional system of medicine) in Sri Lanka.
Study Design: This was a quantitative and qualitative ethnopharmacological survey.
Place and Duration of Study: Eleven selected districts in Sri Lanka covering Western, Sothern, and Mountain hill rages of the country, between January 2018 and January 2019.

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Methodology: Semi-structured validated questionnaires were administered to 173 traditional practitioners in selected eleven districts of Sri Lanka. Plants were categorized based on plant parts used and method of preparation and were used to analyze and summarize the collected data. Quantitative ethnobotanical tools used to claim and prove the use of medicinal plants for Dengue Hemolytic Infection were Frequency index (*FI*), Use Value for one species (UV_{sp}) and the species Use Value index for one informant (UV_{IF}).

Results: The survey identified 180 plant species belongs to 76 families. Approximately 33.6% of the plant species identified were used as air-dried flowers and 30.0% of plants are prepared by aqueous decoction. The most used plants were *Carica papaya L. (43.9), Coriandrum sativum L. (37.0), Mollugo cerviana L. (34.1),* and *Zingiber officinale L. (31.2)*. As calculated by Use Value for one species, *Carica papaya L., Coriandrum sativum L. and Mollugo cerviana L.,* were reported to be of the highest UV_{sp} value above 0.25. There were 5.5% plant species with above 0.20 of UV_{sp} value, and 6.1% plant species were above 0.20 species Use Value index for one informant (UV_{IF}). This signifies the highest relative use of these plants among the respondents and the highest number of uses of those species in the treatment of Dengue hemolytic infection.

Conclusion: According to the analysis, it can be concluded that medicinal plants identified in this study are reported here for the first time concerning their use for Dengue Infection except *Carica papaya L.* Therefore, this documented information on the medicinal plants used in *Deshiya Chikithsa* system of medicine in Sri Lanka may be used as baseline data for future pharmacological and phytochemical studies.

Keywords: Deshiya chikithsa; frequency index; dengue hemolytic infection; medicinal plants.

1. INTRODUCTION

The concepts of an autochthonous medicine known as *Deshiya Chikithsa* (DC) in Sri Lanka are believed to be 3000 years old. It was handed down from generation to generation and in the course of time, DC became fused with Ayurveda. Ayurveda was introduced to Sri Lanka by King Vijaya in the 6th century BC. As a belief, the DC is known to be originated and being practiced during the period of King Ravana "the legendary Great King of ancient Sri Lanka" [1,2]. There is a large traditional knowledge was blend with this DC traditional system of medicine. The Sri Lankan community relies on this system for many treatments including for the treatment of eye diseases, fractures, and dislocations, burns and scalds, boils and carbuncles, and cancers. Some of these practitioners specializing in fractures and dislocations are of such high reputation that they are often the first choice for treatment even by sections of the community accustomed to allopathic (western) medicine. There is more traditional knowledge based on ola-leaf manuscripts and ancient books on this traditional system of medicine. Still, these texts and the traditional knowledge are uncovered for the public. It is a well-known concept in the traditional system is "*Deyyange leda*" or "God's diseases", such as Measles and Variola infections, commonly referred to as viral infectious diseases. Those infections were known to be effectively controlled using medicinal plants and remedies unique to the DC system of medicine in the past. People of Sri Lanka was believed and practiced a strict self-lock-down concept as a curative measurement for so-called "God's diseases", which is an effective controlling method even today for the COVID 19 pandemic.

Dengue is a mosquito-borne viral infection that causes flu-like illness and occasionally develops into a potentially lethal complication called Severe Dengue Hemorrhage (SDH). Dengue Hemolytic Infection (DHI) is a global burden which is about a half of the world population in tropical countries is now at risk [3]. Dengue or severe dengue has no specific treatment yet, only the early detection and proper medical care lowers the fatal rate, but this is not always successful. The DHI is transmitted mainly by the female mosquitos belongs to the species *Aedes aegypti* and, to a lesser extent by *Aedes albopictus.* There are four distinct, but closely related serotypes of the dengue virus that have been identified as, DEN-1, DEN-2, DEN-3, and DEN-4. Among these serotypes, DEN-2 and DEN-3 are considered as 'Asian serotypes' and are mainly associated with SDH accompanying secondary dengue infection. The incubation period of the disease is 4-10 days, where an infected mosquito can transmit the virus within this period [4-6].

Although the current global COVID 19 pandemic situation hinders the prevalence and attention to DHI, the disease progressing in the tropical regions of the world. According to one recent estimate of WHO [3]; there are 390 million dengue infections per year all over the world whereas 96 million manifests clinically (with any severity of disease) and another study of the prevalence in dengue disease estimates that about 3.9 billion people in 128 countries are at risk of infection with dengue viruses [7]. In Sri Lanka, during the outbreaks, it has been identified that serotype 2 (DEN-2) is the circulating strain and DEN-2 is the most frequently detected serotype since 2009. However, during the period between 2019-2020, a total of 41043 dengue cases and 61 dengue deaths have been reported across the country. According to Epidemiology Unit of in Sri Lanka (EUSL) sources, the highest number of dengue cases had been reported from the Colombo district (8856) followed by Gampaha district (5389). Jaffna district representing the northern part of the country reported 3815 cases [8]. An estimated 105 million dengue infections occur per year across 120 countries (case-fatality rate < 1.00%), whereas there were 440 dengue-related deaths (case-fatality rate 0.24%) in Sri Lanka [9-11].

Herbal materials, herbal preparations, and finished herbal products that contain parts of plants, other plant materials, or combinations thereof as active ingredients are considered as the "Traditional and Complementary Medicinal Products" [12]. Sri Lanka, being a country with rich plant diversity, the current survey was decided to focus a study on medicinal plants used in the treatment of DHI. There are about 3,771 species of flowering plants including 927 endemic species (24.6% of the total number of flowering plants) and about 1430 plant species, which is approximately 38.0% of the total number of flowering plants that can be considered as 'medicinal plants" in Sri Lanka. While 174 (which is approximately 12.0% of the total number of medicinal plants) are endemic to Sri Lanka [13]. The knowledge of Sri Lankan indigenous medicine and DC may be found to be more fruitful in future endeavors to fight against the DHI. Since this indigenous medicine knowledge is inherited from certain families among the population, it was assumed that there can be unique treatment strategies available with DC practitioners in Sri Lanka. However, DC has been blended with Ayurveda during the past few decades of practice. Between these two systems, the Ayurveda system is well documented while the DC is less documented, and the knowledge sharing is highly restricted. The knowledge is scattered among certain generations and there is a threat of ceasing of generations with the knowledge on DC system of medicine [14-16]. Though ethnopharmacology has a relatively short history, but for centuries researchers have been discovered new chemical entities through the investigation of indigenous herbs and their biological activities. The scientific investigation of believes and knowledge of practice with natural products requires a critical and engaged discussion about the logical basis, the relevant methods, and the overall standards necessary for excellence [14,16].

The current study was focused on the medicinal plants used in the treatment of DHI under the DC system of medicine in Sri Lanka since there are extremely limited studies were reported. The aim of the study to gather and elaborate a comprehensive review on plant-based systematic remedies for DHI in Sri Lanka to make an inventory of plant species. The data was analyzed quantitatively using standard ethnopharmacological analytical tools. The study population was DC practitioners, who are registered under the Department of Indigenous Medicine Sri Lanka, under Section-55 (1) (e) in Ayurvedic Medical Council (AMC). The study area was selected as respective districts declared by the AMC database [17].

2. MATERIALS AND METHODS

2.1 Description of the Study Area

Sri Lanka formerly known as Ceylon, is an island with a beautiful landscape located in the Indian Ocean. The island consists of three zones basis of relief, Coastal plain up to 30 m from the sea level, Intermediate plain from 30 m to 300 m, and Central mountains over 300 m. Although Sri Lanka has a high humid and high temperature due to its location close to the equator, the temperature decreases as it is surrounded by the Indian Ocean. There are seven vegetation zones identified in Sri Lanka [18, 19]: Namely, Tropical wet forests, Dry mixed evergreen forests, Intermediate evergreen forests, Hill country wet zone forests, Hill country dry zone forests (Patanas), Thorny bushes and scrub lands and Mangroves. This in variation climate and diverse natural vegetation resources allowed a wide choice in medicinal plant selection in DC by TMPs (Fig.1).

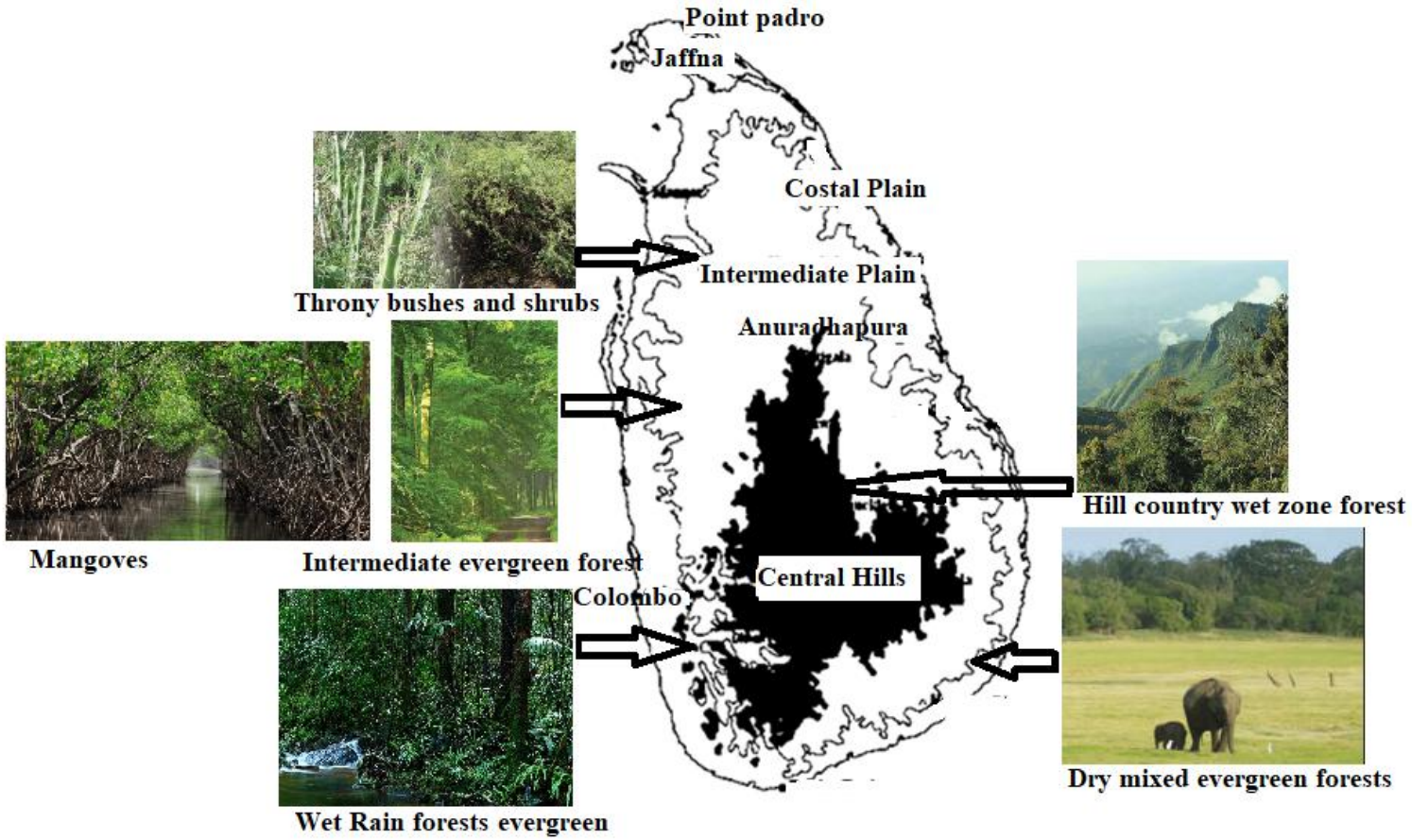

Fig. 1. Map showing the natural vegetation of Sri Lanka

2.2 Population and Ethnicity

The ethnic structure of the population of Sri Lanka is heterogeneous. According to Census of Population and Housing 2001, the ethnic groups include: Sinhalese (82%), Sri Lanka Tamil (4.3%), Indian Tamil (5.1%), Sri Lanka Moor (7.9%), Burgher (0.2%), Malay (0.3%) and Others (0.2%). The main spoken languages are Sinhala and Tamil, even though, Sinhala, Tamil, and English are official languages in the country. The Sri Lankan population belongs to three cultural diversities based on their customs and beliefs according to Buddhist, Hindu, and Islamic cultures. Where the Ayurveda, Siddha and Unani system of medicine mainly focuses based on these cultures. But the DC practice is unique which is an autochthonous medicine system existing in Sri Lanka. However, the uses of medicinal plants have slight variation among these four systems of medicine.

2.3 The Study Population

According to the Ayurvedic Medical Council (AMC) database, a total number of 5,259 TMPs are registered under Section-55 (1) (e) in the Ayurvedic Council in Sri Lanka. Out of that, 3,549 TMPs are general practitioners, while others are snake bite practitioners. Therefore, the sample size distribution within the 3,549 population was 347 TMPs, which can be consulted in Fig. 2. Most of the DC traditionally being practiced using the “Hela” the native Sri Lankan language, which is currently more like Sinhala language, therefore the study population was selected among them.

TMPs were randomly selected from eleven districts using the district-based lists of registered TMPs from AMC data to fulfill district wise sample size requirements. Data collection was carried out in selected eleven (11) districts in the island Fig. 2, representing Western, Southern, North Central, and Southwestern provinces in Sri Lanka.

2.4 Sampling Techniques and Selection of Respondents

The TMPs were selected registered under the general practitioners, after consideration of the current practice, knowledge on medicinal plants as inclusion criteria, while TMPs who were registered under a special category (snake bite) were excluded in the study. The sample size was calculated based on 3,549 TMPs using online Raosoft software using a sample size calculator under 5% margin of error and 95% confidence level. Therefore, the sample size of 175 TMPs were selected in the study.

The information collected through the questionnaire was covered the name, registration number, qualification and whether he/she was treated for dengue or not, whether he/she was aware of plants used in the treatment of dengue, whether there were plants specific to their medical tradition and, whether he/she was willing to declare such plants as personal information of TMPs. Medical clinics and residences of TMPs were selected as the study setting. Random selection of TMPs based on the practice from the selected districts in Sri Lanka were included in the study.

2.5 Ethnobotanical Survey

The study was a qualitative and quantitative ethnopharmacological survey that was designed in order to collect the data on medicinal plants used in the treatment of DHI. A semi-structured questionnaire was used to gather information regarding,

- specific medicinal plant(s) used in the treatment,
- specific parts of plants utilized in the treatment,
- the method and mode of administration,
- recommended period to be used.

2.6 Qualitative and Quantitative Ethnopharmacological Analysis

The use of cross-cultural exchange of diversification of medicinal floras between ethnic groups across the globe utilizes the selection of medicinal herbs in pharmacopeias. Qualitative and quantitative studies in ethnopharmacology, ethnomedicine, ethnobotany, pharmacy, phytochemistry, and pharmacognosy is still a common focus. It scientifically investigates how and why people select plants for medicine [20]. All the plants mentioned by respondents in the study questionnaires were listed based on districts in Microsoft Excel 2010. The plant lists mentioned under section 2.5, were updated with the number of plants. The specific components of the plants used by TMPs were listed. The percentage of each component concerning the total number of components used in the treatment of DHI was calculated. Administrative techniques or modes of administration used by

District	Total Number TMPs (General practitioners)	Sample size
Colombo	443	44
Gampaha	333	33
Kalutara	193	13
Galle	226	22
Matara	198	20
Hambantora	103	10
Kegalla	140	14
Ratnapura	179	18
Kandy	244	24
Matale	73	7
Badualla	71	7
Vaunia	12	1
Nuwara Eliya	38	4
Jaffna	271	27
Trincomalee	33	3
Mulaitivu	11	1
Mannar	30	3
Batticaloa	55	6
Kilinochchi	14	2
Ampara	126	13
Puttlam	106	11
Anuradhapura	178	18
Polonnaruwa	31	3
Moneragala	54	6
Kurunegala	387	38
District Total	3549	347

Ayurvedic Medical Council, Sri Lanka, data base 2019

Fig. 2. Districts selected as study areas

TMPs for a particular plant species s were listed. The percentage of each administrative technique, for each plant species in relation to the total number of administrative techniques used, was calculated.

2.6.1 The frequency index

The frequency index (FI), is an index that shows the local importance of each species and it is given by the following formula,

$$\mathrm{FI} = \frac{N_C}{N_T} \mathrm{X}\, 100\ \%$$

Where, N_C is the total number of use citations by all informants for a given plant species s and N_T is the total number of informants.

2.6.2 The use value

This method evaluates the relative importance (RI) of each medicinal species based on its relative use among informants. This index is useful for the analysis of the use of a single species and to compare plants among the same sample [21]. The Use Value (UV_{sp}) for one species was calculated by method described by Albuquerque et al. [22]. It is calculated as follows:

$$UV_{sp} = \frac{\sum N_C}{N_T}$$

Where, N_C is the sum of the total number of use citations by all informants for a given species, divided by the total number of informants N_T.

2.6.3 The species use value index

The species Use Value index for one informant (UV_{IF}) was used to calculate the number of uses mentioned for species by one informant in different events [23,24].

$$UV_{IF} = \frac{\sum U_{is}}{N_{IF}}$$

Where, U_{is} is the number of uses mentioned for species by the informant and N_{IF} is the number of events in which the informant cites a use for species s.

Plants with high FI were selected. Undamaged healthy plants were collected at the field in the herbal gardens of TMPs and Botanical Garden of Hambantota with proper field notes. Specimens were authenticated at National Herbarium, Hanbantota, Sri Lanka and Bandaranayake Ayurvedic Research Institute, Navinna, Maharagama, Sri Lanka.

3. RESULTS AND DISCUSSION

3.1 Survey on Medicinal Herbs Used for Dengue Hemolytic Fever in *Deshiya chikithsa* in Sri Lanka

Out of 25 districts in Sri Lanka, eleven selected districts have been covered in this survey. In all selected districts, the respondents reported the information on using a vast number of medicinal plants for treating DHI. A satisfactory rate of response was observed but most of the TMPs declared that they can share only a limited portion of their knowledge due to intellectual reasons. During the survey, 173 TMPs were responded with 98.9% of response rate.

3.2 Qualitative Ethnobotanical Analysis

The results of the ethnobotanical research in the selected regions showed that 180 plant species are used in the treatment of the DF in Sri Lanka (Table 1). Species were classified into 66 families. Families such as Fabaceae (8.4%), Euphorbiaceae (4.2%), Cucurbitaceae (4.2%), Lamiaceae/verbinaceae (4.2%), Meliaceae (4.2%), Rutaceae (4.2%), Malvaceae (4.2%), Apiaceae (3.0%), Apocynaceae (3.0%), Asclepiadaceae (3.0%), Moraceae (3.0%), Solanaceae (3.0%) and Acanthaceae (2.4%) had the widest representation (Table 1), with 39.8% of the recorded species that belong to these families.

Investigation on the growth form or use of plant parts is useful to determine the biosynthesis of secondary metabolites in the plant as the plant parts are capable of accumulating diverse phytochemicals. The analysis of the growth forms of the medicinal plants used in the research area revealed that the majority are trees (51.1%), followed by shrubs (42.8%), herbaceous plants (4.4%), and ferns (1.7%). Those plant parts or products used for making plant preparations are whole plant, fruits, leaves, and stem (Fig. 3), which contributes 33.3% from all plant parts used by TMPs in the treatment of DHI.

Table 1. Extent of usage of plants used in the treatment of dengue in selected districts of Sri Lanka

Family	Scientific name	Vernacular name	*Respondent	[a] FI	[b] UV_{sp}	[c] UV_{IF}
Acanthaceae	*Andrographis paniculata*	Heen bin kohomba/Kiratha	37	20.4	0.20	0.21
	Barleria prionitis L.	Ranwan katu/Ela katu karandu	1	0.6	0.01	0.01
	Hygrophila schulli (Buch. -Ham.)	Neeramulliya/Ikiriya	4	2.2	0.02	0.02
	Jasticia adhatoda L.	Adathoda/Pawatta/wanapala	36	19.9	0.20	0.21
Acoraceae	*Acorus calamus L.*	Wada kaha	3	1.7	0.02	0.02
Alangiaceae	*Alangium salviifolium*	Ruk aguna	1	0.6	0.01	0.01
Amaranthaceae	*Aerva javanica L.*	Pol pala	4	2.2	0.02	0.02
	Cyathula prostrarabl	Rath karal haba	2	1.1	0.01	0.01
Anacardiaceae	*Mangifera indica L.*	Amba	2	1.1	0.01	0.01
	Pistacia terebinthus	Terpentine	5	2.8	0.03	0.03
Apiaceae	*Centella asiatica L.*	Gotu kola	1	0.6	0.01	0.01
	Coriandrum sativum L.	Koththamalli	64	35.4	0.35	0.37
	Cuminum Cyminum	Sooduru/Korasami	1	0.6	0.01	0.01
	Trachyspermum involucratum	Asamodagam	1	0.6	0.01	0.01
	Anethum graveolens	Walsathakuppa	1	0.6	0.01	0.01
Apocynaceae	*Alstonia scholaris L.*	Ruk aththana	22	12.2	0.12	0.13
	Hemidesmus indicus L.	Iramusu	11	6.1	0.06	0.06
	Holarrhena antidysenterica	Kelinda/ Kelinda Hal	3	1.7	0.02	0.02
	Pagiantha dichotoma.	Divi kaduru	1	0.6	0.01	0.01
	Wrightia antidysenterica	Wana idda	1	0.6	0.01	0.01
Araceae	*Pothos scandens L.*	Pota wel	1	0.6	0.01	0.01
	Xanthosoma sagittifolium	Kiri ala	1	0.6	0.01	0.01
Arecaceae/Palmae	*Borassus flabellifer L.*	Thal bada	1	0.6	0.01	0.01
	Cocos nucifera	Thambili	1	0.6	0.01	0.01
Aristolochiaceae	*Aristolochia bracteolata*	Sathsanda	5	2.8	0.03	0.03
Asclepiadaceae	*Calotropis procera*	Akrapatta	1	0.6	0.01	0.01
	Hoya ovalifolia	Gonukaa wel	1	0.6	0.01	0.01
	Marsdenia tenacissima	Muruwa	3	1.7	0.02	0.02
	Tylophora indica	Keeta	1	0.6	0.01	0.01
	Wattakaka volubilis	Kiri anguna	1	0.6	0.01	0.01
Asparagaceae	*Asparagus racemosus Willd.*	Hathawariya	6	3.3	0.03	0.03
Asteraceae	*Blumea axillaris*	Kukula	2	1.1	0.01	0.01

Family	Scientific name	Vernacular name	*Respondent	[a] FI	[b] UV_{sp}	[c] UV_{IF}
	Eclipta prostrata L.	Keekirindiya	1	0.6	0.01	0.01
	Tridax procumbens	Thala	1	0.6	0.01	0.01
	Vernonia cineria L.	Monara kudummbiya/ Dutu sathutu	20	11.0	0.11	0.12
Athyriaceae	*Diplazium escolentos*	Miyana dalu	1	0.6	0.01	0.01
Bignoniaceae	*Oroxylum indicum L.*	Thotila	2	1.1	0.01	0.01
	Stereospermum suaveolens DC.	Palol	2	1.1	0.01	0.01
Burseraceae	*Commiphora mukul*	Shodhitha gugul	1	0.6	0.01	0.01
Cannabaceae	*Cannabis sativa L.*	Kansa	2	1.1	0.01	0.01
Cannaceae	*Canna indica*	Seeni ala	1	0.6	0.01	0.01
Capparaceae	*Cleomi gynandra*	Wela kola	1	0.6	0.01	0.01
Caprifoliaceae	*Crateva adansonii*	Lunuwarana	1	0.6	0.01	0.01
Caricaceae	*Carica papaya L.*	Papol/ gas labu	76	42.0	0.42	0.44
Celastraceae	*Gymnosporia emarginata*	Katupila	1	0.6	0.01	0.01
Cesalpinaceae	*Cassia auriculata L.*	Ranawara	2	1.1	0.01	0.01
Clusiaceae	*Mesua ferrea L.*	Namal Renu	1	0.6	0.01	0.01
Combretaceae	*Terminalia arjuna*	Arjuna/Kumbuk	2	1.1	0.01	0.01
	Terminalia bellirica Roxb.	Bulu	13	7.2	0.07	0.08
	Terminalia catappa	Suwanda kottan	3	1.7	0.02	0.02
	Terminalia chebula Retz.	Aralu	20	11.0	0.11	0.12
Conifereae	*Cedrus deodara R*	Dewaduru	1	0.6	0.01	0.01
	Erythroxylu monogynum Roxb.	Dewadaara	15	8.3	0.08	0.09
Convolvulaceae	*Ipomoea pes-caprae,*	Thamburu	3	1.7	0.02	0.02
	Evolvulus alsinoides	Vishnukranthi	18	9.9	0.10	0.10
	Ipomoea batatus	Bathala	8	4.4	0.04	0.05
	Ipomoea pescaprae	Ela bim thamburu	1	0.6	0.01	0.01
Crassulaceae	*Bryophyllum calycinum Salisb.*	Akkapana	1	0.6	0.01	0.01
	Kalanchoe pinnata	Katakataka threegn	1	0.6	0.01	0.01
Cucurbitaceae	*Benincasa hispida*	Puhul	1	0.6	0.01	0.01
	Cucurbita maxima	Wattakka	3	1.7	0.02	0.02
	Momordica charantia L.	Karawila/Batu karawila	5	2.8	0.03	0.03
	Mormodica dioica	Thumba karawila	3	1.7	0.02	0.02
	Solena amplexicaulis (Lam.)	Kawdu kekiri	1	0.6	0.01	0.01
	Tricosanthes cucumerina L.	Dummalla	16	8.8	0.09	0.09
	Lagenaria siceraria	Diya labu	1	0.6	0.01	0.01

Family	Scientific name	Vernacular name	*Respondent	[a] FI	[b] UV_{sp}	[c] UV_{IF}
Cyperaceae	*Cyperus rotundus L.*	Kalanduru	14	7.7	0.08	0.08
Ericaceae	*Vaccinium leschenaultii L.*	Boralu damana	1	0.6	0.01	0.01
Euphorbiaceae	*Acalypha indica*	Kuppamenia	2	1.1	0.01	0.01
	Cleistanthus collinus	Mal madatha	1	0.6	0.01	0.01
	Euphorbia hirta	Dada keeriya/Kapum keeriya	3	1.7	0.02	0.02
	Phyllanthus debilis	Pitawakka/ bim nelli	5	2.8	0.03	0.03
	Phyllanthus embelica L.	Nelli	17	9.4	0.09	0.10
	Ricinus communis	Thel Erandu	3	1.7	0.02	0.02
	Tragia hispida	Kahambiliya/Wel kahambiliya	1	0.6	0.01	0.01
Fabaceae	*Abrus precatorius*	Olinda	1	0.6	0.01	0.01
	Acasia caesia	Hinguru	1	0.6	0.01	0.01
	Aeschynomene indica	Diya siyambala	1	0.6	0.01	0.01
	Alysicarpus vaginalis L.	Aswanna	4	2.2	0.02	0.02
	Caesalpinia bonduc	Kumburu	2	1.1	0.01	0.01
	Cassia tora	Pethi thora	1	0.6	0.01	0.01
	Glycyrrhiza glabra L.	Valmee	3	1.7	0.02	0.02
	Mimosa pudica	Katu nidikumba	1	0.6	0.01	0.01
	Phaseolus radiatus	Mung bean	1	0.6	0.01	0.01
	Pseudarthria viscida	Gonika	1	0.6	0.01	0.01
	Pterocarpus santalinus	Rath handun	2	1.1	0.01	0.01
	Senna alata	Ath thora	2	1.1	0.01	0.01
	Sesbania grandiflora L.	Katurumurunga	1	0.6	0.01	0.01
	Tamarindus indica	Siyambala	2	1.1	0.01	0.01
Graminiae/Poaceae	*Cymbopogon confertiflorus*	Pangiri	5	2.8	0.03	0.03
	Chrysopogon zizanioides	Sawanna	4	2.2	0.02	0.02
Hippocrateaceae	*Salacia reticulata*	Kothala himbutu	1	0.6	0.01	0.01
Lamiaceae	*Leucas aspera*	Kiri thumba	2	1.1	0.01	0.01
	Leucas biflora	Wilanda/Vilanda wanna	2	1.1	0.01	0.01
	Ocimum tenuiflorum L.	Maduruthala/Thulsi	44	24.3	0.24	0.25
	Premna obtusifolia	Midi	3	1.7	0.02	0.02
Lamiaceae/Verbinaceae	*Leucas zeylanica*	Gata thumba	1	0.6	0.01	0.01
	Plectranthus hadiensis	Iriweriya	12	6.6	0.07	0.07
	Allium sativum L.	Sudu loonu	7	3.9	0.04	0.04
	Gmelina asiatica	Demata/Ath demata	5	2.8	0.03	0.03

Family	Scientific name	Vernacular name	*Respondent	[a] FI	[b] UV_{sp}	[c] UV_{IF}
	Lantana camara	Gandapana	1	0.6	0.01	0.01
	Vitex negundo	Nika	3	1.7	0.02	0.02
	Clerodendrum. serratum (L)M.	Sirithaekku/Bhangi	4	2.2	0.02	0.02
Lauraceae	*Cinnamomum verum*	Kurundu	4	2.2	0.02	0.02
Lecythidaceae	*Careya arborea*	wisha kumba	1	0.6	0.01	0.01
Leguminosae	*Desmodium triflorum L.*	Heen Undupiyaliya	1	0.6	0.01	0.01
	Erythrina indica	Erabadu	1	0.6	0.01	0.01
Leguminosae/Fabacae	*Abrus pulchellus*	Ela olinda	1	0.6	0.01	0.01
Loganiaceae	*Strychnos nux-vomica L.*	Goda kaduru/Koon thalan	2	1.1	0.01	0.01
	Strychnos potatorum L.	Ingini ata	1	0.6	0.01	0.01
Malastomataceae	*Osbeckia octandra*	Heen bowitiya	1	0.6	0.01	0.01
Malvaceae	*Abutilon indicum*	Beheth Anoda	1	0.6	0.01	0.01
	Sida alnifolia	Babila	3	1.7	0.02	0.02
	Thespesia populnia	Ran sooriya	1	0.6	0.01	0.01
	Hibiscus micranthus	Siri wadi babila	1	0.6	0.01	0.01
	Azadirachta indica	Kohomba	33	18.2	0.18	0.19
	Munronia pinnata	Bim kohomba	46	25.4	0.25	0.27
	Xylocarpus rumphii	Koo thalan/Goda kaduru	1	0.6	0.01	0.01
Menispermaceae	*Cissampelos pareira*	Diyamiththa	8	4.4	0.04	0.05
	Coscinium fenestratum	Venivelgata	47	26.0	0.26	0.27
	Tinospora cordifolia	Rasakinda	35	19.3	0.19	0.20
Molluginaceae	*Mollugo cerviana*	Pathpadagam/Papiliya	59	32.6	0.33	0.34
Moraceae	*Artocarpus heterophyllus*	Polos	11	6.1	0.06	0.06
	Artocarpus heterophyllus	Waraka	1	0.6	0.01	0.01
	Artocarpus heterophyllus	kos	5	2.8	0.03	0.03
	Ficus racemosa	Aththikka	2	1.1	0.01	0.01
	Ficus religiosa	Bo	1	0.6	0.01	0.01
Moringaceae	*Moringa oleifera*	Murunga	3	1.7	0.02	0.02
Musaceae	*Musax paradisiaca*	Ambul banana	1	0.6	0.01	0.01
Myricaceae	*Myrica esculenta*	Katphala	1	0.6	0.01	0.01
Myristicaceae	*Myristica fragrans Houtt.*	Sadikka/wasa wasi	2	1.1	0.01	0.01
Myrtaceae	*Eugenia bracteata*	Thambiliya	1	0.6	0.01	0.01
	Syzygium aromaticum	Karabu nati	1	0.6	0.01	0.01
	Syzygium cumini	Ma dan	1	0.6	0.01	0.01

Family	Scientific name	Vernacular name	*Respondent	[a] FI	[b] UV_{sp}	[c] UV_{IF}
Nelumbonaceae	*Nelumbo nusifera*	Nelum	1	0.6	0.01	0.01
Nyctaginaceae	*Boerhavia diffusa*	Sarana	4	2.2	0.02	0.02
Oleaceae	*Nyctanthus arbor-tristis L.*	Sepalika	2	1.1	0.01	0.01
Piperaceae	*Piper betle L.*	Bulath	5	2.8	0.03	0.03
	Piper longum L.	Thippili	31	17.1	0.17	0.18
	Piper nigrum	Gammiris	5	2.8	0.03	0.03
Plumbaginaceae	*Plumbago indica L.*	Rath netul	1	0.6	0.01	0.01
Poaceae	*Bambusa vulgaris*	Una/Una kapuru	6	3.3	0.03	0.03
Polypodiaceae	*Drymoglossum piloselloides*	Panam pethi	1	0.6	0.01	0.01
Pteridaceae	*Adiantum capillus-veneris*	Walaa wenna	1	0.6	0.01	0.01
Punicaceae	*Punica granatum L.*	Delum	5	2.8	0.03	0.03
Ranunculaceae	*Aconitum heterophyllum*	Athiwidayam	3	1.7	0.02	0.02
	Nigella sativa	Kalu duru	1	0.6	0.01	0.01
Rosaceae	*Malus sp.*	Apple	2	1.1	0.01	0.01
Rubiaceae	*Ixora coccinea*	Rath mal	1	0.6	0.01	0.01
	Mussaenda frondosa	Mussanda	2	1.1	0.01	0.01
	Nauclea orientalis	Bak mee	2	1.1	0.01	0.01
	Paederia foetida	Prana Jeewa	2	1.1	0.01	0.01
Rutaceae	*Aegle marmelos*	Beli	3	1.7	0.02	0.02
	Atlantia ceylanica	Yaki naran	1	0.6	0.01	0.01
	Citrus aurantinum	Ambul dodam	1	0.6	0.01	0.01
	Citrus aurantium L	Dodam	1	0.6	0.01	0.01
	Citrus limon	Dehi	2	1.1	0.01	0.01
	Citrus reticulata	Heen naran	4	2.2	0.02	0.02
	Pamburus missionis	Pamburu	1	0.6	0.01	0.01
Santalaceae	*Santalum album*	Sudu handun	8	4.4	0.04	0.05
Sapindaceae	*Cardiosprmum halicacabum*	Val penela	4	2.2	0.02	0.02
	Dimocarpus longan	Mora	1	0.6	0.01	0.01
Scrophulariaceae	*Bacopa monnieri*	Lunuwila	1	0.6	0.01	0.01
	Picrorhiza scrophulariiflora	Ela katu karosana	1	0.6	0.01	0.01
	Picrorhiza scrophulariiflora	Katu karosana	15	8.3	0.08	0.09
Selaginellaceae	*Selaginella bryopteris*	Sanjeevani	1	0.6	0.01	0.01
Solanaceae	*Capsicum annuum*	Miris	1	0.6	0.01	0.01
	Solanum indicum L.	Ela batu	12	6.6	0.07	0.07

Family	Scientific name	Vernacular name	*Respondent	[a] FI	[b] UV_{sp}	[c] UV_{IF}
	Solanum nigrum	Kalukammeriya	2	1.1	0.01	0.01
	Solanum violaceum	vel thibbatu	3	1.7	0.02	0.02
	Sonlanum virginianum	Katuwel batu	36	19.9	0.20	0.21
Urticaceae/Euphorbiaceae	*Boehmeria nivea/Tragia plukenetii*	Kahambiliya/Wel kahambiliya	2	1.1	0.01	0.01
Vitaceae	*Cissus quadrangularis*	Heerassa	1	0.6	0.01	0.01
Xanthorrhoeaceae	*Aloe vera*	Komarika	1	0.6	0.01	0.01
Xyridaceae	*Xyris indica L.*	Ran manissan	1	0.6	0.01	0.01
Zingiberaceae	*Alpinia calcarata*	Heen araththa	10	5.5	0.06	0.06
	Curcuma longa	Kaha	1	0.6	0.01	0.01
	Elettaria cardamomum	Enasal/Karanda mungu	2	1.1	0.01	0.01
	Zingiber officinale	Inguru	54	29.8	0.30	0.31
Zygophyllaceae	*Tribulus terrestris*	Heen gokatu /Heen nerenchi	5	2.8	0.03	0.03

Overall response rate: 98.9%

**respondent is the number of occasions the plant species was cited by the traditional medical practitioners.*

[a]FI is the frequency index calculated based on total number of citing by the respondents.

[b] UV_{sp} is the Use Value for one species; [c] UV_{IF} is the species Use Value index for one informant

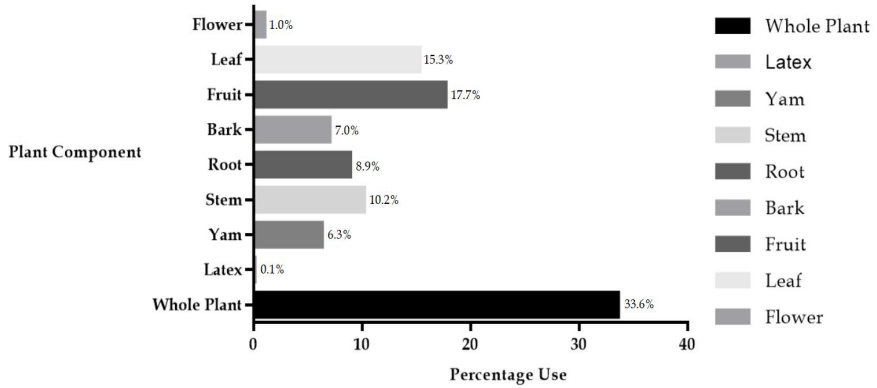

Fig. 3. Assessment of specific plant components used by TMPs in the treatment of dengue (overall response rate 98.9%)

3.3 Quantitative Ethnopharmacological Study

Quantitative data analysis was performed to identify the most promising medicinal plants used in the treatment of DHI. As calculated by UV_{sp}, *Carica papaya L., Coriandrum sativum L., Mollugo cerviana, Zingiber officinale, Coscinium fenestratum, and Munronia pinnata* were reported to be of the highest use value above 0.25. *Carica papaya L.,* is used as the treatment of DHI, with a UV up to 0.42. While both *Coriandrum sativum L.* and *Mollugo cerviana*, used with a UV up to 0.35 and 0.33 respectively. The UV_{IF} for *Carica papaya L, Coriandrum sativum L.* and *Mollugo cerviana* were 0.44, 0.37, and 0.34 respectively. There were 5.5% plant species with above 0.20 UV_{sp} and 6.1% plant species were above 0.20 UV_{IF}.

3.4 Predominant Medicinal Herbs for Dengue Hemolytic Infection

In the present study, the most cited 15 medicinal plants in Sri Lanka were *Carica papaya L. (43.9), Coriandrum sativum L. (37.0), Mollugo cerviana (34.1), Zingiber officinale (31.2), Coscinium fenestratum (27.0), Munronia pinnata (26.6), Ocimum tenuiflorum L. (25.4), Andrographis paniculata (21.4), Solanum virginianum (20.8), Jasticia adhatoda (20.8), Tinospora cordifolia (20.2), Azadirachta indica (19.1), Piper longum L. (17.9), Alstonia scholaris L. (12.7) and Vernonia cinerea L. (11.6).*

Carica papaya leaf extract is the most widely used plant in the treatment of Dengue in Sri Lanka. *C. papaya* leaves have been used traditionally to cure Dengue Fever [25]. Leaf extract of *C. papaya* has significantly increased the platelet count in patients with thrombocytopenia, WBC, and Neutrophils associated with dengue with fewer side effects and good tolerability within 24 hours of treatment [26, 27]. The effect of aqueous extract of *C.* papaya leaves on erythrocyte damage was investigated against Virus-infected THP-1 cells using hemolytic and anti-hemolytic assays. There was a significant decrease in erythrocyte damage and hydrogen-peroxide-induced lipid peroxidation. In the same study the effect of *C. papaya* aqueous extract on platelet augmentation in rats was shown a significant increase in the number of platelets in thrombocytopenic rat group [28]. Evaluation of safety and efficacy of *C. papaya* aqueous extracts in severe thrombocytopenic adult dengue patients showed that significantly ($p = 0.007$) increased platelet counts (482%± 284) compared to placebo (331%±370) group. However, the toxicity study of the leaf extract is still lacking. There were no signs of toxicity and no deaths were observed even at 2000 mg/kg body weight in rats observed for 14 days. The single oral dose of the leaf extract did not produce mortality or significant changes in body weight, and water consumption. However, hemoglobin, hematocrit, red blood cells, and total protein were increased, indicating dehydration. Whereas the white blood cell count was increased [29].

Coriandrum sativum L was cited as an anti-dengue medicinal plant in the current survey, but there was no specific literature for *C. sativum L.* referring to Dengue. However, the plant-based insecticidal activity was proven that the plant extracts have LC_{50} value of 363.7 ppm. The immunomodulatory activity of the plant is also proven [30,31].

Mollugo cerviana is found in most of the South Asian countries. It is a useful herb in Ayurveda medicine that is used as an antimicrobial, antioxidant, hepatoprotective, and photo-protective agent. However antiviral and activity against DHI were reported for a polyherbal extract containing *Vetiveria zizanioides*, *Trichosanthes cucumerina*, and *M. cerviana* [32,33]. The TMPs might have declared these two plants due to traditionally accepted antipyretic and anti-inflammatory properties.

The aqueous extract of *Zingiber officinale* rhizome contributes to the regulation of plasma leakage in dengue infection and decrease the chances of severe dengue complications [34]. Methanolic extracts of *Solanum virginianum (Solanum xanthocarpum)* have been exhibited strong antibacterial effects in a laboratory study due to phenolic compounds and flavonoids. It has been also shown to have antioxidant properties. The extracts have terpenoids, tannins, steroids, and phenols as phytoconstituents. It was suggested that the anti-inflammatory activities of the tested plants by them are at least partially linked with their antioxidant properties [35,36]. Hence it can be assumed that this plant may have been recommended by TMPs to prevent inflammation associated with DHI [34].

Most of the TMPs recommended using *Andrographis panicualta* as an alternative for

Munronia pinnata in their formulations because of the scarcity and expensiveness of *M. pinnata*. Due to certain phytochemical properties and antioxidant capacity of these two plants justifies the use of *A. paniculata* as a substitute for *M. pinnata* in DC systems of medicine in Sri Lanka [32,37,38]. Major bioactive phytoconstituent of *A. paniculata* has been identified with number of vital clinical properties such as antioxidant, anti-inflammatory, anticancer, antimicrobial, antiparasitic, hepatoprotective, antihyperglyc-emic, and anti- hypoglycemic [39]. *The* methanolic extracts of *A. paniculata* and *Ocimum tenuiflorum L* have shown the ability to inhibit the DENV-1 serotype in vitro. The plant is effective against upper respiratory tract infections, common cold, cardiovascular disease (due to anti-thrombotic activity), cancer, and HIV [15,40]. *A. paniculata* whole plant is being used by traditional healers in various districts of Bihar in India, in the management of Dengue fever [15].

Justicia adhatoda and Tinospora cordifolia have been used by TMPs as an anti-dengue treatment in this survey showed possible enhancements in mitochondrial reactive oxygen species generation and increase the permeability of the mitochondrial membrane. Therefore, it is inducing megakaryocytic maturation. These findings suggest thrombopoietic potential of *J. adhatoda* leaf extract on megakaryocyte differentiation [41-43].

Aqueous extracts of *Azadirachta indica* leaves have shown anti-dengue activity by suppressing the replication of Dengue virus type-2 in both in vitro as well as in vivo systems [44,45]. In the present survey, none of the Sri Lankan TMPs stated *Psidium guajava* as a plant used in Dengue treatment. However, *P. guajava* fruits are used to increase platelet counts, therefore helping to avoid bleeding in dengue hemorrhage [46].

Three plants listed in this survey, [47], *Vernonia cinerea and Alstonia scholaris* not cited as an anti-dengue plant. *P. longum and A. scholaris* showed larvicidal activity against the mosquito vector [48].

Traditional Medical Practitioners (TMPs), who use the DC practice in Sri Lanka used a total of 19 methods to prepare plant parts before using them as herbal medicine. The decoction is considered the main mode of preparation (29.6%), followed by dry powder (13.6%) and pills prepared usually in combination of several herbs (12.06%). Meanwhile, paste (10.6%) and natural herbal extract (9.9%) contribute to the most used mode of preparation in the treatment of DHI (Table 2). Extract with boiled coconut milk (6.6%) and the natural herbal extraction among unique methods used in DC in Sri Lanka.

Table 2. Assessment of administrative techniques used by TMPs in the treatment of dengue

Dosage form	Total Number	Percentage
Decoction (aqueous-warm but not boiled)	126	29.6
Alcoholic extract	31	7.3
Pills prepared usually in combination	51	12.0
Fermented form	22	5.2
Dry powder	58	13.6
Paste	45	10.6
Dried form	2	0.5
Extract (natural herbal extract)	42	9.9
Extract with boiled in coconut milk	28	6.6
Boiled with water	6	1.4
External applications	3	0.7
Concentrated form of decoction in sugar/ alcohol	1	0.2
Panchakarma* (five procedures eliminate toxin)	1	0.2
Tablet	1	0.2
Oral iquid	2	0.5
Oil	2	0.5
Enemas to remove toxins from anus	1	0.2
Soup	1	0.2

**Panchakarma is a combination of five procedures of purification of the body including, emesis, purgation, decoction enema, instillation of medicine through nostrils, and anal oil enema. These procedures aim at plucking away the deep-rooted imbalances in the body*

4. CONCLUSION

The local population of Sri Lanka still relies strongly on *Deshiya Chikithsa* and the use of medicinal plants as curative remedies for diseases. Our results highlighted the use of 180 medicinal plants used in the treatment of dengue by *Deshiya chikithsa* practitioners in Sri Lanka. Twelve plant species were identified for treating Dengue hemolytic infection with a high-frequency index (above 20.0%). *Carica papaya L., Coriandrum sativum L., Mollugo cerviana, Zingiber officinale, Coscinium fenestratum, Munronia pinnata, Ocimum tenuiflorum L., Andrographis paniculata, Solanum virginianum, Jasticia adhatoda, Tinospora cordifolia* and *Azadirachta indica,* were among them. Those plants have belonged to 76 different families, where Fabaceae, Euphorbiaceae, Cucurbitaceae, Lamiaceae/verbinaceae, Meliaceae, Rutaceae, Malvaceae, are the most representative families. *Carica papaya L., Coriandrum sativum L. and Mollugo cerviana,* showed the highest use value above 0.25 and species use-value index above 0.30. This signifies the highest relative use of these plants among the respondents and the highest number of uses of those species in the treatment of Dengue hemolytic infection. These medicinal plants are used as a preventative form of treatment, even though, the country has a professionally managed government-funded western medical system. *Deshiya Chikithsa* practitioners transfer this knowledge to the descendants. Our findings showed that some limitations exist in the clinical use of these medicinal plants. The recipes for the preparation and use of medicinal plants are generously not shared with anyone interested in the use. However, the ethnopharmacological data generated in this study can serve as a resource for the identification and characterization of traditional medicinal plants as sources for search of anti-dengue or antimicrobial therapeutic natural products. Further pharmaceutical research is recommended to provide additional knowledge about the positive and negative effects of medicinal plants, thus justifying the need for screening and detailed studies intended to isolate and characterize active compounds against *Deshiya Chikithsa*. Moreover, studies are required to systematically determine the anti-dengue, antimicrobial, cytotoxic activity, adverse effects, toxic effects, dosages, and active chemical compounds of the plants. Also, studies on the effect of the combination of plants may give an insight into their effectiveness in treatment as used by the indigenous communities.

CONSENT AND ETHICAL APPROVAL

All TMPs gave prior written informed consent before they were interviewed, and confidentiality of individual personal information was ensured. Ethical clearance was obtained from the Ethics Review Committee (ERC) of University of Sri Jayewardenepura under ERC Application No 88/17, with effective from 25/01/2018.

Data collection (period between 01/01/2018-01/01/2019) was based on verbal and written consent from the TMPs and confidentiality of individual personal information was ensured. Ethical clearance was obtained from the Ethics Review Committee (ERC) of the University of Sri Jayewardenepura under ERC Application No 88/17, with effective from 25/01/2018.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Padmasiri GJAJoT, Complementary, Medicines A. An investigation into utilization, beliefs and practice of indigenous medicine in Sri Lanka. 2018;15(4):1-12.
2. Padmasiri GR. Management of indigenous knowledge in Sri Lanka, with special reference to indigenous medicine. Information Development. 2017;34(5):475-88.
3. Anonymous. Dengue and severe dengue: World Health Organization; 2020. [cited 2020 Cited. Available:https://www.who.int/news-room/fact-sheets/detail/dengue-and-severe-dengue.
4. Taslim M, Arsunan AA, Ishak H, Nasir S, Usman AN. Diversity of dengue virus

serotype in endemic region of south sulawesi province. J Trop Med. 2018;2018:9682784.
5. Bosch I, Reddy A, de Puig H, Ludert JE, Perdomo-Celis F, Narvaez CF et al. Serotype-specific detection of dengue viruses in a nonstructural protein 1-based enzyme-linked immunosorbent assay validated with a multi-national cohort. PLoS Negl Trop Dis. 2020;14(6): e0008203.
6. Ali S, Khan AW, Taylor-Robinson AW, Adnan M, Malik S, Gul S. The unprecedented magnitude of the 2017 dengue outbreak in Sri Lanka provides lessons for future mosquito-borne infection control and prevention. Infection, Disease & Health. 2018;23(2):114-20.
7. Bhatt S, Gething PW, Brady OJ, Messina JP, Farlow AW, Moyes CL et al. The global distribution and burden of dengue. Nature. 2013;496(7446):504-7.
8. Anonymous. Dengue update: Ministry of Health, Sri Lanka; 2021 [cited 2021; Cited. Available:http://www.epid.gov.lk/web/index.php?option=com_content&view=article&id=171%3Adengueupdate&catid=51%3Amessage-for-public&Itemid=487&lang=en.
9. Hasitha A. Tissera BDWJ, Rajendra Raut, Sakunthala M.D. Janaki, Yesim Tozan, Preshila C. Samaraweera, Prasad Liyanage, Azhar Ghouse, Chaturaka Rodrigo, Aravinda M. de Silva, and Sumadhya D. Fernando. Severe dengue epidemic, Sri Lanka, 2017. Emerging Infectious Diseases. 2020;26:682-91.
10. Miah MA, Husna A. Coinfection, coepidemics of COVID-19, and dengue in dengue-endemic countries: A serious health concern. 2021;93(1):161-2.
11. Lim JT, Dickens BSL, Chew LZX, Choo ELW, Koo JR, Aik J et al. Impact of sars-cov-2 interventions on dengue transmission. PLoS Negl Trop Dis. 2020;14(10):e0008719.
12. World Health Organization. Programme on Traditional M. General guidelines for methodologies on research and evaluation of traditional medicine. Geneva: World Health Organization; 2000.
13. Gunatilleke N, Pethiyagoda R, Gunatilleke S. Biodiversity of Sri Lanka. Journal of the National Science Foundation of Sri Lanka. 2017;36(0):25-62.
14. De Silva N. Sri Lanka's traditional knowledge and traditional cultural expressions of health and wellbeing: History, present status and the need for safeguarding. SAARC Regional Seminar on Traditional Knowledge and Traditional Cultural Expressions in South Asia; 2013.
15. Singh PK, Rawat P. Evolving herbal formulations in management of dengue fever. Journal of Ayurveda and Integrative Medicine. 2017;8(3):207-10.
16. Weragoda PB. The traditional system on medicine in Sri Lanka. J Ethnopharmacol. 1980;2(1):71-3.
17. Srikanth N, Lavekar G, Narayana A, Padhi M, Bandi V. Research database on Ayurveda, Siddha, other Traditional Medicine and Related sciences. 2010;1(IV).
18. Perera NP. A Physiognomic vegetation map of sri lanka (ceylon). Journal of Biogeography. 1975;2(3):185-203.
19. Erdelen W. Forest ecosystems and nature conservation in Sri Lanka. Biological Conservation. 1988;43(2):115-35.
20. Leonti M, Casu L, de Oliveira Martins DT, Rodrigues E, Benítez G. Ecological theories and major hypotheses in ethnobotany: Their relevance for ethnopharmacology and pharmacognosy in the context of historical data. Revista Brasileira de Farmacognosia. 2020;30(4):451-66.
21. Aburjai T, Hudaib M, Tayyem R, Yousef M, Qishawi M. Ethnopharmacological survey of medicinal herbs in Jordan, the Ajloun Heights region. Journal of Ethnopharmacology. 2007;110(2):294-304.
22. de Albuquerque UP, de Medeiros PM, de Almeida ALS, Monteiro JM, de Freitas Lins Neto EM, de Melo JG et al. Medicinal plants of the caatinga (semi-arid) vegetation of NE Brazil: A quantitative approach. Journal of Ethnopharmacology. 2007;114(3):325-54.
23. Phillips O, Gentry AH. The useful plants of Tambopata, Peru: I. Statistical hypotheses tests with a new quantitative technique. Economic Botany. 1993;47(1):15-32.
24. Phillips O, Gentry AH. The useful plants of Tambopata, Peru: II. Additional hypothesis testing in quantitative ethnobotany. Economic Botany. 1993;47(1):33-43.
25. Nuri T, Ming L. Papaya leaves juice as an alternative treatment for dengue fever. Journal of Applied Pharmaceutical Science. 2016;6:172-3.

26. Sundarmurthy D, Jayanthi C, Lakshmaiah KJNJoP, Pharmacy, Pharmacology. Effect of Carica papaya leaf extract on platelet count in chemotherapy-induced thrombocytopenic patients: A preliminary study. 2017;7(7):685.
27. Rajapakse S, de Silva NL, Weeratunga P, Rodrigo C, Sigera C, Fernando SDJBc, et al. Carica papaya extract in dengue: A systematic review and meta-analysis. 2019;19(1):265.
28. Sharma N, Mishra KP, Chanda S, Bhardwaj V, Tanwar H, Ganju L, et al. Evaluation of anti-dengue activity of Carica papaya aqueous leaf extract and its role in platelet augmentation. Archives of Virology. 2019;164(4):1095-110.
29. Sathyapalan DT, Padmanabhan A, Moni MBPP, Prasanna P, Balachandran S et al. Efficacy & safety of Carica papaya leaf extract (CPLE) in severe thrombocytopenia (≤30,000/µl) in adult dengue - Results of a pilot study. PloS one. 2020; 15(2):e0228699.
30. Chung IM, Ahmad A, Kim EH, Kim SH, Jung WS, Kim JH et al. Immunotoxicity activity from the essential oils of coriander (Coriandrum sativum) seeds. Immunopharmacol Immunotoxicol. 2012;34(3):499-503.
31. Bilal H, Akram W, Din S, Khan I, Hassan S, Arshad M. Larvicidal Activity of Selected Plant Extracts Against Aedes albopictus Skuse (Diptera: Culicidae). African Entomology. 2012:8-12.
32. Aglin AA. Medicinal Effects of Mollugo cerviana - A Review. International Journal of Scientific Research in Multidisciplinary Studies. 2018;4(9):34-7.
33. Devanathadesikan Seshadri V, Vijayaraghavan P, Kim YO, Kim HJ, Ahmed Al-Ghamdi A, Elshikh MS, et al. In vitro antioxidant and cytotoxic activities of polyherbal extracts from Vetiveria zizanioides, Trichosanthes cucumerina, and Mollugo cerviana on HeLa and MCF-7 cell lines. Saudi J Biol Sci. 2020;27(6):1475-81.
34. Sharma BK, Klinzing DC, Ramos JD. Zingiber officinale Roscoe aqueous extract modulates Matrixmetalloproteinases and tissue inhibitors of Metalloproteinases expressions in Dengue virus-infected cells: implications for prevention of vascular permeability. Tropical Journal of Pharmaceutical Research. 2015;14(8): 1371.
35. Nithya M, Ragavendran C, Natarajan D. Antibacterial and free radical scavenging activity of a medicinal plant Solanum xanthocarpum. International Journal of Food Properties. 2018;21(1):313-27.
36. Anwikar S, Bhitre M. Study of the synergistic anti-inflammatory activity of Solanum xanthocarpum Schrad and Wendl and Cassia fistula Linn. Int J Ayurveda Res. 2010;1(3):167-71.
37. Murugan NA, Pandian CJ, Jeyakanthan J. Computational investigation on Andrographis paniculata phytochemicals to evaluate their potency against SARS-CoV-2 in comparison to known antiviral compounds in drug trials. J Biomol Struct Dyn. 2020;1-12.
38. Sivaprakasam M, Padmapriya P. Qualitative and quantitative analysis of the phytochemical constituents of mollugo cerviana (l.). International Journal of Pharmaceutics and Drug Analysis. 2014;2:695-9.
39. Jayakumar T, Hsieh CY, Lee JJ, Sheu JR. Experimental and clinical pharmacology of andrographis paniculata and its major bioactive phytoconstituent andrographolide. Evid Based Complement Alternat Med. 2013;2013:846740.
40. Akbar S. Andrographis paniculata: A review of pharmacological activities and clinical effects. Altern Med Rev. 2011;16(1):66-77.
41. Gutti U, Komati JK, Kotipalli A, Saladi RGV, Gutti RK. Justicia adhatoda induces megakaryocyte differentiation through mitochondrial ROS generation. Phytomedicine. 2018;43:135-9.
42. Ali M, Hakeem KR. Pharmacological and bioactive basis of *Adhatoda vasica L*. nees. In: Ali M, Hakeem KR, editors. Scientific Explorations of *Adhatoda vasica*: An Asian Health Remedy. Cham: Springer International Publishing; 2020;61-84.
43. Banerjee N, Saha B, Mukhopadhyay S. Intracellular ROS generated in chikungunya patients with persisting polyarthralgia can be reduced by Tinospora cordifolia leaf extract. VirusDisease. 2018;29(3):375-9.
44. Rao VB, Yeturu K. Possible Anti-viral effects of Neem (Azadirachta indica) on Dengue virus. Bio Rxiv; 2020. 2020.04.29.069567.
45. Dwivedi VD, Bharadwaj S, Afroz S, Khan N, Ansari MA, Yadava U et al. Anti-dengue

infectivity evaluation of bioflavonoid from Azadirachta indica by dengue virus serine protease inhibition. J Biomol Struct Dyn. 2020;1-14.

46. Dakappa SS, Adhikari R, Timilsina SS, Sajjekhan S. A Review on the Medicinal Plant Psidium Guajava Linn. (Myrtaceae). Journal of Drug Delivery and Therapeutics. 2013;3(2):162-8.
47. Dey P, Goyary D, Chattopadhyay P, Kishor S, Karmakar S, Verma AJSAJoB. Evaluation of larvicidal activity of Piper longum leaf against the dengue vector, Aedes aegypti, malarial vector, Anopheles stephensi and filariasis vector, Culex quinquefasciatus. 2020;132:482-90.
48. Soma A, Hien FD, Sourabie S, Yerbanga SR, Bonkian LN, Koama BK et al. Larvicidal activity of crude extracts of Vernonia cinerea less (Asteraceae) against the larvae of Anopheles gambiae in Bobo Dioulasso, Burkina Faso. 2018;1-9.

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