



## Review Article

# Infrequent use of medicinal plants from India in snakebite treatment

Manali Sughosh Upasani<sup>a</sup>, Sughosh Vishweshwar Upasani<sup>b,\*</sup>,  
Vishal Gokul Beldar<sup>c</sup>, Chetana Gokul Beldar<sup>d</sup>, Pranjali P. Gujarathi<sup>e</sup>

<sup>a</sup> KES's College of Pharmacy, Amalner, India

<sup>b</sup> R. C. Patel Institute of Pharmacy, Shirpur, India

<sup>c</sup> Department of Pharmacognosy, R. C. Patel Institute of Pharmaceutical Education and Research, Shirpur, India

<sup>d</sup> Viva College of Pharmacy, Virar, India

<sup>e</sup> Maliba Pharmacy College, Bardoli, India

## ARTICLE INFO

## Article history:

Received 12 June 2017

Received in revised form

8 August 2017

Accepted 26 October 2017

Available online 6 November 2017

## Keywords:

Appraise traditional medicinal plants

Ethnomedicine

India

Snake antivenom

## ABSTRACT

Snakes have fascinated humankind for millennia. Snakebites are a serious medical, social, and economic problem that are experienced worldwide; however, they are most serious in tropical and subtropical countries. The reasons for this are 1) the presence of more species of the most dangerous snakes, 2) the inaccessibility of immediate medical treatment, and 3) poor health care. The goal of this study was to collect information concerning rare, less utilized, and less studied medicinal plants. More than 100 plants were found to have potential to be utilized as anti-snake venom across India. Data accumulated from a variety of literature sources revealed useful plant families, the parts of plants used, and how to utilize them. In India, there are over 520 plant species, belonging to approximately 122 families, which could be useful in the management of snakebites. This study was conducted to encourage researchers to create herbal antidotes, which will counteract snake venom. These may prove to be an inexpensive and easily assessable alternative, which would be of immense importance to society. Plants from families such as Acanthaceae, Arecaceae, Apocynaceae, Caesalpiniaceae, Asteraceae, Cucurbitaceae, Fabaceae, Euphorbiaceae, Lamiaceae, Rubiaceae, and Zingiberaceae are the most useful. In India, experts of folklore are using herbs either single or in combination with others.

© 2017 Korea Institute of Oriental Medicine. Published by Elsevier. This is an open access article under the CC BY-NC-ND license

(<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

\* Corresponding author at: R. C. Patel Institute of Pharmacy, Shirpur 425405, Dhule, Maharashtra, India.

E-mail address: [upasanisughosh@gmail.com](mailto:upasanisughosh@gmail.com) (S.V. Upasani).

<https://doi.org/10.1016/j.imr.2017.10.003>

2213-4220/© 2017 Korea Institute of Oriental Medicine. Published by Elsevier. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## 1. Introduction

For centuries, plants have been important in the treatment of a wide variety of illnesses, diseases, and disorders.<sup>1,2</sup> The inherent traditional systems of medicine, along with information from conservative folklore, are serving a large section of the populace, particularly in rural and tribal areas, despite the dawn of modern medicine. Ethnobotany is the scientific and systematic study of traditional knowledge and customs of people concerning plants and their medical, religious, and other uses. Studies involve literature surveys, detailed investigations, analyses, interpretation, and conclusions concerning various research and scientific data. An ethno-medico-botanical appraisal includes discussions with natives, as well as utilization of available facts and data regarding folklore literature.<sup>3</sup> Indigenous medicinal plant species have been added to several recent drug formulations and preparations for fundamental health care.<sup>3</sup>

## 2. Methodology

The current study provides a collection of information on medicinal plants that grow and can be utilized in various regions of India for snakebite treatment. The appropriate literature, including books, journals, and reports, was reviewed. The relevant information was searched using various electronic catalogs (e.g., Google Scholar, Medline, NISCAIR, Science Direct, Scirus, and Scopus) and keywords such as “anti-venom activity,” “ethno botany,” “ethno pharmacology,” “Indian,” “indigenous,” “medicinal plants,” “snake bite,” and “survey.” It was difficult to include all the information regarding medicinal plants used for snakebite treatment, and as such this study focused on information that would be easily accessible for researchers. Over the last few decades, people from different tribal communities have been recoding and maintaining data regarding traditional and tribal knowledge related to the use of medicinal plants. However, this information has, until now, not been made available to the modern world. In this regard, information on tribal and local use of various plants has been made available and a systematic “ready to use” list of medicinal plants has been formed. The list consists of data, including biological source(s), family, local name(s), part(s) used, method(s) of preparation/formulations, and reference(s). In this review, care was taken to ensure the identification of the herbal medicinal plants that were in the original resources (Table 1).

## 3. The Indian subcontinent and snakes

The Republic of India (3<sup>rd</sup> largest country in Asia and 7<sup>th</sup> by area in world) is a multilingual country home to a diverse culture with a rich and glorious heritage. India’s land border covers 151,067 km, which is shared with neighboring countries, including Bangladesh (border shared = 40,967 km), China (3488 km), Pakistan (3323 km), Nepal (1751 km), Myanmar (1643 km), Bhutan (699 km), and Afghanistan (106 km). India’s coastline covers 75,166 km, and land area including

island territories covers more than 3,287,260 km<sup>2</sup>. Some of these countries were part of India before the partition.<sup>4</sup>

India has numerous and diverse medico-herbal plants. They are dispersed, depending upon geographical and ecological conditions, across the country. Of these, more than 1500 species have demonstrated significant medicinal properties.<sup>4</sup> Envenomation, especially by snakebite, is a serious worldwide public health crisis.<sup>5–8</sup> Inappropriate and unwarranted treatment results from reasons such as the failure to identify the snake species (venomous or non-venomous), which increases the risk of complications. According to the Integrated Taxonomic Information System (ITIS), Elapidae and Viperidae are the two major families of venomous snakes. Elapidae consists of 325 species distributed in 61 genera. Viperidae includes 224 species distributed in 22 genera. In and around India, approximately 216 species of snakes belong to these families, and only 52 are known to be poisonous.<sup>9,10</sup> The ‘Big Four’ snakes cause the largest number of snakebite deaths on the Indian subcontinent. The ‘Big Four’ snakes consist of Russell’s viper (*Daboia russelii*; Marathi translation, *ghonas tawarya*), Indian cobra (*Naja naja*; Marathi translation, *Nag*), saw-scaled viper (*Echis carinatus*; Marathi translation, *phoorsa*), and common krait (*Bungarus caeruleus*; Marathi translation, *manyar kanadar*) (Fig. 1).<sup>11</sup> Apart from these big four, the hump-nosed viper is also hazardous.<sup>12</sup> Envenomation is a ‘choice’ and voluntary action or reaction by snakes. Their bite is a natural protective defense mechanism. All venomous snakes have the ability to bite without including venom (dry bite).<sup>13</sup> Farmers, fieldsmen, and outdoor workers find suffering from snakebites to be an occupational hazard.<sup>14</sup> It is also a leading problem in rural areas of India. It is estimated that snakebite poisoning causes approximately 50,000 deaths annually, and the number is likely higher because not all cases from rural areas are reported.<sup>10,15</sup>

## 4. Snake venom and snake anti-venoms

Snake venom is one of the most intense and ‘mysterious’ biological fluids within the animal kingdom, causing complex medical effects. This is because of the presence of complex mixtures of proteins, peptides, and contain at least 25 enzymes.<sup>16,17</sup> Venom is a complicated combination of proteins (both enzymatic and non-enzymatic), peptides, and small organic compounds, such as acetylcholine citrate and nucleoside.<sup>18,19</sup> There are many potential effects of snake envenomation on humans; however, a few broad categories of major clinical significance are:

1. Systemic myolysis
2. Flaccid (drooping) paralysis
3. Coagulopathy and hemorrhage
4. Cardiotoxicity
5. Renal damage or failure
6. Local tissue injury at the bite site

Each of these may cause a number of secondary effects, and each is associated with potential morbidity and mortality.<sup>3</sup> Similar to other modern medicines, anti-venom can have side effects. In addition, it takes too long to develop and

**Table 1 – List of Medicinal Plants Used for Treatment of Snakebites in India**

Biological source	Family	Local names	Part used	Method of administration	References
<i>Ajuga bracteosa</i> Wall Ex Benth	Lamiaceae	Neelkanthi, Nilkanthi, Kanasar	Rt	Root extract is used as an antidote	29
<i>Ailanthus excels</i> Roxb	Simaroubaceae	Peeyamaram	Lv	Decoction of the leaves with the leaves of <i>Aristolochia indica</i> prepared and mixed with goats' milk to drink for treatment of snakebites	30,31
<i>Alangium lamarbi</i> Thwaites	Alangiaceae	–	Br	Bark paste is taken orally	32
<i>Alangium salvifolium</i> (Linnf) Wang	Alangiaceae	Ankol, Ankula, Alangi, Aankla	Wp, R, Lv, St, Br	Approximately 15 g of bark ground + 10–12 black peppers mixed with 72 g animal fat given every 2 h to cure snakebite Root bark decoction is given internally to treat snakebite	33–36
<i>Albizia lebbek</i> (Linn) Benth	Fabaceae	Siris, Kala, Siris, Segta/Siris, Hombage, bhandi	Lv, Br, Fl, Wp, R	Paste of bark is used	31,37–40
<i>Allium cepa</i> Linn	Liliaceae	Piyaz, Venkayam	Bb	The paste made from fresh skin of bulb is used for external application (5 d)	38,41
<i>Allium sativum</i> Linn	Liliaceae	Lasoon	Bb	Bulb is made into paste and given orally	41,42
<i>Alsophila glabra</i> Sensu Bedd	Cyatheaceae	–	Rz	Unknown	43
<i>Alstonia scholaris</i> (Linn) RBr	Apocynaceae	Saptparni, Chatni, Satina, Barap lei, Lawthong	Lv, Br	Bark decoction given orally	44–47
<i>Alstonia venenata</i> RBr	Apocynaceae	Analivegham, Elaipalai, Analivegham	St, Br, Rt	Tablets made from paste of stem bark are taken with cow's urine Decoction also taken orally	48,49
<i>Alternanthera sessilis</i> (Linn) R Brown ex DC	Amaranthaceae	Kandilijari	St, Lv	External application of stem and leaf paste is used	50–52
<i>Amaranthus blitum</i> Linn	Amaranthaceae	Chaulai	Rt	Root powder is used	39
<i>Amaranthus spinosus</i> Linn	Amaranthaceae	Kateli, Mullikeerai, Kateli, Chaurai, Kanta-bhaji, Kateli-chaulai	R, Lv Wp	Paste of leaves is applied locally	39,53–56
<i>Amaranthus viridis</i> Linn	Amaranthaceae	Khutora, Chaulai	Lv, St	Leaf/stem paste is applied externally	53
<i>Ammannia baccifera</i> Linn	Lythraceae	Neerumulli	Wp	Whole plant powder mixed with hot cow's milk to drink	57
<i>Amomum aromaticum</i> Roxb	Zingiberaceae	Borelachi, Chakma, Bodaelachi	Sd	Seed paste is used	58
<i>Amomum subulatum</i> Roxb	Zingiberaceae	Bara elachi	Pd	Boil 2–3 pods and drink the extract twice daily for a week	58
<i>Amorphophallus campanulatus</i> Blume: ex DC	Araceae	Bhabdi	Tb	The tubers are crushed and applied externally	59
<i>Amorphophallus commutatus</i> (Schott) Engler	Araceae	–	Tb	Unknown	60
<i>Andrographis alata</i> Nees	Acanthaceae	Periyangai	Lv	A handful of fresh leaves or juice is taken orally	61
<i>Andrographis echioides</i> Nees	Acanthaceae	Nadnaur, Gusum puru, Gopuranthangi	Wp	Paste of whole plant is given orally with water It is also applied externally	62
<i>Andrographis lineate</i> Wallich ex	Acanthaceae	Siriyangai, Periyangai, Malaiveempu	Wp, Lv	Paste of leaves is applied externally About 3 grams of whole plant paste is directly administered orally	63–65
<i>Andrographis paniculata</i> (Burm f) Wall Ex Nees	Acanthaceae	Kalmegh, Bhumi neem, Neelaveppu, Nilavaambu, Chiriyangai, Siriyangai, Periyangai	Lv, Lv, Wp	A decoction of the leaves with the leaves of <i>Andrographis alata</i> is given Decoction or extract is applied externally	30,63,65–74

– Table 1 (Continued)

Biological source	Family	Local names	Part used	Method of administration	References
<i>Anisomeles indica</i> (Linn) Kuntze	Lamiaceae	Paeimiratti	Lv	Paste of leaf is taken	75
<i>Anisomeles malabarica</i> (Linn) RBr	Lamiaceae	Siriyapaeyamarati, Peymarutti	Lv	The leaf or juice mixed with water to drink	75
<i>Annona squamosa</i> Linn	Annonaceae	Seethaphala	St, Br, Lv	Unknown	57,76
<i>Anogeissus acuminata</i> Wall	Combretaceae	Dhavra	Pl	Poultice is applied	77
<i>Anthocephalus cadamba</i> Miq	Rubiaceae	Kadam	Wp	Unknown	39
<i>Antidesma bunius</i> (Linn) Spreng	Phyllanthaceae	Tuaitit	Lv	Unknown	78
<i>Arachne cordifolia</i> (Decne) Hurusawa	Euphorbiaceae	–	Lv, St	Unknown	79
<i>Ardisia humilis</i> Vahl	Myrsinaceae	Kumbreth	Br	Crushed paste is applied	80
<i>Argemone Mexicana</i> Linn	Papaveraceae	Sialkatahi, Datturi, Pilikateli, Bharbhand, Brahmathandu	Lv, Sd, Rt	Leaf/seed decoction given orally (7 d) Root paste is also used	53,81,82
<i>Ariesaema barnesii</i> C Fischer	Araceae	Kaattuchenai	Tb	Dried tuber of this plant and whole plant paste of <i>Andrographis paniculata</i> (1:1) applied over wounds twice a day	69
<i>Arisaema flavum</i> (Forsskal) Schott	Araceae	Sapp googli	Tb	The tubers are crushed and a paste is made that is applied	83
<i>Arisaema jacquemontii</i> Blume	Araceae	Khaprya	Fr, Rz	Unknown	79,80
<i>Arisaema leschenaultii</i> Blume	Araceae	Havina jola	Rt, Lv, Fr	Fruit/leaf and root paste is applied on the spot of snakebite thrice a day for about 8 d.	81
<i>Arisaema tortuosum</i> (Wall) Schott	Araceae	Haap roodakaro, Halida, Kotukand, Chambus, Chakrata	Tb, Bb	Paste of the tuber in applied. Infusion of fresh bulb is taken orally thrice daily	60,84,85
<i>Aristolochia bracteolata</i> Lamk	Aristolochiaceae	Kalipad,	Lv, Rt	Leaf paste applied externally, as well as infusion taken orally	60,75,85,86
<i>Aristolochia indica</i> Linn	Aristolochiaceae	Sapasan, Garalika, Garudi, Nagbel, Arkamul, Birthwort, Ishwarmul, Bhedi-Janete, Karalakam, Kaliparh, Kaligulesar, Eashwari, Eshwarballi, Perumarindu, Karuda kodi, Garudakodi, Thalaisuruli	Rt, Wp	Fresh roots are ground along with <i>Rouwolfia serpentina</i> mixed in water taken twice daily (3 d) Root powder is snuffed Root juice is given orally and root paste applied locally	3,34,54,61,62,71,75,87-97
<i>Aristolochia tagala</i> Cham	Aristolochiaceae	Samta, Valiya, Eswaramulli, Perumarunt, Hukodi	Rt	Crushed and mixed with water and drunk, as well as fresh roots ground and applied externally on affected area	80,98
<i>Artocarpus heterophyllus</i> Lam	Moraceae	Kanthal	Pn	Drink 1 cup juice thrice daily	94
<i>Artocarpus hirsutus</i> Lam	Moraceae	–	Br	Bark paste made with coconut oil and applied	99
<i>Artocarpus integrifolia</i>	Artocarpaceae	Kothal, Theibong	Fr	Unknown	78
<i>Asparagus racemosus</i> Willd	Liliaceae	Halavu, Makkala, Beru, Satvari	Rt	Paste of the fasciculate root is applied externally	3,100
<i>Asystasia gangetica</i> Linn	Acanthaceae	Silandhinaayagam	Lv	Leaf paste is given	90
<i>Azadirachta indica</i> A Juss	Meliaceae	Vembu, Veempu, Neem	Fl, Br, Lv, Fr	Decoction/paste is prepared and given orally (7 d)	38,54,59,101

– Table 1 (Continued)

Biological source	Family	Local names	Part used	Method of administration	References
<i>Bacopa monnieri</i> (Linn) Pennell	Scrophulariaceae	Brahmisak, Nirbirami, Neeripirami, Brahmi	Br, Lv, Wp	Juice mixed with castor oil is applied externally to treat Leaf powder decoction mixed with hot cow's milk taken orally	3,86
<i>Barleria cristata</i> Linn	Acanthaceae	Kali, Brenkad	Lv, R, Sd	Leaf juice is applied	50
<i>Barleria prionitis</i> Linn	Acanthaceae	Kattukanagambaram	Rt	Decoction taken orally	49
<i>Boerhaavia diffusa</i> Linn	Nyctaginaceae	Punarnawa, Dabbal bhaji, Chotwa bhaji, Patharchatta, Biskhapara, Ittsitt	Lv, Wp	Leaf juice is also applied locally and taken orally for 7 d	39,50
<i>Boerhavia repens</i> Linn	Nyctaginaceae	Ponownowa	Rt	Unknown	
<i>Bombax ceiba</i> Linn	Bombaceae	Ilavu, Kate savar, Semal, Simul, Semar, Phunchawng, Simbal, Pikriisii	Fls, RBr, Sd	Paste of flowers/fruits/leaves is applied on the bitten spot	39,80
<i>Bryophyllum pinnatum</i> Kuntz	Crassulaceae	Dupartenga	Lv	Unknown	53
<i>Buchanania lanzan</i> Spr	Anacardiaceae	Char, Chironji, Achar, Chironji, Chirongi, Pial	Br	Unknown	37
<i>Butea monosperma</i> (Lamk) Taub	Fabaceae	Palash, Dhak, Parsa, Plash	Br, Lv, Fl, Gu, Sd, St, Br, Re, Lx	Bark paste applied on swelling Paste of one seed in 10 mL lemon juice is given orally	38
<i>Caesalpinia bonduc</i> (Linn) Roxb	Caesalpinaceae	Poonainagam, Karanj	Sd	Seeds paste applied externally (2 weeks)	39,95
<i>Calotropis gigantea</i> (L) R Br	Asclepiadaceae	Dev rui, Aak, Ekke, Akanda, Erukku, Aakdo, Safedaakdo, Gadsa, Akanda, Erukku	R, Lx	Root bark is ground into paste and made into pills and given orally Leaf latex is applied externally	43,76,77,90
<i>Calotropis procera</i> (Ait) R Br	Asclepiadaceae	Rui, Rai, Aakori: Aakra, Biliekke, Ekka (Safed Ak), Rakta arka, Vellerukku, Akra, Aak, Madar, Safed, Madar, Gadsa, Akwan	Lx, Rt, Young, Bd	Leaf latex is applied on bitten area Root is crushed and given to drink and applied externally	75,99
<i>Cannabis sativa</i> Linn	Cannabaceae	Bhang	Lv	Leaf paste is used	38
<i>Capparis decidua</i> (Forssk) Edgew	Capparaceae	Kareel, Karerua	Fr, Sd	Fruits are eaten	39,92
<i>Capsicum annum</i> Linn	Solanaceae	Marchiya	Rt	Unknown	41
<i>Cardiospermum luridum</i> Linn	Sapindaceae	Moddacoatan	Wp	The whole plant powder mixed with goat's milk to drink	75
<i>Carica papaya</i> Linn	Caricaceae	Papita, Amrurbhanda, Papita	Fr, Sd, Lx	Unripened fruit of <i>Carica papaya</i> is taken and the skin is removed by slicing, salt is then rubbed over it, and the fruit is then placed over the bite with sliced portions in contact with the bite and bandaged Few drops of latex are applied to snakebite wound for quick healing	34
<i>Cassia alata</i> Linn	Caesalpinaceae	Senna, Khor-pat daopata, Seemaiyagathi	Lv	Paste of leaves is applied externally, as well as given orally	78
<i>Cassia fistula</i> Linn	Caesalpinaceae	Amaltash, Dhanba, Amaltas, Sonarkhi, Kakke	Fr, Sd, Lv, St, R, Br	The paste & decoction of root bark with black pepper is given orally Paste of stem bark applied on bitten place Fruit pulp is used	37–39,62

– Table 1 (Continued)

Biological source	Family	Local names	Part used	Method of administration	References
<i>Cassia occidentalis</i> Linn	Caesalpiniaceae	Kasaundi, Kasondi, Peeperambi, Thagarai	Rt, Lv	Oral administration of root paste	38,39,67
<i>Cassia sophera</i> Linn	Caesalpiniaceae	Sularai	Rt	Unknown	86
<i>Cassia tora</i> Linn	Caesalpiniaceae	Takala, Sickle, senna, Chakawad, Chakunda, Tagarai, Bon medelwa	Rt, Lv	Root paste & leaf decoction is applied externally (30 d)	39,53
<i>Catharanthus roseus</i> G Don	Apocynaceae	Nithya pushpa	Rt	Root paste mixed with pepper and lime is applied externally	81
<i>Cayratia trifolia</i> (Linn) Domin	Vitaceae	Khhata nimbi	Tb	Paste of tuber applied on the affected area	84
<i>Centratherum anthelminticum</i> (L) Kuntze	Asteraceae	Kattujeerakam	Sd	Unknown	66
<i>Cheilocostus speciosus</i> (JKeonig) CDSpecht	Costaceae	Keu, Chengalva kostu	Rz	Unknown	95
<i>Chlorophytum laxum</i> R Br	Liliaceae	Neerootikizangu	Tb	Tuber paste applied on affected area	89
<i>Cissampelos pareira</i> Linn	Menispermaceae	Patha, Patindu, Batindu, Patha, Urikkakodi, Chokipar, Tijumala, Ekladi Poa	Tb, Rt	Root paste with long pepper is prescribed once daily for 5 d	92,93,96
<i>Citrullus colocynthis</i> (Linn) Schrad	Cucurbitaceae	Kadva inravarna, Tumba, Gadumba, Tumbo, Indrayan	Sd, Rt, Fr	Seed oil used externally, as well as root crushed and given to drink	33,38
<i>Clematis triloba</i> Linn	Ranunculaceae	Badarsiti, Jangali, Bhoda, Bendar, Siti	Rt	Root paste is applied	77
<i>Cleome gynandra</i> Linn	Cleomaceae	Hul-hul	Lv, Wp	Unknown	39
<i>Cleome viscosa</i> Linn	Capparidaceae	Nayivelai	Lv	Leaf paste applied externally	30
<i>Clerodendron inerme</i> Gaertn	Verbenaceae	Vishaparihari	Rt	Root paste mixed with lime is applied twice daily for a week	81
<i>Clitoria ternatea</i> Linn	Fabaceae	Ruhu tuhu, Aparajita, Syahiful, Aparajita, Gokarni, Aparajita, Bili, Shankhapushpa	R	The root extract is taken with the root of <i>Aristolochia indica</i> and <i>Rauwolfia serpentina</i>	39,87
<i>Cocculus villosus</i> DC	Menispermaceae	Nagdun, Vachan karalla	Rt	The root bark extract is given internally and applied	3,38
<i>Commelina bengalensis</i> Linn	Commelinaceae	Kana simolu	R	Roots are useful	53
<i>Corallocarpus epigaeus</i> (Rottl & Willd) Hook f	Cucurbitaceae	Aathalai, Marsikand, Kollan, Kova killangu	Rt, Tb	Root decoction given internally 3–7 times	64,68,97
<i>Costus speciosus</i> (Koen) Sm	Costaceae	Keon, Kanda, Kebuk, Mahalakri, Jamlakhuti, Pewa, Jamlakhuti, Khongbam, Takhelei, Sumbul, Jomalkhuti, Myonpobap	Rt, Rz	Rhizome and root paste is used internally & externally	58,60,80,87
<i>Crateva magna</i> (Lour) DC	Capparaceae	Jong-sia	Br	Chewed and applied on bitten area	80
<i>Curculigo orchioide</i> Gaertn	Amaryllidaceae	Nilapanai, Nela tengu, Kali musli	Rt, Tb	Root paste use topically	39,80,81
<i>Curcuma amada</i> Roxb	Zingiberaceae	Amba haldi	Rz	The powder of the rhizome is applied locally	84
<i>Curcuma aromatica</i> Salisb	Zingiberaceae	Bon haladhi, Lam-yaingang	Rz	Paste of rhizome taken with water	58
<i>Curcuma caesia</i> Roxb	Zingiberaceae	Kalahalud, Kalahaldi, krushna kedara, Neelkanth	Rz	The dried rhizome powder is mixed with powdered seeds of <i>Andrographis paniculata</i> and applied	34,58



– Table 1 (Continued)

Biological source	Family	Local names	Part used	Method of administration	References
<i>Cyathula tomentosa</i> Roth	Amaranthaceae	–	Lv	Unknown	79
<i>Cyphostemma auriculatum</i> (Roxb) Singh & Shetty	Vitaceae	Kali-vel	Br	Bark is taken in some water and taken once a day (7–8 d)	96
<i>Daemia extensa</i> RBr	Asclepiadaceae	Vaelipparuththi	Rt	Powder of root is given	90
<i>Datura metel</i> Linn	Solanaceae	Kala Dhatura, Dhutura	Sd, Rt, Lv	Extract of roots are taken with garlic	39,70,80,81
<i>Delphinium denudatum</i> Wall ex Hook f & Thomson	Ranunculaceae	Nirbishi	Rt	Unkown	41
<i>Desmodium gangeticum</i> (Linn) DC	Fabaceae	Kareti, Salparni	R	Half-cup root decoction is taken orally	39,60
<i>Dichrostachys cinerea</i> Linn Wight & Arn	Araceae	Vedathalai, Kheri	Lv, Rt	Root powder is used Leaves are crushed into paste and applied locally	54
<i>Dicliptera paniculata</i> (Forssk) IDarbysh	Acanthaceae	Chebeera	Wp	Unknown	95
<i>Dioscorea pentaphylla</i> Linn	Dioscoreaceae	Lalvala vahrikand	Tb	Extract is also given	60
<i>Dregea volubilis</i> (Lf) BenthEx Hookf	Apocynaceae	Dudipala, Bandi guriya	Lv	Unknown	95,96
<i>Drymaria cordata</i> (L) Willd Ex Roem & Schult	Caryophyllaceae	Mecanachil, Theiphelwang, Kynbat thalap	Wp	Whole plant is used (crushed paste applied)	80
<i>Dryopteris cochleata</i> CChr	Aspidiaceae	Chhoti Bhulan	Wp, Lv, R	The whole plant crushed in a bowl and the extract is given orally twice a day The leaves and roots are applied on the bite wound	43
<i>Eclipta alba</i> (Linn) Hassk	Asteraceae	Manchal karisalankanni, Bhringraj, Maka	Wp	Whole plant juice is given orally (30 d)	38
<i>Elaeodendron glaucum</i> Pers	Celastraceae	Ratangaur, Bhairao, Niuri Mamri, Jamrasi Mukarthi (Bhutphal)	Br, Rt	Roots and bark of plant made into paste taken orally with cow's milk	62
<i>Elettaria cardamomum</i> Maton	Zingiberaceae	Elassi	Sd, Pd	Decoction	58
<i>Eleusine indica</i> (L) Gaertn	Poaceae	Malkantari-Mundari	Rt	20 g root is crushed along with 10 g <i>Zingiber officinale</i> and nine black pepper pieces; paste is divided into two equal parts One part with a few drops of honey is administered orally and the other part is applied on the snake bitten area	92
<i>Enicostemma axillare</i> (Lam) A Raynal	Gentianaceae	Vellarugu	Rt	5–10 drops of root extract is poured in the spot	91
<i>Ervatamia coronaria</i> Stapf	Apocynaceae	–	Rt, Br	Root and bark infusion mixed with milk and butter, filtered, and used	99
<i>Ervatamia heyneana</i> Cooke	Apocynaceae	Kadunandibattalu	Rt	Root paste mixed with lemon juice & applied	81
<i>Euphorbia neriifolia</i> Linn	Euphorbiaceae	Mausa sij, Dudhbol, Thor, Thundar, Manasa	Lx, Rt	Latex is applied locally Root is used with black pepper	54,80
<i>Ficus benghalensis</i> Linn	Moraceae	Badd, Bar, Bargad	Lx, Ap, Rt, Fr	Unknown	38
<i>Ficus glomerata</i> Roxb	Moraceae	Medi	St, Br	The stem bark paste is applied	31
<i>Ficus hirta</i> Vahl	Moraceae	Tamangaddu	Rt	Root crushed & rubbed	47
<i>Ficus racemosa</i> Linn	Moraceae	Gular	Br	The stem bark is pounded with whey and applied locally	54

– Table 1 (Continued)

Biological source	Family	Local names	Part used	Method of administration	References
<i>Ficus religiosa</i> Linn	Moraceae	Peepal	Lv, Br, Fr	25 g stem bark and 8–10 cloves are pounded with animal fat (pure ghee) and given 4–6 times a day	35,37,59
<i>Ficus tinctoria</i> Forstf	Moraceae	Tella barnika	Lv	Unknown	31
<i>Fimbristylis spathacea</i> Roth	Cyperaceae	Hathia	Rt	The fresh root is taken internally & externally	87
<i>Gloriosa superb</i> Linn	Liliaceae	Vadhavadiyo, Vach, Nag, Nagardi, Gowri, Huvu, Kalihari, Kalihari, Karianaga, Agnishikha, Kariyari, Kalappa, Kilangu	Tb, Rt, Rz, Sd	Root paste or tuber paste is applied externally (2–5 d)	38,39,81,82
<i>Habenaria commelinifolia</i> Wall	Orchidaceae	Ankra	Tb	The tuber paste is applied	59
<i>Hedychium spicatum</i> SM	Zingiberaceae	Aithur, Takhellei-hanggam-mapan	Rz, Rt	Root decoction is used	58
<i>Helicteres isora</i> Linn	Sterculiaceae	Hateri, Murud sheng, Maror Phali	Br, Rt	Bark powder is given in snakebite	39,57
<i>Heliotropium indicum</i> Linn	Boraginaceae	Nakkipoo	Lv	The leaf juice mixed with hot water is used	75
<i>Heliotropium marifolium</i> Koen ex Retz	Boraginaceae	Choti-santri	Wp	Unknown	82
<i>Heliotropium supinum</i> Linn	Boraginaceae	Goma	Ap	Pounded aerial portions are applied externally and its juice is given orally in a dose of 5 mL at frequent intervals	35
<i>Hemidesmus indicus</i> (Linn) R Br	Asclepiadaceae	Suganti Jad, Anantmul, Choti dudhia, Anantamul, Analsing, Nannari, Anantamul	Rt, Lv	Aqueous extract of root is prepared in water and given orally & root paste is applied two or three times a day	92,93
<i>Heteropogon contortus</i> (Linn) P Beauv	Poaceae	Lapia, Lapida, Soorwala	Rt	Root paste is taken orally Poultice of root paste is also applied on the bitten portion for early cure	60
<i>Holarrhena pubescens</i> (Buch-Ham)Wall ex GDon	Apocynaceae	Pandhara Kula, Bolmatra	Sd, Rt, St, Br	Paste is applied on the bitten area two times a day	80
<i>Hordeum vulgare</i> Linn	Poaceae	Jau, Jav	Gr	Unknown	54
<i>Hyptis suaveolens</i> (Linn) Poit	Lamiaceae	Ban Tulsi	R	Unknown	39
<i>Impatiens glandulifera</i> Royle	Balsaminaceae	Hillu	Fls	Unknown	83
<i>Ipomoea obscura</i> (L) Ker Gawler	Convolvulaceae	Siruthaalkkodi	Lv	Leaf juice is administered	91
<i>Jatropha gossipifolia</i> Linn	Euphorbiaceae	Kattamanakku	Lv, St, Br, Sd, Lx	Unknown	55
<i>Kyllinga monocephala</i> Rottb	Cyperaceae	Safad, Nirbashi	Un	Unknown	38
<i>Lantana camara</i> Linn	Verbenaceae	Ragadd, Gajukampa, Arippu	R, Fl, St, Lv, Wp	Decoction of roots, flower, and stem are used	75
<i>Leucas aspera</i> Spreng	Lamiaceae	Durum bon, Gumma, Bhodaki, Tumbe, Thumbai, Gadde tumbe, Thumbi, Thumbai, Kennathumbai	Wp, Lv, Rt	Leaf paste or crushed leaf is taken both externally & internally to treat The root juice is mixed with goat's milk three times a day (4 d)	73,75,81,90,99,100
<i>Leucas cephalotes</i> (Roth) Spreng	Lamiaceae	Goma, Gumbi, Gumma	Wp	Decoction of whole plant (twice a day for 6 d)	38,39
<i>Lindenbergia muraria</i> (Roxb) Brühl	Scrophulariaceae	Chatti	Wp	Paste of leaf is applied externally	82



– Table 1 (Continued)

Biological source	Family	Local names	Part used	Method of administration	References
<i>Lobelia nicotianaefolia</i> Heyne	Campanulaceae	Heddumbe, Kadu hogesoppu	Lv, Lx	Latex is applied externally	81,100
<i>Luffa acutangula</i> (Linn) Roxb	Cucurbitaceae	Torai, Peerkan, Jangli Torai	Fr, Tn, Sd	Tendrils & seed paste is used	39,90
<i>Malva sylvestris</i> Linn	Malvaceae	Bendi gida	Lv	Extract of leaf mixed with lime juice given	99
<i>Martynia annua</i> Linn	Martyniaceae	Bagnakha	Rt	Decoction	67
<i>Mimosa pudica</i> Linn	Mimosaceae	Lajwanti, Thotta, Sinungi, Uskadpoda, Chhuimui/Lajwanti, Thottal surungi, Thottalvadi, Thottasiniki	Rt, Lv, Wp	Whole plants are made into extract in drinking water and shaken well and filtered Extract of whole plant is given twice a day for one day only Leaves are ground and made into paste and applied over affected area	31,39,47,90
<i>Mirabilis jalapa</i> Linn	Nyctaginaceae	Jahai juhi	Tb	The solution of tuber paste is given orally	62
<i>Mitragyna parvifolia</i> (Roxb) Korth	Rubiaceae	Neer-kadamba, Kadamba	Br, Fr	Unknown	57
<i>Momordica charantia</i> Linn	Cucurbitaceae	Karela, Pakakai	Wp, Sh, Rt	Juice of tender shoot or root is applied	42
<i>Momordica dioica</i> Roxb Ex Willd	Cucurbitaceae	Kakoda, Kankoda, Madi hagala kayi	Rt	Root tuber pounded with lime is applied externally on bitten spot daily thrice for 7 d	81,82
<i>Moringa oleifera</i> Lam	Moringaceae	Sajina, Nugge, Sahigan, Mungna, Sainjna, Sahjan, Sainjnad, Murungaih	Rt, Sd, Wp, St, Br, Lv	Fresh extract of bark is taken orally Bark root tincture applied externally (3 d)	3,54
<i>Mucuna pruriens</i> (Linn) DC	Fabaceae	Kevach, Konch	Sd, Fr, Rt	Aqueous extract of root is given orally twice a day	39
<i>Musa paradisiaca</i> Linn	Musaceae	Vazhai, Valaimaram, Valai	Br, St, skin, Br	A plant extract is given orally	30,68
<i>Nerium indicum</i> Mill Gard	Apocynaceae	Kaner, Kaner/Kanail, Lal kanher	Lv, Br Rt	The root is crushed with roots of <i>Capparis sepiaria</i> and <i>Datura innoxia</i> and paste applied externally thrice for 5 d Leaf paste is used	39,54
<i>Nymphoides hydrophylla</i> O Kuntze	Menyanthaceae	–	Lv		52
<i>Ochna obtusata</i> DC	Ochnaceae	–	Rt	Powder of root drunk with hot water frequently	80
<i>Ocimum adscendens</i> Wild	Lamiaceae	Heddumbe	Rt	Unknown	99
<i>Ocimum basilicum</i> Linn	Lamiaceae	Naitulasi, Kali Tulsii	Wp	Whole plant decoction orally given (week)	39
<i>Ocimum sanctum</i> Linn	Lamiaceae	Barpai, Tulasi	Lv, Rt, Wp	A paste of <i>Ocimum</i> leaf with the rhizome of <i>Curcuma longa</i> L (Zingiberaceae) is applied externally Leaf juice oral (8 d)	3,38,51
<i>Ophiorrhiza mungos</i> Linn	Rubiaceae	Havina gedde, Pambupoo, Keeripundu	Rt	Root juice is given (twice a day for 6 d)	61,98
<i>Opuntia dillenii</i> (Ker-Gawl) Haw	Cactaceae	Sappathikali	St, Br, Fr, Wp	The fruit paste is applied	75
<i>Ottelia alismoides</i> (L) Pers	Verbenaceae	–	Lv	Unknown	57
<i>Oxalis debilis</i> HBK var <i>corymbosa</i> (DC) Lour	Oxalidaceae	Khatti Booti	Wp	Unknown	39
<i>O martiana</i> Zucc					
<i>Pandanus nepalensis</i> St John	Pandanaceae	–	Lv	Unknown	42
<i>Parnassia nubicola</i> Wall ex Royle	Parnassiaceae	–	Tbs, Rt	Unknown	79

– Table 1 (Continued)

Biological source	Family	Local names	Part used	Method of administration	References
<i>Pavetta indica</i> Linn	Rubiaceae	Therani	Lv	A leaf paste is used externally	68
<i>Pergularia daemia</i> (Forsk)Chiov	Apocynaceae	Veliparuthi	Rt, Lv	The decoction of the leaves is used	30,75,95
<i>Peucedanum anamallayense</i> Cl	Apiaceae	Padachurukki	Wp	Whole plant paste along with cow's urine is taken	48
<i>Phyllanthus acidus</i> (Linn) Skeels	Euphorbiaceae	Kawlsunhlu	Rt	Decoction of roots is given	78
<i>Piper nigrum</i> Linn	Piperaceae	Bolkaalu, Menasina kaalu, Maricha, Kali-mirch, Milagu	Fl, Sd, Fr	Seed powder mixed with butter is given orally against snakebite Flower paste with ghee given orally (4 d)	3,54
<i>Pistia stratiotes</i> Linn	Araceae	Jalkumbhi	Sd	Decoction of seeds is given	67
<i>Pittosporum tetraspermum</i> Wight & Arn	Pittosporaceae	Analivegam	St, Br	Paste of stem bark is taken with cow's urine	48,66
<i>Plantago erosa</i> Wall	Plantaginaceae	Chhakur-blang	Lv	Poultice of the leaves is given	80
<i>Platanthera susannae</i> Lindl	Orchidaceae	Nela site huvu	Rt	In combination with lime and salt, the paste of root tubers is applied on the affected area	81
<i>Pouzolzia indica</i> Gaud	Urticaceae	Dudhmor	Wp	Unknown	53
<i>Prosopis cineraria</i> Druce	Fabaceae	Khejdi, Vanni maram	Br	Paste of bark tied on the affected area	71
<i>Quercus leucotrichophora</i> A Camus	Fagaceae	Banj	Sd	Unknown	41
<i>Randia dumetorum</i> (Retz) Poiret Linn	Rubiaceae	Kaare	Rt	Paste with water The root of this plant and leaves of <i>Acacia suma</i> (Mimosaceae) are pounded with salt and applied externally	81
<i>Rauwolfia serpentina</i> (Linn) Benth ex Kurz	Apocynaceae	Nagbel, Bhuin karuan, Patal-garuda, Bhuikurma, Sarpagandha, Keramaddinagaddi, Sutranabhi, Sarpagandha lairusich, Sarpagandha Nagamalli	Lv, Rt	Leave juice used as antidote Roots and leaf buds crushed with milk to make into paste used both internally and externally on affected area	34,39,43,62,76,99
<i>Rhinacanthus nasutus</i> (L) Kurz	Acanthaceae		Lv	Fresh leaves are taken orally, as well as the paste of the leaf applied externally	49,61
<i>Rivea hypocrateriformis</i> (Desr) Choisy	Convolvulaceae	Parh	Wp, Rt	The plant juice/paste is orally taken	95,96
<i>Rubus niveus</i> Thunb	Rosaceae	–	Fr	Unknown	79
<i>Ruta graveolense</i> Linn	Rutaceae	Nagadali	Rt	Root paste is used	99
<i>Sanseveria roxburgiana</i> Schultes F	Agavaceae	Saganaara, Gaju kura	Rt	Tuberous root paste is applied on the area of snakebite	97
<i>Saraca asoca</i> (Roxb) De Wilde	Cesalpiniaceae	Ashok, Asoka	Sd	Unknown	40
<i>Sauromatum venosum</i> (Ait) Kunth	Araceae	Halida, Samp ki dawa	Tb	The paste of tuber is applied on the affected area	33,84
<i>Saussurea costus</i> (Falc) Lipsch	Asteraceae	Kuth	Rt	Unknown	41
<i>Sesamum indicum</i> Linn	Pedaliaceae	Til	Sd	Seeds are mixed with butter, ginger powder, and oil and given orally	54
<i>Sida acuta</i> Burm	Malvaceae	–	Wp	The whole plant extract is given internally and applied externally	3

– Table 1 (Continued)

Biological source	Family	Local names	Part used	Method of administration	References
<i>Sida caprinifolia</i> Linn	Malvaceae	Ariavaal mania poondu	Lv	Leaf paste is used	90
<i>Sida cordifolia</i> Linn	Malvaceae	Kungyi	Wp	Unknown	82
<i>Solanum nigrum</i> Linn	Solanaceae	Makoi	Rt	Paste of dried root is applied	54
<i>Solanum xanthocarpum</i> Schard & Wendl	Solanaceae	Bhui ringani, Bhat kataiyan, Choti kateli	Lv, Rt	Fresh leaf extract (paste or decoction) of this species is given	101
<i>Soymida febrifuga</i> A Juss	Meliaceae	Rohina	St, Br, Br, Rt	Fresh bark of this plant together with root of <i>Holarrhena pubescens</i> (1:1) are made into paste and mixed with drinking water given orally three times a day for 3 d	31
<i>Sterculia urens</i> Roxb	Sterculiaceae	Karaya	Br	Unknown	60
<i>Strychnos nux-vomica</i> Linn	Loganiaceae	Kajara, Kaasarka, Kanjiram, Vishamushti, Etti, Visakkotai, Yeti	Rt, Sd	Root bark juice in cow's milk is externally rubbed 3–4 times a day to treat The seed powder is also used	89
<i>Strychnos potatorum</i> Linn	Leguminoceae	Thethamkottai	Sd	Seed powder given orally	49
<i>Tabernaemontana coronaria</i> RBr	Apocynaceae	Nandibattalu huvu	Rt	The crushed root mixed with salt and turmeric is applied	81
<i>Tabernaemontana divaricata</i> (Linn) RBr	Apocynaceae	Nanjatte, Maddarasa, Kathona, Amli, Tengtere, Tetul	Rt, Lv Sd	The extract of the seed is given, as well as crushed paste applied on bitten area	80
<i>Tamarindus indica</i> Linn	Caesalpiniaceae	Puli	Sd, Rt	Unknown	51,55
<i>Tectona grandis</i> Linn	Verbenaceae	Sagwan	Lv, Br	Unknown	44
<i>Terminalia arjuna</i> (DC) Wight & Arn	Combretaceae	Arjun, Marutham, Vellamarthu	Br	Bark paste applied externally (5 d)	45
<i>Thottea siliquosa</i> (Lamk) Ding Hou	Aristolochiaceae	Kuttalvayana, Padamchurukkial- pam, Kuttalvayana	Rt, Lv	Roots and leaves decoction are given orally	66,89
<i>Tiliacora acuminata</i> (Lamk) Miers	Menispermaceae	Kappa teega	Lv	Leaf paste is applied on the affected area	31
<i>Trewia nudiflora</i> Linn	Euphorbiaceae	Panigambhar	Br	Pounded bark is taken internally	88
<i>Trichisanthes cucumerina</i> Linn	Cucurbitaceae	Nagfani beldi	Tb	Powder of tuber is applied locally	84
<i>Tridax procumbens</i> Linn	Asteraceae	Munya arxa, Dagad Ful	Lv	The leaves are crushed and the juice is dripped on the wound of snakebite Juice is taken orally after its dilution with some quantity of water	62,76
<i>Tylophora indica</i> (Burm f) Merr	Asclepiadaceae	Nangilai, Asthamakodi	Lv, Rt	Paste of leaf and root is mixed with equal amount of root paste of <i>Rauvolfia serpentina</i> and applied externally on the spot, as well as leaf juice alone taken internally	31,63,65
<i>Urginea indica</i> (Roxb) Kunth	Liliaceae	Koliknada	Cm	Half of the corm is ground with some quantity of black pepper seeds & animal fat (pure ghee) and given in three doses within a day	35

– Table 1 (Continued)

Biological source	Family	Local names	Part used	Method of administration	References
<i>Ventilago maderaspatana</i> Gaertn	Rhamnaceae	Rakta pichula	Br	The infusion of bark is given orally	43
<i>Vitex negundo</i> Linn	Verbenaceae	Nukki, Lakkigida, Karinochi notchi, Nishindi, Shet nishinda	Br, Rt, Lv, Sd	Leaf paste applied over the bitten area (5 d), as well as root extract is given with warm water	81
<i>Vitex penduncularis</i> Wall	Verbenaceae	Charaigorh	Br	Decoction of the bark is given orally at 30 min intervals	62,88
<i>Zingiber rubens</i> Roxb	Zingiberaceae	Pauphok	Lv	The leaves are torn into thin strips and rope is made that is used to tie up parts of snakebite to prevent flow of venom in blood	45

Abbreviations used – Ap, arial portion; Bb, bulb; Bd, bud; Br, bark; Cm, corm; Fl, flower; Fr, fruit; Gr, grain; Gu, gum; Lv, leaves; Lx, latex; Pd, pods; Pl, poultice; Pn, penduncle; Re, resin; Rt, root; Rz, rhizomes; Sd, seeds; Sh, shoot; St, stem; Tb, tuber; Tn, tendril; Un, unknown; Wp, whole plant; d, day(s); h, hour(s).



**Fig. 1 – Big Four Russell's viper (*Daboia russelii*, Marathi – ghonas, tawarya), Indian cobra (*Naja naja*, Marathi – Nag), saw-scaled viper (*Echis carinatus*, Marathi – phoorsa), and the common krait (*Bungarus caeruleus*, Marathi – manyar, kanadar). Images reprinted with permission from indiansnakes.org.**

is expensive. Strict and specific conditions are required for long-term storage.<sup>10</sup> Because of the lack of availability of antidotes and anti-venoms at any specific time, alternatives from plant sources (which are abundant) should be developed. Adequate information about herbal preparations or formulations is needed. The Indian system of medicine, especially Ayurveda medicine, has thrown light on this subject. A variety of plants mentioned in Ayurvedic literature are useful in snakebite treatment.<sup>20</sup> Considering that treatment at a proper clinic or

hospital is at an unreachable distance for approximately 80% of victims, these people are primarily treated or handled by a traditional practitioner, or Vaidya, or other tribal herbalist. If the situation is beyond their control, they must proceed to a nearby clinic or hospital for advanced therapy.<sup>8</sup> The traditional practitioners rely on various plants for treatment because they are knowledgeable about a variety of plant species that are helpful against snakebites and associated complications.<sup>3,21</sup> In the management of snakebites, there are two main aspects:



1. Proper first aid treatment and
2. Anti-venom/anti-ophidian treatment, such as serum therapy

Because of side effects or adverse events (e.g., anaphylactic reactions), serum sickness and sometimes the anti-venom itself produces complications during treatment.<sup>22</sup>

## 5. Diversity of India

World Health Organization (WHO) stated that almost 80% of the population in developing countries depend on various herbal plants for the management of diverse diseases and illnesses because of the lack of modern health care services.<sup>3,23</sup> In addition, for prime health care, people are dependent on their earnings and improvement of the standard of living. More than 65,000 plant species are traditionally used in addition to modern medicines.<sup>24</sup> In India, Ayurveda is the most widely practiced system of medicine, which has a marvelous diversity of plant information. The Republic of India has 29 states and seven union territories comprising an area of 3,287,263 km<sup>2</sup>. The Indian people speak a variety of languages, including 23 regional languages: Assamese, Bengali, Bodo, Dogri, Gujrathi, Kannada, Kashiri, Kokborok, Konkani, Maithili, Malayalam, Manipuri, Marathi, Mizo, Nepali, Odia, Punjabi, Sanskrit, Santali, Sindhi, Tamil, Telugu, and Urdu. Apart from these, other local or tribal people have their own tribal or native language per locality. India encompasses different ethnic groups with over 539 core indigenous people living in diverse territories. It has varied cultures, foods, traditions, and religious rituals, which causes separations among the people. Furthermore, there is a wealth of knowledge of conventional medicine, particularly herbal and folk medicine, for treatment of snakebites.

## 6. Clinical significance of snakebite

Traditional herbalists treat people earlier and use plants to cure various complications and ailments.<sup>3</sup> The snake is still not perfectly understood to worldwide researchers. The word 'snake' invokes feelings of fear because of an instinctive human emotion and its image is powerful and primal. Snakes are as fascinating to psychologists, pharmacologists, and clinicians as they are to evolutionists. Snakes are either poisonous or nonpoisonous. Snakebites can be considered as environmental or occupational hazard because they occur regularly and repeatedly, with overwhelming frequency, particularly in remote rural areas in tropical developing nations. It is estimated that each year in India there are more than 80,000 snake envenoming and 11,000 deaths, which makes India a seriously affected nation. Snakes are present on each continent, except Antarctica.<sup>9</sup> Mishal et al listed some critical and medically significant (clinical) conditions and syndromes related to snakebite envenomation<sup>14</sup> as follows:

1. Local or restricted area envenoming (swelling of the affected part) with hemorrhage or difficulty clotting (this is particularly seen in Viperidae envenomation).

2. Local or restricted area envenoming (viz. swelling) with hemorrhage or difficulty clotting damages the kidneys or contributes to infections that cause neuro-paralysis and shock.
3. Local or restricted area envenoming (such as swelling) along with paralysis.
4. Paralysis with/without local or restricted area envenoming.
5. Paralysis with urine that is dark brown in color in addition to acute kidney injury.

## 7. Composition of snake venom

Medical science occasionally ignores community health values. Snake venom is rich in protein and peptide toxins. These proteins have a definite action on numerous tissue receptors. The wide range of action of snake venoms makes them clinically demanding and scientifically interesting, in particular, for drug design.<sup>25</sup> The mysterious biological nature of venom and its complex medical effects have long captured human imagination and inquisitiveness. Venoms, mainly snake venoms, have been the focus of ancient mythology, early biomedical speculation, folklore, and scientific investigation, in addition to pharmacognosy.<sup>24</sup> The venom of any species may have more than 100 diverse toxic and non-toxic proteins and peptides, along with non-protein toxins (amines, carbohydrates, lipids, and additional small molecules).<sup>25</sup> Proteins and peptides comprise approximately 90 ± 05% of the dry weight of venom. Supplementary components in the venom consist of carbohydrates, metallic cations, nucleosides, biogenic amines, and a small amount of free amino acids and lipids. The venom of snakes contains at least 25 enzymes, although no single snake venom has all of them. Enzymes are responsible for catalyzing numerous precise biochemical reactions that occur in living matter. They are the mediators upon which cellular metabolism depend. Among the available choices, the more important snake venom enzymes are as follows: 5'-nucleotidase, acetylcholinesterase, arginine ester hydrolase, collagenase, DNase, hyaluronidase, lactate dehydrogenase, L-amino acid oxidase, NAD nucleosidase, phosphodiesterase, phospholipase A<sub>2</sub> (A), phospholipase B, phospholipase C, phosphomonoesterase, proteolytic enzymes, RNase, and thrombin-like enzymes. All these enzymes are not present in all venoms. Among the peptides originating in snake venoms are pre-synaptic and postsynaptic neurotoxins, myotoxins, cytotoxins, cardiotoxins, and potassium channel-binding neurotoxins, along with platelet aggregation inhibitors (disinterring).<sup>3,26,27</sup>

## 8. Snakebite treatment in India

Because India is the only country of its kind in terms of the diversity of geographical, environmental, and climatic features, it has a rich and wide-ranging flora of medicinal herbal plants that have been used since the Vedic period. A huge portion of the nation still uses plants as home remedies in rural and remote areas for a number of illness, infections, and diseases, including snakebites. India is a nation with mega diversity; moreover, approximately 10% of world's species are

indigenous to India. Because India has a prosperous, flourishing, enlightening legacy, almost all Indians have directly and indirectly been connected with a variety of herbs during their ritualistic ceremonies and various cultural activities. A recent study found that rich ethno-medicinal knowledge could be gathered from the community members, which would provide a great advantage to future generations by documenting and preserving the knowledge. This requires that the ethno-medicinal plants used by the native tribal people should be comprehensively revised and the proper significance of these plant species assigned, such that they can be managed and conserved for the welfare of mankind.<sup>3</sup> Reliable progress has been made in that direction. Snakebite treatment in India (before partition) consisted of various snake antivenom drugs and/or combination formulations, such as Surucuina (1908), Ofidina (1909), Viborina (1910), an unknown plant used by the Civil Surgeon of Hugli (1912), an ointment made by Mr M Robert of Bordeaux (1914), Goor Boinchee Antitoxicum (1915), Tiriyaq (1916, repeated in 1929), white champa pod and root (1920), Payam-i-Hayat (February 14, 1921), El Elixir Antiviperino Lexin (1923), remedy by firozuddin (June 1928), and lobelin (1929) that have been tested since 1908 in various pharmacological labs across India, then British India and the Indian subcontinent.<sup>28</sup> The severity of snakebite poisoning is always a catastrophic issue for the sufferer and physician. Usually death will result because of many reasons, such as failure of the patient to reach the hospital, lack of appropriate treatment, difficulty in production, deployment, and accessibility of current snake anti-venoms. The mortality rate depends largely on the species of snake. Elapid poisoning (viz. cobra and krait) always has a higher mortality rate than that of Viperidae poisoning (saw-scaled viper and Russell's viper). The point to be considered is that an approximately 70-kg healthy person will succumb to only a small quantity of venom, and typically it takes the venom 6 seconds or less to reach the heart.<sup>14</sup> In various ancient texts and literature, more than 320 medicinal plants and more than 180 different combinations are reported to have snake anti-venom activity. However, after comprehensive evaluation, all of these Ayurvedic preparations from medicinal plants had no snake anti-venom properties.<sup>28</sup>

## 9. Vaidya – Indian herbalist, physician, compounder and dispenser

In the Indian system of medicine, the Vaidya is known as doctor of herbs, who makes a diagnosis of illness and compounds medicinal preparations, such as asava, aristha, churna (powders), lotions, liniments, pills, syrup, and taila. Furthermore, many old-aged persons (such as a grandmother) are familiar with the application of various herbs. Practitioners of Ayurveda believe that every plant on the Earth has some significant medicinal property for the purpose of the good of the world; the right person just has to show you. The practitioner of Ayurveda states नास्तीमुलंअनौषधीम (Naasti Moolam Anaushadhim translation Every plant on earth has a medicinal property). Allopathy (the treatment of disease by conventional means, that is, with drugs having effects opposite to the symptoms) or modern medicinal systems sometimes has a number of undesired effects from drugs, such as adverse drugs



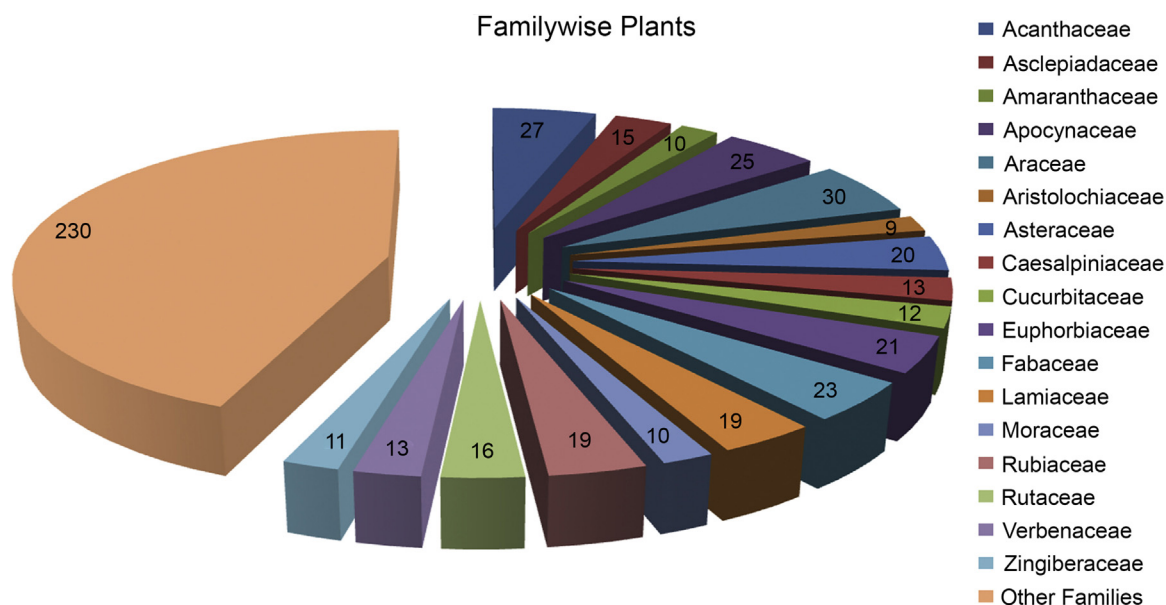
**Fig. 2 – Paata Varvanta, the traditional Indian mortar pestle (Google).**

reactions. Therefore, an increasing number of people in developed and developing countries are using medicinal plants for some betterment.<sup>3</sup> The formulations or plant preparations rely on the availability of the plant part(s). Usually preparation is made by crushing the plant or its part(s) by using stones or pieces of wood. Often a juice or paste is made to apply to the affected area or sometimes is given orally. A number of villagers or Vaidya have a specific stone set called a “Paata-Varvanta” (Fig. 2). The Paata is a Marathi language word meaning base on which the plant or its part(s) are kept. The Varvanta is a Marathi language word meaning a pastel-like stone to crush the plants or its part(s). The present review is an attempt to cover the traditional/ethnobotanical medicinal plants utilized in various parts of India for snakebites. Apart from previous reviews, this will also help future researchers to recognize the herbal approach for the treatment of snakebites. In Table 1, the data from the current analysis is presented. Arrangement of medicinal plant species is in alphabetical order.

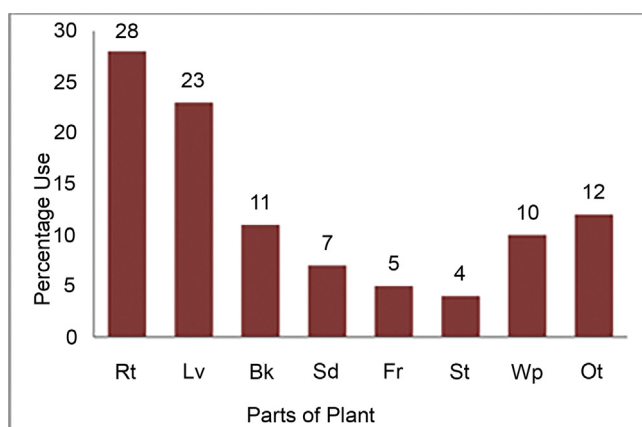
## 10. Conclusion

Mother Nature has given humans a most precious gift in medicinal plants. The natives of India are people who are very connected to Nature, as Indians are “celebration affectionate” people. In almost every festival in India, there is connectivity of human beings to animals and Mother Nature. The local tribes understand biodiversity and serve as a source of knowledge regarding proper use of medicinal plants. For various reasons, the focus altered from modern medicine to Ayurveda herbs and medicinal plants for various diseases or disorders. India is homeland for such a marvelous variety of diversity. In cultural heritage, India has a long history





**Fig. 3 – Graphical representation showing number of plant according to various families (Upasani et al, 2017).**



**Fig. 4 – Plant parts used in treatment of Snake bite. (Upasani et al, 2017) (Rt, root; Lv, leaves; Bk, bark; Sd, seed; Fr, fruit; St, stem; Wp, whole plant; Ot, other parts).**

of medicinal plant utilization. This review has attempted to cover remarkable similarities among medicinal plants that are used across India. In our study, a total of 523 plant species belonging to 122 families were reported for treatment of snakebites. Furthermore, this review encompasses some plants that are rarely or less often used. The most common families include Acanthaceae, Apocynaceae, Araceae, Asteraceae, Caesalpiniaceae, Cucurbitaceae, Euphorbiaceae, Fabaceae, Lamiaceae, Rubiaceae, and Zingiberaceae (Fig. 3). For a long time, the traditional healers have practiced using herbal traditional medications for snakebite treatment, as well as numerous other diseases. Biological source(s), family, local name(s), part(s) used (Fig. 4), method of preparation, and reference(s) are provided to increase the ease of availability for the data.

There is a lot of information yet to be gathered and formulated. Ethno-botanical investigation is the future branch that

will aid in maintaining good health for all mankind because much is still hidden and there are chances to make new phytochemical phytopharmacological drug discoveries, which will become the most reliable progression in the direction of utilization of medicinal plants for the treatment of various illnesses.

#### Conflict of interest statement

The authors declare no conflict of interest.

#### Sources of funding

Nil.

#### Acknowledgments

The authors are thankful to all relevant personnel from R C Patel Institute of Pharmaceutical Education and Research Shirpur, as well as R C Patel Institute of Pharmacy Shirpur for their help, encouragement, and occasional suggestions. The authors are very thankful to Jose Louies, Member – IUCN Viper Specialist Group and Founder of indiansnakes.org <<http://indiansnakes.org/>> & snakebiteinitiative.in <<http://snakebiteinitiative.in/>> and his team for providing high resolution images of Big four snakes.

#### REFERENCES

- Nasab FK, Khosravi AR. Ethnobotanical study of medicinal plants of Sirjan in Kerman Province Iran. *J Ethnopharmacol* 2014;154:190-7.
- Ody P. *The complex medicinal herbal*. New York: Dorling Kindersley Limited; 1993.

3. Upasani SV, Beldar VG, Upasani MS, Tatiya AU, Surana SJ, Patil DJ. Ethnomedicinal plants used for snakebite in India: a brief overview. *Integr Med Res* 2017;6:114–30, <http://dx.doi.org/10.1016/j.imr.2017.03.001>.
4. Ministry of Home Affairs Government of India official website [http://mhanicin/sites/upload\\_files/mha/files/bmintro-1011.pdf](http://mhanicin/sites/upload_files/mha/files/bmintro-1011.pdf). Published March 23, 2017. Updated March 23, 2017. Accessed March 23, 2017.
5. Kasturiratne A, Wickremasinghe AR, de Silva N, Gunawardena K, Pathmeswaran A, Premaratna R. The global burden of snakebite: a literature analysis and modelling based on regional estimates of envenoming and deaths. *PLoS Med* 2008;5:e218.
6. Gutiérrez JM, Theakston RDG, Warrell DA. Confronting the neglected problem of snake bite envenoming: the need for a global partnership. *PLoS Med* 2008;3:e150.
7. Gutiérrez JM, Williams D, Fan HW. Snakebite envenoming from a global perspective: towards an integrated approach. *Toxicon* 2008;56:1223–35.
8. Chippaux JP. Snake-bites: appraisal of the global situation. *Bull World Health Organ* 1998;76:515.
9. Bawaskar HS. Snake venoms and antivenoms: critical supply issues. *J Assoc Phys India* 2008;52:11–3.
10. Meenatchisundaram S, Parameswari G, Subbaraj T, Michael A. Anti-venom activity of medicinal plants – a mini review. *Ethnobotan Leaf* 2008;12:1218–20.
11. Indian snakes on indiansnakes.org website (accessed 28.12.2015). Published March 23, 2017. Updated March 23, 2017. Accessed March 23, 2017.
12. Simpson ID, Norris RL. Snakes of medical importance in India: is the concept of the “Big 4” still relevant and useful? *Wilderness Environ Med* 2007;18:2–9.
13. Young BA, Cynthia EL, Kylie MD. Do snakes meter venom? *BioScience* 2002;12:1121–6.
14. Mishal HB, Mishal RH, Saudagar RB. Focus on the various corridors of snake bite envenomation treatment – a review. *Int J Curr Res Life Sci* 2015;4:492–8.
15. David AW. *Guidelines for the clinical management of snakebite in the south East Asia region*. New Delhi: WHO Regional Office for South East Asia; 2005.
16. Zelanis A, Tashima AK. Unraveling snake venom complexity with ‘omics’ approaches: challenges and perspectives. *Toxicon* 2005;87:131–4.
17. Markland FS. Snake venoms and the hemostatic system. *Toxicon* 1998;36:1749–800.
18. Elbey B, Baykal B, Yazgan UC. The prognostic value of the neutrophil/lymphocyte ratio in patients with snake bites for clinical outcomes and complications. *Saudi J Biol Sci* 2017;24:362–6.
19. Aird SD. Ophidian envenomation strategies and the role of purines. *Toxicon* 2002;40:335–93.
20. Kanojia A, Chaudhari KS, Gothecha VK. Medicinal plants active against snake envenomation. *IJRAP* 2012;3:363–6.
21. Mors WB, DoNascimento MC, Pereira BMR, Pereira NA. Plant natural products active against snake bite – the molecular approach. *Phytochemistry* 2000;55:627–42.
22. Lakshmi V, Lakshmi T. Antivenom activity of traditional herbal drugs: an update. *Int Res J Pharm* 2000;4:1–3.
23. Calixto JB. Twenty-five years of research on medicinal plants in Latin America: a personal review. *J Ethnopharmacol* 2005;100:131–4.
24. Polat R, Satil F. An ethnobotanical survey of medicinal plants in Edremit Gulf (Balıkesir – Turkey). *J Ethnopharmacol* 2012;139:626–41.
25. Warrell DA. Snake bite. *Lancet* 2010;375:77–88.
26. Stocker K. Composition of snake venoms. In: Stocker KF, editor. *Medical use of snake venom proteins*. Boca Raton: CRC Press; 1990:33–56.
27. Niewiarowski S, McLane MA, Kloczewiak M. Disintegrins and other naturally occurring antagonists of platelet brinogen receptors. *Sem Hematol* 1994;31:289–300.
28. Mhaskar KS, Caius JF. *Indian Med Res Memoirs* 1931:1–96.
29. Guleria V, Vasishth A. Ethnobotanical uses of wild medicinal plants by Guddi and Gujjar Tribes of Himachal Pradesh. *Ethnobotan Leaf* 2009;13:1158–67.
30. Alagesaboopathi C. Ethnomedicinal plants used as medicine by the Kurumba Tribals in Pennagaram Region Dharmapuri District of Tamil Nadu India. *Asian J Exp Biol Sci* 2011;2:140–2.
31. Krishna NR, Varma YN, Saidulu C. Ethnobotanical studies of Adilabad District Andhra Pradesh. *India J Pharmacognosy Phytochem* 2014;3:18–36.
32. Kadhivel K, Ramya S, Sathya Sudha TP, Ravi AV, Rajasekaran C, Selvi VR, et al. Ethnomedicinal survey on plants used by tribals in Chitteri Hills. *Environ We Int J Sci Technol* 2010;5:35–46.
33. Meena KL, Yadav BL. Studies on ethnomedicinal plants conserved by Garasia tribes of Sirohi district Rajasthan India. *Indian J Nat Prod Res* 2010;1:500–6.
34. Panda T, Padhy RN. Ethnomedicinal plants used by tribes of Kalahandi district Orissa. *Indian J Tradit Knowl* 2008;7:242–9.
35. Anis M, Sharma MP, Iqbal M. Herbal ethnomedicine of the Gwalior forest division in Madhya Pradesh. *India Pharm Biol* 2000;38:241–53.
36. Mallik BK, Panda T, Padhy RN. Ethnoveterinary practices of aborigine tribes in Odisha India. *Asian Pacific J Trop Biomed* 2012;2:S1520–5.
37. Samar R, Shrivastava PN, Jain M. Ethnobotanical study of traditional medicinal plants used by tribe of Guna District Madhya Pradesh India. *Int J Curr Microbiol Appl Sci* 2015;4:466–71.
38. Panghal M, Arya V, Yadav S, Kumar S, Yadav JP. Indigenous knowledge of medicinal plants used by Saperas community of Khetawas Jhajjar District Haryana India. *J Ethnobiol Ethnomed* 2010;6:1–11.
39. Singh PK, Kumar V, Tiwari RK, Sharma A, Rao CV, Singh RH. Medico-ethnobotany of ‘chatara’ block of district sonebhadra Uttar Pradesh India. *Adv Biol Res* 2010;4:65–80.
40. Shiddamallayya N, Yasmeen A, Gopakumar K. Hundred common forest medicinal plants of Karnataka in primary healthcare. *Indian J Tradit Knowl* 2010;9:90–5.
41. Phondani PC, Maikhuri RK, Kala CP. Ethnoveterinary uses of medicinal plants among traditional herbal healers in Alaknanda catchment of Uttarakhand India. *Afr J Tradit Complement Altern Med* 2010;7:195–206.
42. Pradhan BK, Badola HK. Ethnomedicinal plant use by Lepcha tribe of Dzongu valley bordering Khangchendzonga Biosphere Reserve in north Sikkim India. *J Ethnobiol Ethnomed* 2008;4:1–18.
43. Rout SD, Panda T, Mishra N. Ethno-medicinal plants used to cure different diseases by tribals of Mayurbhanj district of North Orissa. *Ethno-med* 2009;3:27–32.
44. Harney NV. Ethnomedicinal plants diversity of Bhadravati Tahsil of Chandrapur District Maharashtra India. *Int J Sci Res Publ* 2013;3:1–6.
45. Choudhury S, Sharma P, Choudhury MD, Sharma GD. Ethnomedicinal plants used by Chorei tribes of Southern Assam North Eastern India. *Asian Pacific J Trop Dis* 2012;2:141–7.
46. Hazarika R, Abujam SS, Neog B. Ethno medicinal studies of common plants of Assam and Manipur. *Int J Pharm Biol Arch* 2012;3:809–15.
47. Choudhury PR, Choudhury MD, Ningthoujam SS, Das D, Nath D, Das TA. Ethnomedicinal plants used by traditional healers of North Tripura district Tripura North East India. *J Ethnopharmacol* 2015;166:135–48.

48. Udayan PS, George S, Tushar KV, Bhalchandran I. Medicinal plants used by the Kaadar tribes of Sholayar forest Thrissur district Kerala. *Indian J Tradit Knowl* 2005;4:159–63.
49. Karuppusamy S. Medicinal plants used by Paliyan tribes of Sirumalai hills of southern India. *Nat Prod Rad* 2007;6:436–42.
50. Bhatia H, Sharma YP, Manhas RK, Kumar K. Ethnomedicinal plants used by the villagers of district Udhampur J&K India. *J Ethnopharmacol* 2014;151:1005–18.
51. Das AK, Dutta BK, Sharma GD. Medicinal plants used by different tribes of Cachar district Assam. *Indian J Tradit Knowl* 2008;7:446–54.
52. Swapna MM, Prakashkumar R, Anoop KP, Manju CN, Rajith NP. A review on the medicinal and edible aspects of aquatic and wetland plants of India. *J Med Plants Res* 2011;5:7163–76.
53. Sikdar M, Dutta U. Traditional phytotherapy among the Nath people of Assam. *Ethno Med* 2008;2:39–45.
54. Upadhyay B, Dhaker AK, Kumar A. Ethnomedicinal and ethnopharmacological studies of Eastern Rajasthan India. *J Ethnopharmacol* 2010;129:64–86.
55. Rameshkumar S, Ramakritinan CM. Floristic survey of traditional herbal medicinal plants for treatments of various diseases from coastal diversity in Pudhukkottai District Tamilnadu India. *J Coastal Life Med* 2013;1:225–32.
56. Sharma P, Rana JC. Assessment of ethnomedicinal plants in Shivalik Hills of Northwest Himalaya India. *Am J Ethnomed* 2014;1:186–205.
57. Rao DM, Rao UV, Sudharshanam G. Ethno-medico-botanical studies from Rayalaseema region of southern Eastern Ghats Andhra Pradesh India. *Ethnobotan Leaf* 2006;1:198–207.
58. Basak S, Sarma GC, Rangan L. Ethnomedicinal uses of Zingiberaceous plants of Northeast India. *J Ethnopharmacol* 2010;132:286–96.
59. Maheshwari JK, Kalakoti BS, Lal B. Ethnomedicine of Bhil tribe of Jhabua District MP. *Anc Sci Life* 1986;5:255–61.
60. Jain A, Katewa SS, Galav PK, Sharma P. Medicinal plant diversity of Sitamata wildlife sanctuary Rajasthan India. *J Ethnopharmacol* 2005;102:143–57.
61. Kottaimuthu R. Ethnobotany of the Valaiyans of Karandamalai Dindigul District Tamil Nadu India. *Ethnobotan Leaf* 2008;12:195–203.
62. Marandi RR, Britto SJ. Ethnomedicinal plants used by the Oraon Tribals of Latehar District of Jharkhand India. *Asian J Pharm Res* 2014;4:126–33.
63. Ignacimuthu S, Ayyanar M. Ethnobotanical investigations among tribes in Madurai district of Tamil Nadu (India). *J Ethnobiol Ethnomed* 2006;2:1–7.
64. Rajendran SM, Sekar KC, Sundaresan V. Ethnomedicinal lore of Valaya tribals in Seithur Hills of Virudunagar district Tamil Nadu India. *Indian J Tradit Knowl* 2002;1:59–71.
65. Ignacimuthu S, Ayyanar M, Sivaraman SK. Ethnobotanical investigations among tribes in Madurai District of Tamil Nadu (India). *J Ethnobiol Ethnomed* 2006;2:56–63.
66. Yesodharan K, Sujana KA. Ethnomedicinal knowledge among Malamalasar tribe of Parambikulam wildlife sanctuary Kerala. *Indian J Tradit Knowl* 2007;6:481–5.
67. Vijendra N, Kumar KP. Traditional knowledge on ethno-medicinal uses prevailing in tribal pockets of Chhindwara and Betul Districts Madhya Pradesh India. *Afr J Pharm Pharmacol* 2010;4:662–70.
68. Ganesan S, Pandi NR, Banumathy N. Ethnomedicinal survey of Alagarkoil Hills (Reserved forest) Tamil Nadu India. *ej Indian Med* 2008;1:1–18.
69. Udayan PS, George S, Tushar KV, Bhalchandran I. Medicinal plants used by the Malayali tribe of Servarayan Hills Yercaud Salem District Tamil Nadu India. *Zoos' Print J* 2006;21:2223–4.
70. Beverly CD, Sudarsanam G. Ethnomedicinal plant knowledge and practice of people of Javadhu hills in Tamilnadu. *Asian Pacific J Trop Biomed* 2011;1:79–81.
71. Bosco FG, Arumugam R. Ethnobotany of irular tribes in redhills tamilnadu India. *Asian Pacific J Trop Dis* 2012;2:S874–7.
72. Ganesan S, Suresh N, Kesaven L. Ethnomedicinal survey of lower Palni Hills of Tamilnadu. *Indian J Tradit Knowl* 2004;3:299–304.
73. Revathi P, Parimelazhagan T. Traditional knowledge on medicinal plants used by the Irula tribe of Hasanur Hills Erode District Tamil Nadu India. *Ethnobotan Leaf* 2010;14:136–60.
74. Pattanaik C, Sudhakar Reddy C. Medicinal plant wealth of local communities in Kuldiha Wildlife Sanctuary Orissa India. *J Herbs Spices Med Plants* 2008;14:175–84.
75. Alagesabooopathi C. Ethnomedicinal plants and their utilization by villagers in Kumargiri hills of Salem district of Tamilnadu India. *Afr J Tradit Complement Altern Med* 2009;6:222–7.
76. Sravan PM, Venkateshwara RKN, Santhosha D, Chaitany RSNACK, David B. Medicinal plants used by the ethnic practitioners in Naldonda District Andhra Pradesh India. *Int J Res Ayurveda Pharm* 2010;1:493–6.
77. Dahare DK, Jain A. Ethnobotanical studies on plant resources of Tahsil Multai District Betul Madhya Pradesh India. *Ethnobotan Leaf* 2010;14:694–705.
78. Hazarika TK, Nautiyal BP. Studies on wild edible fruits of Mizoram India used as ethno-medicine. *Genet Resour Crop Evol* 2012;59:1767–76.
79. Bhat JA, Kumar M, Bussmann RW. Ecological status and traditional knowledge of medicinal plants in Kedarnath Wildlife Sanctuary of Garhwal Himalaya. *India J Ethnobiol Ethnomed* 2013;9:1–18.
80. Singh B, Borthakur SK, Phukan SJ. A Survey of ethnomedicinal plants utilized by the indigenous people of Garo Hills with special reference to the Nokrek Biosphere Reserve (Meghalaya) India. *J Herbs Spices Med Plants* 2014;20:1–30.
81. Lingaraju DP, Sudarshana MS, Rajashekar N. Ethnopharmacological survey of traditional medicinal plants in tribal areas of Kodagu district Karnataka. *India J Pharm Res* 2013;6:284–97.
82. Jain SC, Jain R, Singh R. Ethnobotanical survey of Sariska and Siliserh regions from Alwar district of Rajasthan India. *Ethnobotan Leaf* 2009;13:171–88.
83. Kumar M, Paul Y, Anand VK. An ethnobotanical study of medicinal plants used by the locals in Kishtwar Jammu and Kashmir India. *Ethnobotan Leaf* 2009;13:1240–60.
84. Swarnkar S, Katewa SS. Ethnobotanical observation on tuberous plants from tribal area of Rajasthan (India). *Ethnobotan Leaf* 2008;12:647–66.
85. Katewa SS, Chaudhary BL, Jain A. Folk herbal medicines from tribal area of Rajasthan. *India J Ethnopharmacol* 2004;92:41–6.
86. Vanila D, Ganthikumar S, Manickam VS. Ethnomedicinal uses of plants in the plains area of the Tirunelveli-District Tamilnadu India. *Ethnobotan Leaf* 2008;12:1198–205.
87. Kumar K, Murthy AR, Upadhyay OP. Plants used as antidotes by the tribals of Bihar. *Anc Sci Life* 1998;17:268–72.
88. Chandra K, Paney BN, Lal VK. Folk-lore medicinal plants of Dumka (Bihar). *Anc Sci Life* 1985;4:181–5.
89. Vanam A. Traditional remedies of Kani tribes of Kottoor reserve forest Agasthyavanam Thiruvananthapuram Kerala. *Indian J Tradit Knowl* 2007;6:589–94.
90. Vijayakumar S, Yabesh JM, Prabhu S, Manikandan R, Muralidharan B. Quantitative ethnomedicinal study of

- plants used in the Nelliampathy hills of Kerala India. *J Ethnopharmacol* 2015;161:238–54.
91. Shanmugam S, Rajendran K, Suresh K. Traditional uses of medicinal plants among the rural people in Sivagangai district of Tamilnadu Southern India. *Asian Pacific J Trop Biomed* 2012;2:S429–34.
  92. Dey A, De JN. Traditional use of plants against snakebite in Indian subcontinent: a review of the recent literature. *Afr J Tradit Complement Altern Med* 2012;9:153–74.
  93. Chakraborty MK, Bhattacharjee A. Some common ethnomedicinal uses of various diseases in Purulia district West Bengal. *Indian J Tradit Knowl* 2006;5:554–8.
  94. Ghosh A. Ethnomedicinal plants used in West Rarrh region of West Bengal. *Nat Prod Rad* 2008;7:461–5.
  95. Suthari S, Kanneboyena O, Raju VS. Ethnomedicinal knowledge of inhabitants from Gundlabrahmeswaram Wildlife Sanctuary (Eastern Ghats) Andhra Pradesh India. *Am J Ethnomed* 2015;2:333–46.
  96. Suthari S, Sreeramulu N, Omkar K, Raju V. The climbing plants of northern Telangana in India and their ethnomedicinal and economic uses. *Indian J Plant Sci* 2014;3:86–100.
  97. Reddy MB, Reddy KR, Reddy MN. A survey of medicinal plants of Chenchu tribes of Andhra Pradesh India. *Pharm Biol* 1988;26:189–96.
  98. Rajendran SM, Agarwal SC, Sundaresan V. Lesser known ethnomedicinal plants of the Ayyarkoail Forest Province of Southwestern Ghats Tamilnadu India—Part I. *J Herbs Spices Med Plants* 2004;10:103–12.
  99. Parinitha M, Harish GU, Vivek NC, Mahesh T, Shivanna MB. Ethno-botanical wealth of Bhadra wild life sanctuary in Karnataka. *Indian J Tradit Knowl* 2004;3:37–50.
  100. Prakasha HM, Krishnappa M. People's knowledge on medicinal plants in Sringeri taluk Karnataka. *Indian J Tradit Knowl* 2006;5:353–7.
  101. Koche DK, Shirsat RP, Imran S, Nafees M, Zingare AK, Donode KA. Ethnobotanical and ethnomedicinal survey of Nagzira Wildlife Sanctuary District Gondia (MS) India-Part I. *Ethnobotan Leaf* 2008;12:56–69.