



A Literature Review on Medicinal Plants That are being Used in Traditional Medicine for the Management of the Snake Bites in Sri Lanka

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Authors' contributions

This work was carried out in collaboration between both authors. Author NRM designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author VS managed the literature searches and analyses of the study. Both authors read and approved the final manuscript.

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ABSTRACT

Background: Traditional Medicine is time-tested and still caters to the health needs of the society and provides health care through prophylactic treatment and rejuvenation. Today poisonous snake bites are life-threatening problems resulting in high morbidity and mortality all over the world including Sri Lanka. The medicinal plants available locally and used widely by traditional healers. Therefore they need attention in this aspect.

Aim: The primary aim of this study was to do a literature review on essential characteristics of medicinal plants which are being used for the management of snake bites in Traditional Medicine.

Place and Duration of the Study: Unit of Siddha Medicine, University of Jaffna from April to June 2018.

Methodology: Data for the literature review on 94 medicinal plants from 41 families were collected from relevant books and research articles. The characteristics of the medicinal species that were

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identified for the review were morphology; habitat; parts used; Siddha properties such as taste, potency and efficacy; pharmacological action; the number of plants used for dietary purposes; poisonous plants; phytochemical contents and mode of transmission.

Results: From the 94 medicinal plants, 9 (9.6%) of the species were found in *Fabaceae* and followed by 6 (6.38%) in *Cucurbitaceae* and *Apocynaceae* families. Based on the morphology 24 (25%) plants were herb and shrub; 42 (45%) were found in the natural habitat. From these plants, 31 species (26%) were used as root and 29 (24%) as leaves. These plants contain: Siddha properties such as bitter taste [52 (48.14%)]; hot potency [64 (70.32%)] and pungent efficacy [68 (72.34%)]. Pharmacological actions such as diuretic [36 (38.3%)]; tonic [35 (37.23%)]; astringent [33 (35.1%)] and stimulant [32 (34.04%)]. Phytochemicals such as flavonoids 88 (93.61%) and saponin 81 (86.17%) were highly found in these medicinal plants. Fifty (53.19%) of these species were used as external and internal medication in the management of snake bites.

Conclusion: This literature review provides useful documented evidence on the management of snake bites in Traditional Medicine. However, there is a need for further extensive scientific studies to be carried out to justify its clinical potential in the management of snake bites.

Keywords: Medicinal plants; management; snake bite; traditional medicine.

1. INTRODUCTION

Traditional Medicine comprises a medical aspect of traditional knowledge that developed over generations within various societies before the era of modern medicine [1]. It is termed as Alternative Medicine, Complementary Medicine, and Indigenous Medicine in many countries [2]. The World Health Organization (WHO) defines traditional medicine as “the sum total of the knowledge, skills and practices based on theories, beliefs and experiences indigenous to different cultures, whether explicable / not, used in the maintenance of health as well as in the prevention, diagnosis, improvement or treatment of physical and mental illness” [2].

Snake envenomation is a significant global health issue. It constitutes an occupational hazard mainly in the field of agriculture [3]. Universally higher than 5 million snake bites occur each year. They result in about 2.5 million cases of poisoning and 20,000 to 125,000 deaths in the world [4]. Sri Lanka has a great diversity of snake species. Around 294 species of snakes are found globally and 96 species are found in Sri Lanka, of these 50 species are endemic to the Island. There are also 13 species of sea snakes and 10 species of blind snakes in Sri Lanka [5]. Around 5 species of land snakes are venomous such as King Cobra, Common Cobra, Common Krait, Russell's viper and Saw Scaled Viper [6,7]. These poisonous snakes are dangerous as they are responsible for 98% of the human deaths in Sri Lanka [5].

In the traditional healing system, the plant kingdom has been a primary source of medicine.

In this region, 70%-80% of the people use herbal treatment for primary health care [2]. The plant kingdom provides a good alternative to the anti-snake venom. Traditionally medicinal plants have been used as folk medicine for the management of snake bites [3].

Traditional knowledge of snakebite treatments has been passed on from generation to generation within families. Globally Traditional Physicians are practicing herbal medicine for the treatment of snake envenomation; however, the practice is not really recognized by modern medicine [3]. Few scientific studies have evaluated the use of medicinal plants in the treatment of snake bites. Commonly in Sri Lanka, there is only limited information on this topic. This present literature review is an attempt to produce documentation and awareness of the numerous herbal materials which are being utilized for the management of snake bites in Sri Lanka.

2. METHODOLOGY

2.1 Study Design

It is a review of relevant and current literature on herbal treatment of snake bites.

2.2 Place and Duration of the Study

Unit of Siddha Medicine, University of Jaffna from April to June 2018.

2.3 Data Collection

Data for the literature review were collected from related past and recent textbooks, websites,

proceedings, research articles and other documents from Jaffna/ Sri Lanka. This information was used to identify the medicinal plants that are being used in the management of snake bites in the Traditional Medicine [8-56]. For this purpose 94 medicinal plants from 41 families which were mentioned in the textbooks were reviewed. The characteristics of the identified medicinal plants species for the review were taxonomic positions (Scientific, Sanskrit, English, & Tamil), families, morphology (herb, shrub, climber, tree, creeper & aquatic), habitats (natural, cultivated, & ornamental), the specific parts used, Siddha properties such as taste, potency and efficacy, specific pharmacological action, number of plants which are used as diet and poisonous plants, phytochemical contents and modes of action (internal & external). These were recorded for the 94 selected medicinal plants. Most of the information was obtained from the textbooks which were available in the Library/ Unit of Siddha Medicine, University of Jaffna.

2.4 Statistical Analysis

Collected data were processed and statistically analyzed by a simple statistical method using Ms. Excel 2010.

3. RESULTS AND DISCUSSION

3.1 Taxonomic Position of the Medicinal Plants

Ninety four (94) plant species belonging to 41 families which had been documented as remedies for the management of snake bites were used for the review. The taxonomic position of the individual plants is summarized in Table 1. Plant taxonomy is the science that finds, identifies, describes, classifies, and names of the plants [57].

Giovannini and Howes mentioned in their article that, around 208 plant species are traditionally used to treat snakebites in Central America but there is a lack of clinical research to evaluate their efficacy and safety [58].

3.2 Family Distribution of the Medicinal Plants

A plant family is simply a collection of plants that share characteristics grouped together. Plants can be categorized by similar features, including overall appearance, seed groupings, flower

shape, and more, to show their relationship to one another. Understanding how a particular species of plant relates to others within its family is important for all forms of growing and gardening because it can provide information about aspects of plant care [59].

Families of the selected medicinal plants are shown in Table 2. From these 94 medicinal plants, 9 (9.6%) of the species were found in *Fabaceae* followed by 6 (6.38%) in *Cucurbitaceae* and *Apocynaceae* families. This review also encompasses some plants that are rarely or less often used.

This finding was almost comparable with the previous study which stated that the highest numbers of plants were reported from the two families *Fabaceae* (32 species) and *Apocynaceae* (14 species) in a total of 341 different species belongs to 99 families [60]. Another study mentioned that, the 8 species out of 50 were found in the *Fabaceae* family [61]. Day and De reported in their review that, 73 plant families having 198 species were used for the treatment of snakebites plant family *Fabaceae* represents the maximum species (25) followed by *Apocynaceae* (16), *Asteraceae* (11) and others [62]. A recent study also found that 150 botanical families containing plants with a reputation for treatment of snakebites are *Fabaceae*, *Asteraceae*, *Apocynaceae*, *Lamiaceae*, *Rubiaceae*, *Euphorbiaceae*, *Araceae*, *Malvaceae*, and *Acanthaceae* [63].

3.3 Morphology of the Medicinal Plants

Plant morphology is the study of the physical form and external structure of plants. This is usually considered distinct from plant anatomy, which is the study of the internal structure of plants, especially at the microscopic level. Plant morphology is useful in the visual identification of plants [64].

Based on the morphology (Fig. 1) of medicinal plants 24 (25%) plants were classified to be herbs and shrubs; and trees 20 (20.83%).

3.4 Habitat of the Medicinal Plants

Fig. 2 shows the characterization of medicinal plants which are utilized for the management of the snake bites according to their habitats.

Table 1. Taxonomic Position of the medicinal plants

No	Botanical name	Sanskrit name	English name	Tamil name
01	<i>Indigofera tinctoria</i>	Nilini	Indian Indigo Plant	Avuri
02	<i>Alangium salvifolium</i>	Amkolam	Sage leaved Alangium	Alingil
03	<i>Corallocarpus epigaeus</i>	Mahamulam	Broyoms	Aakasakerudan
04	<i>Aristolochia bracteolate</i>	Ajaspurisaha	Worm Killer	Aadtheendapalai
05	<i>Cinnamomum verum</i>	Twak	Cinnamon	Karuma
06	<i>Aristolochia indica</i>	Ishwari	Indian birth wort	Perumarunthu
07	<i>Purgularia daemia</i>	Pahala antaka	Dogs bane white low plant	Uthamakaani
08	<i>Acalypha indica</i>	Arittamanjarie	Indian acalypha, Catsstruggle	Kuppaimeani
09	<i>Calotropis gigantean</i>	Arka	Mudar, Gigantic swallow wort	Arukkan
10	<i>Piper nigrum</i>	Maricha	Black pepper	Milaku
11	<i>Tylophora indica</i>	Kondaichaali	Vomiting swallow wort	Nanjaruppan
12	<i>Polygala glabra</i>	Meradu	Milk wort	Sriyaalnangai
13	<i>Polygala elongate</i>	Periyanka	Snake root	Periyaalnangai
14	<i>Luffa acutangula</i>	Kosavathee	Ribbed luffa	Peaipeerku
15	<i>Acorus calamus</i>	Vacha	Sweet flag	Vasambu
16	<i>Allium cepa</i>	Pallandu	Onion	Vengaayam
17	<i>Pavatta indica</i>	Pappans	Indian pellet shrub	Pavattai
18	<i>Pongamia pinnata</i>	Karanja	Indian beech	Pungu
19	<i>Momordica charantia</i>	Karavalli	Bitter gourd	Paakal
20	<i>Croton tiglium</i>	Danthi	Purging croton	Nearvaalam
21	<i>Lagenaria siceraria</i>	Alabu	Bottle gourd	Surai
22	<i>Citrullus colocynthis</i>	Indra varuni	Colococynthal fruit of bitter	Aatruthummatti
23	<i>Phyllanthus amarus</i>	Bhummygmalaiki	Indian phyllanthus	keelanelli
24	<i>Gynandropsis gynandra</i>	Vivitham	Spider wisp	Thaivealai
25	<i>Datura metal</i>	Datura	Dhatura, Throne apple	Umathai
26	<i>Alternanthera sessilis</i>	Meenakshi	Sessile plant	Ponnankaani
27	<i>Leucas aspera</i>	Dronapush	Thumbai	Thumbai
28	<i>Nicotiana tabacum</i>	Tamarakuta	Tobacco	Pukaillai
29	<i>Allium sativum</i>	Lesuna	Garlic	Ulli
30	<i>Piper betel</i>	Nagavalli	Betel leaf	Vetrillai
31	<i>Sarcosemma brevistigma</i>	Somavalli	Moon plant	Kodikalli
32	<i>Albizia lebbek</i>	Shirisha	Srissa tree	Vaakai

No	Botanical name	Sanskrit name	English name	Tamil name
33	<i>Azadirachta indica</i>	Nimba	Margose tree	Vembu
34	<i>Hemidesmus indicus</i>	Sariba	Indian sarsaparilla	Nannari
35	<i>Rhinacanthus nasuta</i>	Yathikapurni	-	Anichai
36	-	-	-	Ninraartchinunki
37	<i>Moringa olifera</i>	Siguru valkalum	Horse radish	Murunkai
38	<i>Ocimum sanctum</i>	Thulasi	Holy basil , Sac red basil	Thulasi
39	<i>Zingiber officinale</i>	Nagaram	Dried ginger	Sukku
40	<i>Ziziphus oenoplica</i>	Kakoli	Jackal jujube	Surai
41	<i>Madhuca longifolia</i>	Madhuka vriskhaha	The narrowed leaved mohua , Mowa tree	Iluppai
42	<i>Curculigo orchioides</i>	Musali	Black musale	Nilappanai
43	<i>Cocus nucifera</i>	Narikela	Coconut tree	Thennai
44	<i>Cissampelos pareria</i>	Patha	Velvet leave	Ponmusuttai
45	<i>Prosopis spicigera</i>	Sami	Indian Mesquite	Vanni
46	<i>Cissus quadrangularis</i>	Asthisamhari	Bone selter	Pirandai
47	<i>Tacca pinnatifida</i>	Vana surana	Wild amorphophalus	Kaatu karunai
48	<i>Spheranthus indicus</i>	Mundi	East Indian Globe Thistle	Kottaikaranthai
49	<i>Clitoria ternatea</i>	Shankha pushpa	Butterfly pea	Kaakanavan
50	<i>Mimusops elengi</i>	Vakula	Pointed leaved ape flower	Makizh
51	<i>Ferula asafetida</i>	Hingu	Asafoetida	Perunkaayam
52	<i>Abutilon indicum</i>	Kanka tika	Indian mallow	Thuthi
53	<i>Punica granatum</i>	Shukhdana	Pomaganatum.	Maathulai
54	<i>Toddalia asiatica</i>	Kanchana	Forest pepper	Mulakaranai
55	<i>Tinosoera cordifolia</i>	Guduchi	Heart leaved moon seed	Seenthil
56	<i>Withania somnifera</i>	Aswagandha	Winter cherry	Amukkira
57	<i>Sesamum indicum</i>	Tilam	Gingili oil plant	Ellu
58	<i>Strychnos potatorum</i>	Kataka	Clearing nut tree	Theatraan
59	<i>Strychnos nux-vomica</i>	Kulaka	Nux vomica	Etti
60	<i>Achyranthes aspera</i>	Apamarga	Rough chaff	Naayuruvi
61	<i>Physalis minima</i>	Tankari	Cape gooseberry	Thakkaali
62	<i>Musa paradisiaca</i>	Kadali	The Plantain tree	Vaazhai
63	<i>Cynodon dactylon</i>	Durva	Barmuda grass	Arukampul
64	<i>Catunaregum spinosa</i>	Maanda	Emetic nut tree	Marukkarai
65	<i>Gymnema sylvestre</i>	Sarpadarushtrik	Periploca of the woods	Sirukurinjaan
66	<i>Alstonia scholaris</i>	Sapthaparna	Devil tree, Shaitan wood	Eazhilaipaalai

No	Botanical name	Sanskrit name	English name	Tamil name
67	<i>Terminalia bellirica</i>	Vebeethaki	Beleric myrobalans	<i>Thaanri</i>
68	<i>Calophyllum inophyllum</i>	Punnagaha	Alexandrian laurel	<i>Punnai</i>
69	<i>Caesalpinia bonduc</i>	Kuberaakshi	Bonduc nut	<i>Kazhtchi</i>
70	<i>Psoralea corylifolia</i>	Baakuchi	Babchi	<i>Kaarbogarisi</i>
71	<i>Amaranthus tricolor</i>	Marisa	Chinese spinach	<i>Sirukeerai</i>
72	<i>Oldenlandia umbellata</i>	Rajana	Chaya root	<i>Impooral</i>
73	<i>Portulaca oleracea</i>	Lonica	Garden purslane	<i>Paruppukeerai</i>
74	<i>Abrus precatorius</i>	Gunja	Crabs eye ,Cocks eye	<i>Kunrimani</i>
75	<i>Solanum trilobatum</i>	Alarka	Purple fruited pea egg	<i>Thuthuvazhai</i>
76	<i>Cassia senna</i>	Swarnamukhi	Country senna	<i>Nilavaarai</i>
77	<i>Citrus limon</i>	Jambira	Lime	<i>Elumichai</i>
78	<i>Aegle marmelos</i>	Bilra	Bael tree, Holy fruit tree	<i>Vilvam</i>
79	<i>Anamirta cocculus</i>	Garalaphala	Indian berry, Fish berry	<i>Kakkollivirai</i>
80	<i>Anoectochilus setaceus</i>	Vanasarpagandi	Bristy Anoectochilus	<i>Oorchid</i>
81	<i>Argemone Mexicana</i>	Brahamadandi	Mexican poppy	<i>Bramadandu</i>
82	<i>Biophytum reinwardtii</i>	Jalapushpa	Reinwardts tree plant	-
83	<i>Caryota urens</i>	Sritalah	Wine palm	<i>Tippilipana</i>
84	<i>Hibiscus abelmoschus</i>	Latakasturika	Musk mallow	<i>Kasturivendai</i>
85	<i>Horsfieldia irya</i>	-	Irya tree	<i>Eeriya maram</i>
86	<i>Maranta arundinacea</i>	Hulankiriya	Arrow root plant	<i>Aruruttukkilangu</i>
87	<i>Morinda citrifolia</i>	Tunnavu	Indian mulberry	<i>Nuna</i>
88	<i>Nelumbo nucifra</i>	Abja	Chinese water lily	<i>Ambal</i>
89	<i>Nymphaea lotus</i>	Alagandha	White Egyptian lotus	<i>Allithamarai</i>
90	<i>Ophiorrhiza mungos</i>	Bhiyangakshi	Indian snake root	<i>Kirippundu</i>
91	<i>Prunus cerasoides</i>	Charu	Himalaya cherry	-
92	<i>Tiliacora acuminata</i>	-	-	-
93	<i>Wissadula periplociflia</i>	Wisadooliya	-	<i>Wisadooliya</i>
94	<i>Zeuxine regia</i>	-	-	<i>Orchid</i>

This review indicates that, 42 (45%) of the medicinal plants grow in the natural habitat; 32 (34%) plants are cultivated plants and 18 (19%) are in both natural and cultivated habitats.

3.5 Parts of the Medicinal Plants Used for Treatment of Snake Bites

Medicinal properties derived from plants may come from many different parts of a plant including leaves, roots, barks, seeds, fruits, and

flowers. The different parts of these plants contain different active ingredients. Thus, one part of the plant could be toxic while another portion of the same plant could be curative (harmless) [65].

The important parts of plants used for the management of snake bites are shown in Fig. 3. The review revealed that parts used for treatment were roots 31 species (26%), leaves 29 (24%) and seeds 15 (12%). However, in some cases, latex and resin were also used but rarely.

Table 2. Family distribution of the medicinal plants

No	Family name	Frequency	Percentage (%)
01	<i>Fabaceae</i>	9	9.60
02	<i>Alangiaceae</i>	1	1.06
03	<i>Cucurbitaceae</i>	6	6.38
04	<i>Aristolochiaceae</i>	2	2.12
05	<i>Lauraceae</i>	1	1.06
06	<i>Asclepiadoideae</i>	2	2.12
07	<i>Euphorbiaceae</i>	3	3.19
08	<i>Apocynaceae</i>	6	6.38
09	<i>Piperaceae</i>	2	2.12
10	<i>Polygalaceae</i>	2	2.12
11	<i>Acoracea</i>	1	1.06
12	<i>Amaryllidaceae</i>	2	2.12
13	<i>Rubiaceae</i>	5	5.31
14	<i>Caparidaceae</i>	1	1.06
15	<i>Solanaceae</i>	5	5.31
16	<i>Amaranthaceae</i>	3	3.19
17	<i>Lamiaceae</i>	3	3.19
18	<i>Meliaceae</i>	1	1.06
19	<i>Acanthaceae</i>	1	1.06
20	<i>Moringaceae</i>	1	1.06
21	<i>Zingiberaceae</i>	1	1.06
22	<i>Rhamnaceae</i>	1	1.06
23	<i>Sapotaceae</i>	2	2.12
24	<i>Hypoxidaceae</i>	1	1.06
25	<i>Arecaceae</i>	1	1.06
26	<i>Menispermaceae</i>	4	4.25
27	<i>Vitaceae</i>	1	1.06
28	<i>Dioscoreaceae</i>	1	1.06
29	<i>Asteraceae</i>	1	1.06
30	<i>Apiaceae</i>	1	1.06
31	<i>Malvaceae</i>	2	2.12
32	<i>Lythraceae</i>	1	1.06
33	<i>Rutaceae</i>	1	1.06
34	<i>Pedaliaceae</i>	1	1.06
35	<i>Loganiaceae</i>	2	2.12
36	<i>Musaceae</i>	1	1.06
37	<i>Poaceae</i>	1	1.06
38	<i>Combretaceae</i>	1	1.06
39	<i>Calophyllaceae</i>	1	1.06
40	<i>Portulacaceae</i>	1	1.06
41	<i>Orchidaceae</i>	2	2.12

Morphology of Medicinal Plants

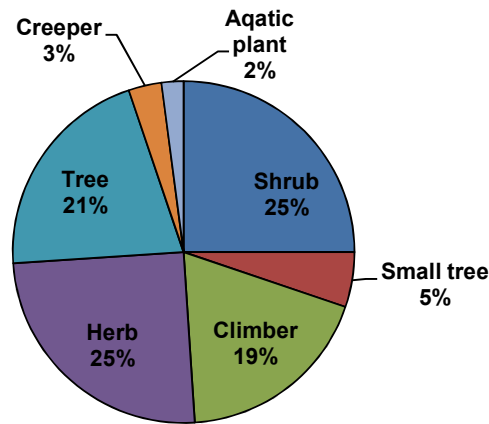


Fig. 1. Morphological classification of medicinal plants that are used for the management of snake bites

habitat of Medicinal Plants

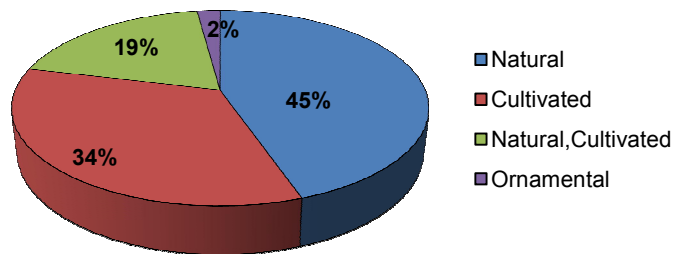


Fig. 2. Habitats of medicinal plants that are used for the management of snake bites

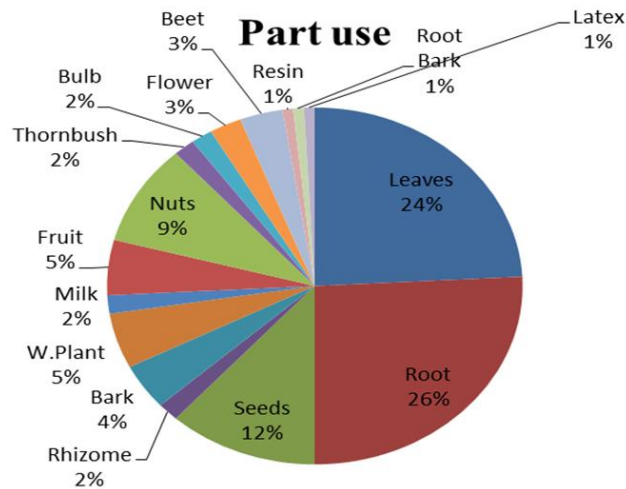


Fig. 3. Parts of medicinal plants that are used for the management of snake bites

The findings of this present study was fairly comparable with the previous study of 71 identified plant species which showed that leaves (24.82%), stems (11.68%) and flowers (10.95%) to be the most frequently used parts for preparing the extract [66]. Another study reported that, leaves and roots were the parts of plants most used in folk medicine [63].

3.6 Siddha Properties of the Medicinal Plants

The drugs used in Siddha medicine are classified on the basis of five properties: taste, character, potency, class/ efficacy and action [67]. Taste has got a significant place in Siddha Medicine. Tongue experiences these tastes when a drug is administered orally. The dynamics of Siddha preparations are based on taste parameters. Six tastes are known as sweet, sour, salty, pungent (spicy), bitter and astringent. Potency is described as an active constituent of the drug. This constituent is responsible for the pharmacological activity of the medicinal herb and other drugs. The drugs have cold and hot potency. Class (Bio transformation) is said to be the post absorptive taste or taste of the drug after absorption which also is considered to be an important aspect [68,69]. Table 3 shows the siddha properties such as taste, potency and efficacy of the medicinal plants which are used for the management of snake bites.

Table 3 shows, these plants that contain: Siddha properties such as bitter taste 52 (48.14%); hot potency [64 (70.32%)] and pungent efficacy [68 (72.34%)].

3.7 Pharmacological Actions of the Medicinal Plants

Action is the function of the drug which mentions the outcome effect of the drug like expectorant, tonic, diuretic etc. A drug can have more than one action [68,69].

Table 3. Siddha properties of the medicinal plants

No	Taste	Fr.	%	Potency	Fr.	%	Efficacy	Fr.	%
01	Bitter	52	48.14	Hot	64	70.32	Pungent	68	72.34
02	Sweet	24	22.22	Cold	27	29.67	Sweet	26	27.65
03	Pungent	15	13.88						
04	Astringent	14	12.96						
05	Sour	03	02.77						
06	Salty	00	00.00						

Fr. - Frequency; % - Percentage

The specific pharmacological actions of the medicinal plants which are utilized for the management of snake bites are listed in Table 4. According to this table, pharmacological actions such as diuretic [36 (38.3%); tonic [35 (37.23)]; astringent [33 (35.1%)] and stimulant [32 (34.04%)] were present in these medicinal plants.

3.8 Dietary and Poisonous Plants

The Fig. 4 revealed that from these 94 medicinal plant species 39 (41.49%) plants were commonly used for dietary purposes and 9 (9.57%) plants were shown to be poisonous.

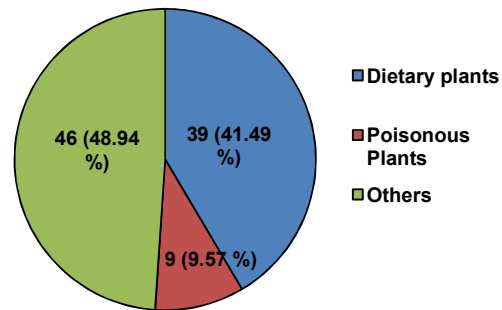


Fig. 4. Dietary and poisonous plants

3.9 Phytochemical Contents

Phytochemicals are non-nutritive plant chemicals that have protective or disease preventive properties. They are non-essential nutrients, meaning that the human body does not require them for sustaining life. It is well-known that plants produce these chemicals to protect themselves but recent researches demonstrate that they can also protect humans against diseases. There are more than a thousand known phytochemicals [70]. Therefore, the phytochemical contents seen in these selected plants are reported in Table 5.

Table 4. Pharmacological action of medicinal plants

No	Pharmacological action	Frequency	Percentage (%)
01	Stimulant	32	34.04
02	Antiperiodic	11	11.70
03	Germicide	02	02.13
04	Alterative	24	25.53
05	Anthelmintic	17	18.08
06	Diuretic	36	38.30
07	Emetic	20	21.27
08	Febrifuge	07	07.45
09	Laxative	30	31.91
10	Nauseant	03	03.19
11	Nutritive	17	18.08
12	Tonic	35	37.23
13	Purgative	20	21.28
14	Emmenagogue	12	12.77
15	Abortifacient	02	02.13
16	Carminative	16	17.02
17	Aphrodisiac	11	11.70
18	Expectorant	25	26.60
19	Antipyretic	02	02.13
20	Analgesic	01	01.06
21	Anti-inflammatory	09	09.57
22	Anodyne	08	08.51
23	Cathartic	03	03.19
24	Stomachic	19	20.21
25	Digestive	01	01.06
26	Rubefacient	11	11.70
27	Deodorant	01	01.06
28	Diaphoretic	08	08.51
29	Antidote	13	13.83
30	Acrid	01	01.06
31	Anti-bilious	05	05.34
32	Demulcent	19	20.21
33	Disinfection	10	10.64
34	Blood purificator	01	01.06
35	Astringent	33	35.11
36	Cooling	17	18.08
37	Anti-spasmodic	11	11.70
38	Antiseptic	16	17.02
39	Sialagogue	01	01.06
40	Galactagogue	03	03.19
41	Styptic	10	10.64
42	Emollient	05	05.34

Phytochemicals such as flavonoids 88 (93.61%) and saponin 81 (86.17%) were found to be high in these medicinal plants. This was followed by tannin 60 (63.82%). In vitro studies showed that the flavonoid contents inhibited the hyaluronidase activity based on different venom dose-dependency [71]. Another study mentioned that the phytochemicals such as plant phenols, alkaloid, triterpenoid, steroid showed effective anti-snake venom activity [72]. In vitro and *in vivo*

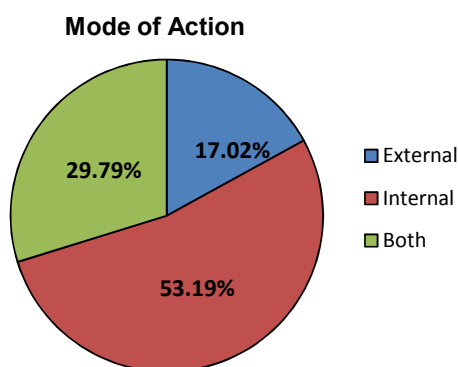
studies demonstrated that several alkaloids, flavonoids, polyphenols, terpenoids, saponins, sterols, glycosides, etc., from herbal medicines, effectively neutralized local tissue damage induced by venom toxins/enzymes [73].

3.10 Mode of Action

Modes of transmission of the selected medicinal plants are shown in Fig. 5.

Table 5. Phytochemical contents of medicinal plants

No	Phytochemicals	Frequency	Percentage (%)
01	Flavonoids	88	93.61
02	Saponin	81	86.17
03	Anthraquinones	13	13.82
04	Glycosides	40	42.55
05	Cardiac glycosides	16	17.02
06	Alkaloids	44	46.80
07	Tannin	60	63.82
08	Gumarine	12	12.76
09	Formic acid	04	04.25
10	Reducing sugar	28	29.78
11	Amino acids	32	34.04
12	Carbohydrates	20	21.27
13	Phenolic compound	12	12.76
14	Terphenoids	18	19.14
15	Lignin	09	09.57
16	Catechols	16	17.02
17	Steroids & Sterols	19	20.21
18	Gum & mucilage	12	12.76
19	Protein	12	12.76

**Fig. 5. Mode of action of the selected medicinal plants**

Commonly, the Siddha system of Medicine classifies all medicinal preparations into 64 categories, of which 32 are internal medications and 32 are external medications and methods [67,68]. A review of some of the more commonly used dietary supplements and their chemistry and topical use confirms that there is merit in using these plants both internally and externally [8].

This review confirmed that fifty (53.19%) of these species were used as external and internal (Both) medication in the management of snake bites. A previous related study mentioned that, regarding the mode of use, the most frequent one is the topical application of the vegetal

products directly on the place of the bite. On the other hand, the use of some plant species is through internal and external routes simultaneously, while for some other species the route of administration could be chosen to be internal or external use [63].

4. CONCLUSION

This literature review provides useful documented evidence on the management of snake bites in traditional medicine. However, there is a need for further reviews related to the chemical composition, chemical elements, phytochemicals, physicochemical properties, toxic substances. Extensive scientific studies should also to be carried out to justify its clinical potential in the management of snake bites in future.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX

APPENDIX 1. Review records of the medicinal plants which are utilizing in the management of the snake bite

No	Morphology	Common part use	Part use on snake bite	Mode of administration	Used as diet	Poisonous plant
01	Shrub	Leaves ,Root	Leaves, Root	External & Internal		
02	Small tree	Leaves ,Seeds, Bark	Leaves, Seed	External		
03	Climber	Root, Rhizome, Whole plant	Rhizome	External & Internal		
04	Climber	Leaves ,seeds, Root, Whole plant	Root	External & Internal		
05	Small tree	Leaves ,Bark	Bark	Internal	✓	
06	Climber	Leaves ,Root, Rhizome	Leaves	Internal		
07	Climber	Leaves, Whole plant	Leaves, Whole plant	External & Internal		
08	Herb	Leaves, Root, Whole plant	Leaves, Root	Internal		
09	Shrub	Leaves, Root, bark, Flowers, Milk	Leaves, Milk	External & Internal		✓
10	Climber	Fruits	Fruits	External & Internal	✓	
11	Climber	Rhizome, Whole Plant, Seed	Seeds	Internal		
12	Shrub	Leaves, Whole plant	Leaves	Internal		
13	Shrub	Leaves, Whole plant	Leaves	Internal		
14	Climber	Leaves, Root, Seeds, Nuts, Fruit, Matured Fruit	Leaves, Seed, Nuts, Thorn bush	External & Internal	✓	
15	Herb	Root, Rhizome	Root	External & Internal		
16	Herb	Leaves, Flowers, Seeds, Bulb	Bulb	Internal	✓	
17	Shrub	Leaves, Root, Fruit	Leaves	Internal		
	Tree	Leaves, Root, Seeds, flowers	Root, Seeds	Internal		
19	Climber	Leaves, Seeds, Fruit	Leaves	Internal	✓	
20	Tree	Seeds, Nuts	Nuts	Internal		✓
21	Creepers	Leaves, Seeds, Fruit, stem	Fruit	External	✓	
22	Creepers	Root ,Seeds, Fruit, Matured Fruit	Root	External		
23	Herb	Whole Plant, Root	Root	External		
24	Herb	Leaves , Whole Plant	Whole plant	Internal	✓	
25	Shrub	Leaves ,seeds, Fruit, Flowers	Leaves	External		✓

No	Morphology	Common part use	Part use on snake bite	Mode of administration	Used as diet	Poisonous plant
26	Herb	Leaves	Leaves	Internal	✓	
27	Shrub	Leaves ,Flowers	Leaves	External & Internal		
28	Shrub	Leaves	Leaves	Internal		✓
29	Herb	Bulb	Bulb	Internal	✓	
30	Climber	Leaves	Leaves	Internal		
31	Climber	Matured leaves ,Milk	Milk	External		✓
32	Tree	Leaves , Root, Bark, Root bark, Seeds, Resin, Flowers	Flowers	Internal		
33	Tree	Leaves ,Tender, Flowers, Fruit, Seeds, Bark, Root bark, Wood, Resin	Seeds	Internal	✓	
34	Shrub	Root	Root	Internal	✓	
35	Shrub	Leaves ,Root	Leaves	Internal		
36	Herb	Whole plant	Whole plant	Internal		
37	Tree	Leaves ,Seeds, Flowers, Bark, Tender, Resin, Pods, Root, Whole plant	Leaves	External & Internal	✓	
38	Shrub	Leaves ,Seeds	Leaves	Internal		
39	Herb	Dry beet/Rhizome	Dry beet	External & Internal	✓	
40	Tree	Root ,Beet, Fruit	Root	External & Internal		
41	Tree	Leaves, Flowers, Fruit, Seeds, Root bark, Bark	Root, Palanggothu	External & Internal	✓	
42	Herb	Root, Beet	Beet	Internal		
43	Tree	Leaves, Sprouting, Flowers, Spathe Fruit , Thorne bush, Root, Coconut shell, Bat, Whole plant	Root, Thorne bush	Internal	✓	
44	Climber	Leaves, Root	Root	Internal	✓	
45	Tree	Leaves, Fruit, Bark	Leaves, Bark	External & Internal		
46	Creeper	Stem, Root	Root	Internal	✓	
47	Herb	Beet	Beet	Internal	✓	
48	Herb	Leaves, Flowers, Seed, Root, Root bark, Whole plant		External		
49	Herb	Leaves, Seeds, Root, Whole plant	Whole plant	External & Internal		
50	Tree	Seeds, Flowers, Bark	Seeds	Internal		
51	Shrub	Resin	Resin	Internal	✓	

No	Morphology	Common part use	Part use on snake bite	Mode of administration	Used as diet	Poisonous plant
52	Shrub	Leaves, Flowers, Root, Bark	Root	Internal	✓	
53	Small Tree	Flowers, Pods, Fruit, Seeds, Root, Bark	Root	External & Internal	✓	
54	Shrub	Leaves, Bark, Root	Root	External		
55	Climbing shrub	Leaves, Stem, Root, Beet	Root	External & Internal	✓	
56	Shrub	Leaves, Seeds, Root, Beet	Root, Beet	Internal	✓	
57	Shrub	Leaves, Flowers, Seeds, Fruit	Seeds	External & Internal	✓	
58	Tree	Fruit, Seeds	Fruit	Internal		
59	Tree	Leaves, Fruit, seeds, Bark, Root Bark.	Seeds	External		✓
60	Herb	Leaves, Root, Whole plant	Leaves, Root	External & Internal		
61	Shrub	Fruit, Whole plant, Root	Root	Internal	✓	
62	Tree /shrub	Leaves, Flowers, Pods, Fruit, Bark ,Wood, Stem	Bark	External & Internal	✓	
63	Herb /Grass	Root, Whole plant	Whole plant	Internal	✓	
64	Small tree	Fruit, Bark, Root	Root	External		
65	Climber	Leaves, Root	Root	External & Internal	✓	
66	Tree	Bark, Root	Root	Internal		
67	Tree	Leaves, Fruit, Seeds	Seeds	External & Internal		
68	Tree	Leaves, Flowers, Seeds, Bark, Resin	Seeds	External & Internal		
69	Climbing Shrub	Leaves, Seeds, Bark, Root, Root Bark	Seeds	External & Internal		
70	Herb	Seeds	Seeds	External & Internal		
71	Herb	Leaves, Stem	Leaves	Internal	✓	
72	Herb	Leaves, Root, Root Bark, Whole plant	Leaves, Root	Internal	✓	
73	Herb	Leaves, Seeds	Leaves	Internal	✓	
74	Climber	Leaves, Seeds, Root	Root	Internal		✓
75	Climber	Leaves, Flowers, Fruit, Whole plant	Fruit, Flowers	Internal	✓	
76	Shrub	Leaves	Leaves	Internal		
77	Shrub/ Climber	Leaves, Fruit, Root	Root	Internal	✓	
78	Tree	Leaves, Flowers, Pods, Fruit	Root	Internal	✓	
79	Climber	Fruit, Bark, Seeds	Fresh bark	External		✓
80	Herb	Whole plant	Whole plant	External		

No	Morphology	Common part use	Part use on snake bite	Mode of administration	Used as diet	Poisonous plant
81	Herb	Seeds, Whole plant Milk	Seeds	External		✓
82	Small Tree	Leaves	Leaves	Internal		
83	Tree	Leaves, Root Bark, <i>Spatha</i>	Root Bark	Internal	✓	
84	Shrub	Leaves, Root, Seeds	Seeds	External & Internal		
85	Tree	Leaves, Root, Latex	Latex, Root	External & Internal		
86	Herb	Tuber, Rhizome	Rhizome	Internal	✓	
87	Tree	Leaves, Root, Tender leaves, Unripe berries, Charred, Stem bark, Fruit	Tender leaves	External	✓	
88	Aquatic plant	Flowers, Fresh root stock, Seeds, Rhizome.	Fresh root stock	Internal	✓	
89	Aquatic plant	Root stock, Flowers, seeds, Fruit, Rhizome, Leaves	Fruits	Internal		
90	Herb	Leaves, Root	Root	Internal	✓	
91	Shrub	Bark, Fruit	Bark	External		
92	Herb	Bark, Root	Root	Internal		
93	Tree	Leaves, Whole plant	Leaves	External		
94	Herb	Leaves, Flowers	Leaves	External		



KING COBRA



COMMON COBRA



COMMON KRAIT



RUSSELL'S VIPER



SAW SCALED VIPER

Appendix 2. Venomous species of snakes in Sri Lanka

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