Journal of Research in Health Sciences
ISSN: 2228-7809 | https://jrhsjournal.com

Traditional Ethnomedicinal Applications of Apocynaceae Roots Among Indigenous Indian Communities

Dr. Ricardo Sousa[1]*, Dr. Inês Carvalho[1], Dr. Tiago Mendes[2]
[1]Centro Hospitalar Universitário de Lisboa Central, Lisbon, Portugal
[2]University of Porto Faculty of Medicine, Porto, Portugal

Abstract

Apocynaceae is one of the largest angiosperm families with numerous medicinal plant species. Plants of the family Apocynaceae are rich in toxic and medicinal secondary metabolites such as alkaloids, triterpenoids, flavonoids, glycosides, phenols, steroids, lactones, sterols, and sugars lignans. Roots of family Apocynaceae are used by indigenous communities in different parts of India to treat many health problems. The present study aimed to review and analyze ethnomedicinal usage of raw root drugs of fourteen species of family Apocynaceae by India's indigenous communities. The available literature in scientific journals, edited books, floras, eFloras, online databases, scientific databases, etc., was reviewed to collect information on the ethnomedicinal uses of the roots of the selected fourteen species by various indigenous communities in different parts of India. Indigenous communities used raw roots of the studied species to manage various health problems, including animal bite, asthma, boils, burn injuries, cold, constipation, cough, diabetes, dysentery, epilepsy, fever, fits, gonorrhea, hypertension, insect bite, jaundice, leprosy, leucoderma, piles, rheumatism, scorpion sting, skin disease, snakebite, stomach-ache, and wound healing. The study revealed that there are many pharmacologically active compounds in the roots of these species, which are responsible for the related biological activities. The present review will provide baseline information for planning future research on the ethnobotany, natural products chemistry, and pharmacology of the studies root drugs of family Apocynaceae.

Keywords: Dogbane family, indigenous communities, traditional knowledge, root drugs, medicinal plants.

Introduction

Apocynaceae, commonly known as the Dogbane or poisonous plant family, is one of the largest angiosperm families with 375 genera and 5100 species (Endress et al., 2007). Plants of family Apocynaceae are herbs, shrubs, vines, succulents, and trees, mostly distributed in tropical and subtropical regions (Endress, 1997; Endress and Bruyns, 2000). Apocynaceae is known as a medicinally important family, with most plant species characterized by the production of milky exudates or latex (Nazar et al., 2013; Bhadane et al., 2018). Its species are rich in toxic and medicinal secondary metabolites such as alkaloids, triterpenoids, flavonoids, glycosides, phenols, steroids, lactones, and sterols (Hofling et al., 2010; Bhadane et al., 2018; Dey et al., 2017). Several indigenous communities in different regions of India use Apocynaceae plants for medicinal and non-medicinal purposes, such as food, fodder, timber, ornamental, perfume, dyes, poison, etc. (Islam and Lucky, 2019).

Plants of this family are a potential source of important compounds and novel drugs in treating various diseases (Devi et al., 2017). Different species of Apocynaceae have been reported to have many ethnomedicinal uses in different parts of India. Gairola et al. (2014) reported ethnomedicinal usage of eight species of Apocynaceae by indigenous communities of UT of Jammu & Kashmir and UT of Ladakh. Devi et al. (2017) reported about 25 species of Apocynaceae belonging to 16 genera with ethnomedicinal importance. Different plant parts of Apocynaceae, such as leaves, bark, latex, stem, root, and flowers, are used to treat various health ailments (Devi et al., 2017). Botanical, phytochemical, and pharmacological properties, including important biological activities, of some species of Apocynaceae have been reviewed by many researchers (Wong et al., 2013; Ekalu et al., 2019). However, a comprehensive review of the ethnomedicinal uses of family Apocynaceae plants' root drugs is not available. The present study aimed to review and analyze ethnomedicinal usage of root drugs of fourteen medicinally important species of family Apocynaceae by indigenous communities of India.

Methodology

Plant species of the Apocynaceae family are well known for their medicinal values, with various aerial and underground parts used to cure many health problems in different parts of India. A total of fourteen species of the family Apocynaceae were selected for the present study (Table 1). The species reviewed in the present study are distributed in tropical in subtropical regions throughout India (Khare, 2007). Roots of all the selected species are widely used in Indian traditional medicine systems and by India's indigenous communities. Information on the ethnomedicinal usage of the selected species' roots was reviewed. The available literature from various sources, including floras, eFloras, online databases, scientific databases, scientific journals, and edited books, was analyzed. The literature reviewed included accepted scientific names, synonyms, common or vernacular, ayurvedic, and trade names. Accepted scientific names and the synonyms were confirmed from theplantlist.org (TPL, 2013). Information on some major compounds found in these plants and their proven biological activities was also compiled (DNP, 2020). Accepted scientific names, plant subfamily, synonyms, local or trade names, and Ayurvedic names are provided in Table 1.

Table 1: Details of the studied species of family Apocynaceae reported from India.

S.No.	Botanical name	Subfamily	Synonyms (TPL, 2013)	Local/ Trade names
1.	*Asclepias curassavica* L.	Asclepiadoideae	*Asclepias cubensis* Wender., *Asclepias curassavica* var. *concolor* Krug & Urb., *Asclepias nivea* var. *curassavica* (L.) Kuntze	Curassavian Swallow-wort, Kaakanaasikaa, Kaakatundi
2.	*Calotropis gigantea* (L.) Dryand.	Asclepiadoideae	*Asclepias gigantea* L., *Calotropis gigantea* (L.) R. Br. ex Schult., *Madorius giganteus* (L.) Kuntze.	Madar, Giant Milk-weed, Erukkin veru, Aak

3.	*Calotropis procera* (Aiton) Dryand.	Asclepiadoideae	*Asclepias procera* Aiton, *Calotropis gigantea* var. *procera* (Aiton) P.T.Li, *Calotropis heterophylla* Wall. ex Wight.	Swallow-Wart, Milk Weed, King's Crown, Akada Phool
4.	*Carissa carandas* L.	Rauvolfioideae	*Arduina carandas* (L.) Baill., *Carissa salicina* Lam., *Capparis carandas* (L.) Burm.f.	Christ's Thorn, Bengal, Currant
5.	*Carissa spinarum* L.	Rauvolfioideae	*Carissa abyssinica* R. Br., *Carissa carandas* var. *congesta* (Wight) Bedd., *Carissa opaca* Stapf ex Haines	Jangali Karondaa, Garnaa
6.	*Catharanthus roseus* (L.) G. Don.	Rauvolfioideae	*Catharanthus roseus* var. *albus* G. Don, *Lachnea rosea* (L.) Rchb., *Vinca rosea* L.	Sadaabahaar, Nayantaaraa, Nityakalyaani, Madagascar Periwinkle, Vinca
7.	*Cryptolepis dubia* (Burm.f.) M.R.Almeida	Periplocoideae	*Cryptolepis buchananii* Roem. & Schult., *Cryptolepis reticulata* (Roth) Wall. ex Steud., *Nerium reticulatum* Roxb.	Indian Sarsaparilla, Karantaa, Anantamuula, Medaksinghi, Krsnasariva, Sveta sariva
8.	*Hemidesmus indicus* (L.) R. Br. ex Schult.	Periplocoideae	*Periploca indica* L.	Indian Sarsaparilla, Anatmool, Sariwa, Sveta sariva
9.	*Holarrhena pubescens* Wall. ex G.Don	Apocynoideae	*Holarrhena antidysenterica* (Roth) Wall. ex A.DC., *Holarrhena codaga* G.Don., *Holarrhena glabra* Klotzsch	Easter tree, Ivory tree, Tellicherry Bark
10.	*Ichnocarpus frutescens* (L.) W.T.Aiton	Apocynoideae	*Apocynum frutescens* L., *Ichnocarpus affinis* (Roem. & Schult.) K.Schum., *Tabernaemontana parviflora* Poir.	Black Creeper
11.	*Marsdenia tenacissima* (Roxb.) Moon	Asclepiadoideae	*Gymnema tenacissimum* (Roxb.) Spreng., *Marsdenia tenacissima* Wight & Arn., *Asclepias tenacissima* Roxb.	Maruaa-bel, Khaarchu, Nishod, Sufed Murva
12.	*Nerium oleander* L.	Apocynoideae	*Nerium indicum* Mill., *Nerium japonicum* Gentil., *Nerium latifolium* Mill.	Indian oleander, White Oleander, Oleander, Kaner, Karavira
13.	*Rauvolfia serpentina* (L.) Benth ex Kurz.	Rauvolfioideae	*Rauvolfia obversa* (Miq.) Baill., *Rauvolfia trifoliata* (Gaertn.) Baill., *Ophioxylon album* Gaertn.	Rauvolfia root, Serpentina root, Indian Snakeroot
14.	*Tabernaemontana divaricata* (L.) R.Br. ex Roem. & Schult.	Rauvolfioideae	*Nerium divaricatum* L., *Tabernaemontana coronaria* (Jacq.) Willd., *Vinca alba* Noronha	East Indian Rosebay, Chandni

Result and discussion

Recording and analyzing knowledge of ethnomedicinal plants' usage are very important. Due to various secondary metabolites, the aerial and underground parts of several Apocynaceae species show various medicinal properties, and they are used in several Ayurvedic formulations (API, 2001). The roots of all the studied 14 plants are widely used by various indigenous communities throughout India. Vernacular names used by different indigenous communities and ethnomedicinal uses of the roots of Apocynaceae's selected species in India are presented in Table 2. Ethnic people in different regions of India use different parts of these plants as a decoction, infusion, extracts, powders, medicated oils, incineration-calcination preparations, etc., to treat several health problems. The selected plant species are also widely used in Ayurveda and various other Indian traditional systems of medicine. In Ayurveda, these plants are used to treat several diseases, including wound healing,

ulcers, skin diseases, leucorrhoea, urinary diseases, heart disease, eye diseases, nervous disorders, mental disorder, psychotic disease, insanity metabolic disorder, abdominal, diarrhea, dyspepsia, indigestion, worms related problems, obesity, asthma, cough, fever, blood-related problems, tuberculosis, leprosy, herpes zoster, and tumor (API, 2001). Roots of the studied plants were found to be used for the treatment of some major health problems, including skin problems, wound, ulcers, swellings, stomach, liver, spleen, kidney-related complaints, urinary problems, fever, heart pain, asthma, other respiratory problems, insomnia, leprosy, epilepsy, paralysis, cancer, diabetes, blood pressure, hypertension, insect bite, snakebite, dog bite, protracted labor, postnatal complaints, etc. (Table 2).

Different indigenous communities in India use the roots of *A. curassavica* for the treatment of gonorrhea, piles, and wounds; *C. gigantea* roots are used for treatment of asthma, burn injuries, cough, dysentery, fevers, gum infection, labour pain, leprosy, scorpion stings, snakebite, stomach-ache, swellings and wound; roots of *C. procera* are used for the treatment of asthma, diabetes, elephantiasis, jaundice, leucoderma, malarial fever, protracted labour, rheumatism, skin diseases and spleen complaints; roots of *C. carandas* are used for the treatment of anasarca, diabetic ulcer, dropsy, madness, rheumatism, and wound; roots of *C. spinarum* are used for the treatment of epilepsy, fever, infected sores, poor digestion, stomach ailments and wounds; roots of *C. roseus* are used for the treatment of diabetes, insect bite, snakebite, wound, and cancer; roots of *C. dubia* are used for the treatment of bone fracture and jaundice; roots of *H. indicus* are used for the treatment of dysentery, fever, fits, herpes, jaundice, leucorrhoea, snakebite, stomach-ache, urinary diseases, and wound; roots of *H. pubescens* are used for the treatment of animal bite, cold, constipation, cough, diarrhoea, dog bite, dysentery, fever, haematuria, piles, skin healing, snake bite, and stomach-ache; roots of *I. frutescens* are used for the treatment of anaemia, gum bleeding, blood purification, body pain, diabetes, fever, kidney disease, kidney stone, skin disease, and bladder stone; roots of *M. tenacissima* are used for the treatment of postnatal complaints; root of *N. oleander* are used for the treatment of epilepsy, insect bite, leprosy, snakebite, ulcers, and wound; roots of *R. serpentina* are used for the treatment of asthma, blood pressure, boils, epilepsy, facial paralysis, heart pain, hypertension, insomnia, leucoderma, scorpion sting, snake bite, and stomach-ache; roots of *T. divaricata* are used in treatment of jaundice, toothache, snake bite and scorpion sting.

Table 2: Ethnomedicinal uses of the roots of the studied species of family Apocynaceae by India's indigenous communities.

Region, State	Vernacular name	Community	Ethnomedicinal use	Reference
A. curassavica				
Juvvadhu Hills, Tamil Nadu	NA	Local community	Emetic, purgative, and a remedy for piles and gonorrhea.	Sekharan and Jagadeesan (1997)
Uttarakhand	Bharadwaji, Kakatundi, Kaura Dodi	NA	Powder with *Acorus* root topical administered for wound healing.	Pullaiah (2002), Dhiman (2004)
C. gigantea				
Paschim Medinipur district, West Bengal	Akanda	Santhals, Mundas, Lodhas, Bhumijs, Oraon Kherias	In snakebite, the root bark is ground into a paste and made into pills. Plant latex is	Sarkhel (2014)

		communities	applied over the bitten area.	
West and South of Tripura, Tripura	Akanda, Angon	Different tribal communities	Fevers, cough, asthma, gum infection.	Sen et al. (2011)
Santhal Pargana, Bihar	Rui, Madar, Parkha	NA	The powder used for wound healing.	Bakshi et al. (1999), CCRAS (1999)
Paderu division, Visakhapatnam district, Andhra Pradesh	NA	Local community	Stomach ache.	Padal et al. (2010)
Juvvadhu Hills, Tamil Nadu	NA	Local community	Powdered root bark used for dysentery.	Sekharan and Jagadeesan (1997)
Assam	NA	Miris	Bark paste used to cure dysentery. Juice applied to burn injuries and swellings.	Hajra and Baishya (1981)
Mayurbhanj district, Orissa	NA	Local community	Paste applied to snakebite and scorpion stings.	Jain et al. (1973)
Mayurbhanj district, Orissa	NA	Local community	Pounded and applied with country liquor on the wounds of leprosy patients as well as internally taken.	Choudhury et al. (1975)
Mayurbhanj district, Orissa	NA	Local community	Bark paste applied on wounds and along with ghee taken to cure snake bite.	Murthy et al. (1986)
Koraput, Orissa	NA	Local community	A piece of root is given to cattle with grass or straw to cure cleft on the pallet.	Misra et al. (1993)
Uttara Kannada district, Karnataka	Akke, Giant milkweed, Crown flower	Siddis	Root juice smeared over the abdomen and vaginal region at childbirth to reduce labour pain.	Bhandary et al. (1995)
C. procera				
Billawar, Kathua district, Jammu & Kashmir	Daryai aak	Gujjar, Bakerwal and Dogra communities	A paste of charcoal prepared from root, and bland oil mixture applied on skin diseases.	Bhushan and Kumar (2013)
Sariska and Silisher regions, Alwar district, Rajasthan	Aakada	Local community	A decoction of root bark and black pepper are used twice a day for three days for malarial fever.	Parveen et al. (2007)
Paderu division of Visakhapatnam district, Andhra Pradesh	NA	Local community	Diabetes.	Padal et al. (2010)
Sub-Himalayan tract, Uttarakhand	NA	Gujjar community	The grounded roots are externally applied on leukoderma.	Sharma et al. (2013a)
Jhabua, Dhar, Khargone, and Ratlam districts, Madhya Pradesh	NA	Bhil community	One pinch of root bark powder mixed with one teaspoon of honey orally taken twice a day for 3–5 days as a jaundice remedy.	Samvatsar and Diwanji, (2000)
Rajasthan	NA	Local community	In Asthma decoction prepared by boiling bark of *Acacia ferruginea* and *Holarrhena antidysenterica* in water with *Acacia catechu* and *Calotropis procera* root, cooled and given at bedtime.	Sharma and Khandelwal (2016)
Sonaghati of Sonbhadra	Madar	Gond and	Roots powder (10 g per day)	Singh et al. (2002)

district, Uttar Pradesh		Kharwar communities	with water used for spleen complaints, elephantiasis, and rheumatism. In protracted labour, roots are given with black pepper.	
C. carandas				
Sariska and Silisher regions, Alwar district, Rajasthan	Karunda	Local community	Root bark paste used in a diabetic ulcer. Insect repellent, hypotensive dropsy, anasarca, madness.	Asolkar et al. (1992)
Eastern Rajasthan	Karunda	Local community	Roots with bark used in rheumatism for 15 days.	Upadhyay et al. (2010)
Mayurbhanj, Odisha	Karandakoli	Local community	Wound healing.	Das et al. (2003)
North-Eastern Uttar Pradesh	Karaunda	Local community	Topical application of paste for wound healing.	Trivedi (2006), Dhiman (2004)
C. spinarum				
District Udhampur, Jammu & Kashmir	Garna	Local community	Root decoction with roots of *Justicia adhatoda* used to cure fever.	Bhatia et al. (2014)
District Rajouri, Jammu & Kashmir	Garanda	Gujjar-Bakerwal community	Root bark extract is given to cure poor digestion.	Rashid (2012)
Kathua district, Jammu & Kashmir	Garna	Local community	Roots purgative, used against stomach ailments.	Kumar and Bhagat (2012)
Different regions, Jammu & Kashmir	Garanda	Tribal, hakims and local community	Powdered root sprinkled over wounds and infected sores.	Mahajan et al. (2012)
Yelagiri hills of Eastern Ghats, Tamil Nadu	Sirukila	Malayali tribal community	Roughly ground root powder mixed with water is poured into a snake burrow.	Salai et al. (2014)
Uttarakhand		Local community	Root used internally in the remedy of epilepsy.	Kala et al. (2004)
C. roseus				
West and South of Tripura	Nayantara, Khumbaragi	Different tribal communities	Diabetes, insect bite, wound.	Sen et al. (2011)
Kodagu district, Karnataka	Nithya pushpa	Herbal healers and local community	Root paste mixed with pepper and lime is applied externally on the snake-bitten spot thrice a day.	Lingaraju et al. (2013)
Odisha	Sada sawagaon	Lodha community	The paste used for wound healing	Bakshi et al. (1999)
Tons river area, Dehradun, Uttarakhand	Sadabhar	Local community	Diabetes, cancer.	Kumar and Pandey (2015)
C. dubia				
Mokhada, district Thane, Maharashtra	Medvad	Local community	Root paste is applied over the bone fracture.	Sonawane et al. (2012)
Nasik district, Maharashtra	NA	Local community	Half a glass of root extract is taken orally in the early morning for seven days before breakfast, used internally in the remedy of jaundice.	Patil and Patil (2005)
H. indicus				
Paschim Medinipur district, West Bengal	Anantmula	Santhals, Mundas, Lodhas, Bhumijs, Oraon Kherias community	The root is ground with bulbs of *Allium sativum* (1:1). In the case of snakebite, the paste is applied to the bitten areas.	Sarkhel (2014)

Kodagu district, Karnataka	Sogade	Herbal healers and local community	Root decoction with a pinch of common salt, is taken internally in a stomach ache.	Lingaraju et al. (2013)
Wayanad, Kerala	Nannari	Local community	Paste topically administered for wound healing.	Gupta (2007)
Phulbani, Odisha	Sugandhi	Local community	Pounded and poultice topically administered for wound healing.	CCRAS (1999)
Paderu division, Visakhapatnam district, Andhra Pradesh	NA	Local community	Aphrodisiac, cooling effect, dysentery, fits, herpes.	Padal et al. (2010)
Uttara Kannada district, Karnataka	Sugandhi, Sarsaparilla	Siddis	Roots powdered with 'Nachki' (*Minosa pudica* L.), taken orally every morning to treat leucorrhoea during the menstrual period. Root powder also is taken with milk as a daily tonic.	Bhandary et al. (1995)
Vellore District, Tamil Nadu	Nannari	Local community	Jaundice and snakebite.	Thirumalai et al. (2010)
Sivagangai district, Tamil Nadu	NA	Local community	The root is powdered and given with honey in jaundice.	Shanmugam et al. (2009)
Shahdol district, Madhya Pradesh	Dudhi	Ojha	The root paste mixed with water is given in small quantities to children in dysentery.	Bharti (2015)
Sonaghati, Sonbhadra district, Uttar Pradesh	Anantamul, Kapuri	Gond and Kharwar communities	Root juice (10 ml twice per day) is orally taken to cure urinary diseases and fever.	Singh et al. (2002)
Mokhada, Thane district, Maharashtra	Anantmul	Local community	Roots are crushed, and powder is taken internally for urinary troubles. Root paste is taken orally in snakebite.	Sonawane et al. (2012)
H. pubescens				
West and South of Tripura, Tripura	Kurchi, Pandhra Kuda, Kuichama	Different tribal communities	Dysentery, fever, cold, piles.	Sen et al. (2011)
Bonai Hills Sundargarh, Odisha	Kurai	Paudi, Bhuinya communities	Root mixed with equal quantity of 'Harada' [*Terminalia chebula* Retz.] 'Bhada' [*Terminalia bellerica* (Gaertn) Roxb.] and 'Bhejri' [*Solanum surttense* Burm. f.] fruits boiled in water taken twice daily for a week to cure cough/cold.	Aminuddin and Girach (1991)
Yelagiri Hills, Eastern Ghats, Tamil Nadu	Kutasappalai	Malayali tribal community	A decoction of root bark taken to get relief from dysentery.	Salai et al. (2014)
Paderu division, Visakhapatnam district, Andhra Pradesh	NA	Local community	Stomach-ache.	Padal et al. (2010)
Juvvadhu Hills, Tamil Nadu	NA	Local community	Powder prepared from roots and leaves was administered to stop bleeding from the nose and hemorrhages after childbirth.	Sekharan and Jagadeesan (1997)
Uttara Kannada district,	Kodasa, Easter tree	Siddis community	Root bark decoction taken	Bhandary et al.

Karnataka			orally acts as depurative.	(1995)
Sagar taluk, Shimoga district, Karnataka	Kodasiga	Adikarnataka, Besta, Brahmin, Ganiga, Idiga, Lambani, Muslim, Vokkaliga communities	Root paste applied over infected part of skin till cured.	Rajakumar and Shivanna (2010)
Sonaghati, Sonbhadra district, Uttar Pradesh	Koraya	Gond and Kharwar communities	Root paste is taken orally with water to stimulate urine discharge and remove constipation, diarrhea, and haematuria. It is also used as an antidote to a dog bite or bite of poisonous animals/ snake.	Singh et al. (2002)
I. frutescens				
Sagar taluk, Shimoga district, Karnataka	Karibantana balli	Adikarnataka, Besta, Brahmin, Ganiga, Idiga, Lambani, Muslim, Vokkaliga communities	A root decoction is taken orally in body pain.	Rajakumar and Shivanna (2010)
West and South Tripura, Tripura	Dugdha lata, Perialata, Soyalata	Different tribal communities	Bleeding in gum, skin disease, fever, kidney disease.	Sen et al. (2011)
Paderu division, Visakhapatnam district, Andhra Pradesh	NA	Local community	Blood purification, hemorrhage from the mouth.	Padal et al. (2010)
Juvvadhu Hills, Tamil Nadu	NA	Local community	The root powder is administered with milk to treat diabetes, stone in the bladder, and as a blood purifier.	Sekharan and Jagadeesan (1997)
Wayanad district, Kerala	Paravalli	Kurichar community	Root juice is used internally to treat anemia and kidney stone.	Thomas and Rajendran (2013)
Sonaghati, Sonbhadra district, Uttar Pradesh	Khapri-Bela	Gond and Kharwar communities	The dried root powder is administered a spoonful (10 g) twice a day with a freshwater glass after meals as lactagogue.	Singh et al. (2002)
M. tenacissima				
Kanika, Sundargarh, Odisha	Chunhar	Munda community	The powdered root is eaten with water to treat postnatal complaints.	Girach et al. (1998)
N. oleander				
Eastern Rajasthan	Kaner	Local community	The root is crushed with roots of *Capparis sepiaria* and *Datura innoxia* and applied against snakebite and insect bite. The roots are made into a paste with water and are applied externally on ulcers and leprosy. The roots are used for procuring abortion both by local application and internal administration.	Upadhyay et al. (2010)
Uttarakhand	Karavira	Local community	Topical application of paste	Dhiman (2004),

			for wound healing	CCRAS (1999)
Nagpur and Wardha, Maharashtra	Kanher	Local community	Topical application of crushed root for wound healing.	Badhe and Pande (1999)
West Rarrh region, West Bengal		Ethnic community	5 ml juice of root once daily for 15 days used internally as a remedy for epilepsy.	Ghosh (2008)
R. serpentina				
Paschim Medinipur district, West Bengal	Sarpagandha	Santhals, Mundas, Lodhas, Bhumijs, Oraon Kherias communities	Root paste along with that of *Azadirachta indica* and black pepper seeds are made into a paste, and the extract is administered orally soon after a snake bite.	Sarkhel (2014)
Kodagu district, Karnataka	Sarpagandha	Herbal healers and local community	Root paste is given orally to reduce blood pressure. Root paste mixed with cow's milk is given orally to the pregnant woman, before childbirth to promote easy labour.	Lingaraju et al. (2013)
Paderu division, Visakhapatnam district, Andhra Pradesh	NA	Local community	Asthma, heart pain, stomach-ache, high blood pressure.	Padal et al. (2010)
Mokhada, Thane district, Maharashtra	Sarpagandha	Local tribal community	Root with the petiole of betel leaf made into a paste is given to cure facial paralysis. It is also used in epilepsy, intestinal disorders.	Sonawane et al. (2012)
Keonjhar, Similipal Mayurbhanj, Odisha	Patalgaruda	Santal, Kolha, Bunda, Bathuri and Bhuian communities	An antidote to the snake.	Nayak et al. (1998)
Angul-Talcher Mining Area, Odisha	Patal garuda	Local inhabitants, tribes, village medicine men, Vaidyas	Hypertension, insomnia, epilepsy.	Mahalik et al. (2014)
Sub-Himalayan region, Uttarakhand	Gandhak	Gujjar community	1 g root powder is taken internally, twice a day in skin infection.	Sharma et al. (2013a)
Udham Singh Nagar District, Uttarakhand	Jhaberbarua	Tharu community	Root paste is topically applied for boils.	Sharma et al. (2014)
Sub-Himalayan tract, Uttarakhand	Gandhak	Gujjar community	The root paste is mixed with oil of *Cinnamomum tamala* (tejpaat) and externally applied on leucoderma at night.	Sharma et al. (2013a)
Sub-Himalayan region, Uttarakhand	NA	Gujjar community	1 g root powder is taken internally twice a day used as a remedy for epilepsy.	Sharma et al. (2013b)
Garhwal Himalaya, Uttarakhand	NA	Jaunsari community	Root used internally as a remedy for epilepsy.	Bhatt and Negi (2006)
Garhwal Himalaya, Uttarakhand	NA	Local community	Root used internally as a remedy for epilepsy.	Gaur (1999)
Gorakhpur and Maharajganj districts, Uttar Pradesh	NA	Taungya community	1–2 teaspoon root powder taken twice daily in the remedy of epilepsy.	Poonam and Singh (2009)
Uttarakhand	NA	Local	Root used internally as a	Adhikari et al.

		community	remedy for epilepsy.	(2007)
T. divaricata				
Kodagu district, Karnataka	Nandibattalu huvu	Herbal healers and local community	The crushed root mixed with salt and turmeric is applied to the snake bite.	Lingaraju et al. (2013)
Paderu division, Visakhapatnam district, Andhra Pradesh	NA	Local community	Toothache.	Padal et al. (2010)
Rewa district, Madhya Pradesh	Gulchandini	Local vaidyas	Root paste applied over scorpion sting.	Shukla et al. (2010)
Tripura	Khuntautai	Reang community	The extract used in toothache.	Shil et al. (2014)
Jalgaon, Dhule and Nandurbar districts, Maharashtra	NA	Bhil, Gavit, Kokani, Mavachi, Padvi, Tadvi, Valvi and Vasave communities	Root powder (100–200 g) is boiled in water, and the extract is taken thrice a day for two weeks internally as a remedy for jaundice.	Badgujar and Patil (2008)

NA: Not Available

Some significant phytochemicals in the studied plants with already proven pharmacological activities are given in Table 3. Some major compounds from studied species are asclepin, calotropin, carinol, carissanol, carissin, serpentine, cryptosin, rauwolfine, and vobasine. All these compounds are known to have proven important pharmacological activities (Table 3). Many phytoconstituents from Apocynaceae plants are reported to have important pharmacological activities such as anticancer, antimicrobial, anti-inflammatory, antioxidant, cytotoxic, cardiovascular, hepatoprotective, CNS activity, neuroprotective, psychoactive, antineuroinflammatory, biocidal, antiviral, antibacterial, antifungal, antiplasmodial/antimalarial, topoisomerase II inhibitory, antidiabetic, and gastroprotective (Dey et al., 2017; Bhadane et al., 2018; Islam and Lucky, 2019). Serpentine, ajmalicine, catharanthine from root samples of *C. roseus* are known to reduce acetylcholine activity (Pereira et al., 2010).

Table 3: Some major compounds with biological activities reported from selected plant species of the family Apocynaceae.

Plant name	**Compound (DNP, 2020)**	**Biological activity (DNP, 2020)**
A. curassavica	Asclepin	Cardiotonic agent
	Calotropin, Pekilocerin A	African arrow poison
	Coroglaucigenin	Antineoplastic agent
	Uzarigenin, Odorigenin B	Cardiotonic agent. Antidiarrhoeal
C. gigantea	α-(Acetylamino)-4-[(ethoxycarbonyl)amino]benzeneacetic acid	Insect antifeedant
	Calotropin, Pekilocerin A	African arrow poison
	9-Methoxypinoresinol	Exhibits potent cytotoxic activity
C. procera	Calactin, Pecilocerin B, Pekilocerin B	Cardiotonic agent
	Calotropin, Pekilocerin A	African arrow poison
C. carandas	Carinol	Exhibits cytotoxic activity and increases cell viability in anti-hypoxia study
	Carissanol	Cytotoxic against breast MCF7 and lung A 549 cancer cell lines
	Carissin	Inhibitor of the nucleation phase in amyloid β42 aggregation
C. spinarum	Cycloolivil, Isoolivil	Shows moderate anti-DPPH free radical activity

	Carinol	Exhibits cytotoxic activity and increases cell viability in anti-hypoxia study
	Carissanol	Cytotoxic against breast MCF7 and lung A 549 cancer cell lines
C. roseus	Trichosetin	Phytotoxin. Active against Gram-positive bacteria
	Vinleurosine	Antineoplastic agent. Possesses antihyperglycaemic activity
	Lochnerinine, Hazuntine	Shows antitumour activity
	Lochnerinine, Hazuntine	Shows antitumour activity
	Carbazoline	Plant growth and enzyme inhibitor. Potentiator of benzo[a]pyrene induced mutagenicity, antiparasitic, antitrypanosomal agent. A comutagen with aromatic amines active towards bacteria
	Roseamine	It Shows antineoplastic props.
	Serpentine	Shows antitumour activity
	Strictosidine, Isovincoside	A key intermediate in the biosynthesis of terpenoid indole alkaloids
	Vincaleukoblastine, Vincaleucoblastine, Velbe, VLB	An antineoplastic agent used widely in the treatment of Hodgkin's disease and other lymphomas. Microtubule assembly inhibitor. Shows trypanosomicidal effect
	Vindoline	Active against Gram-positive bacteria and fungi
C. dubia	Cryptosin	Acts as a positive inotropic agent
H. indicus	Hemidesmin 1, 2; hemidesmoside A, B, C; Indicusin; Hemidescine; Hindicusine; hemisine, etc.	NA
H. pubesccens	Estrone acetate, Hovigal, Puboestrene	Estrogen
	Holamide	Shows hypotensive activity in rats
	Mokluangine A, B, C	Acetylcholinesterase inhibitor
	Pubescinine	Shows hypotensive activity in rats
I. frutesens	Nonadecyl benzoate	NA
M. tenacissima	Tenacigenin B, Tanacissimoside B, C, D, E, F, I; Marsdenoside C, K; Tenacigenoside A, F, etc.	NA
N. oleander	Adynerin	Antineoplastic agent
	Dambonitol, Dambonite	Allergy inhibitor
	Δ16-Dehydroadynerigenin	CNS depressant
	Echujin, Digitoxigenin strophanthotrioside	Arrow poison
	Gitoxigenin, Bigitaligenin, 16-Hydroxydigitoxigenin, Anhydrogitaligenin	Antineoplastic agent
	cis-Karenin	Cytotoxic agent
	trans-Karenin	Cytotoxic agent
	Uvaol, Uvalol	HIV-1 protease inhibitor, an antineoplastic agent
	Vanderoside, Periplogenin diginoside, Neridiginoside	Used in anticancer therapy
R. serpentina	Ajmalan-17,21-diol, Ajimaline, Gilurytmal, Merabitol, Raugalline, Rauwolfine, Rytmalin, Tachmalin, Many other names	Antiarrhythmic (Class Ia) drug, which functions by inhibition of glucose uptake by heart tissue mitochondria. Platelet-activating factor antagonist. Anti-inflammatory agent
	Renoxydine, Reserpoxidine, Renoxidine	Shows similar Pharmacological properties to Reserpine but with about half the activity
	Serpentine	Shows antitumor activity
	Yohimbic acid, Yohimbinic acid	α2-Adrenoceptor antagonist
T. divaricata	Conolidine	Analgesic with unusual non-opioid pharmacology
	3S-Cyanocoronaridine	Cytotoxic

	Vobasine	Weak CNS depressant, also showing analgesic and antipyretic action

Conclusion

The study revealed that the roots of the selected species are used across India for medicinal purposes. They are used to treat health issues, including insect or animal bites, skin problems, respiratory problems, and metabolic health issues. Among the reviewed species, roots of *R. serpentina*, *H. indicus*, *C. gigantea*, *H. pubescens*, *C. procera*, *C. spinarum*, *I. frutescens*, and *T. divaricata* were found to be widely used in different regions of India than other species (Table 1). The dry root material of the studied plant species has high demand in the Indian herbal drug market. Species like *H. indicus* (500-1000 MT), *H. pubescens* (1000-2000 MT), *C. roseus* (200-500 MT), *C. dubia* (100-150 MT), *R. serpentina* (200-500 MT), *C. gigantea* (50-100 MT) and *C. procera* (50-100 MT) have very high trade value (NMPB, 2020). Only a few species, such as *C. roseus, N. oleander, R. serpentina,* and *T. divaricata*, are cultivated in gardens or farms for ornamental or medicinal purposes. However, the majority of species for medicinal purposes are collected from wild habitats. Cultivation of highly medicinal plant species can provide a new pathway in the conservative use of plants. Identifying crude herbal samples may require a botanical reference standard for correct identification of raw herbal samples (Kumar et al., 2018, 2020a, 2020b, 2020c; Singh et al., 2020). Further macroscopic and microscopic studies are required to develop the studied plants' botanical standards to control adulteration and substitution of the raw plant material in the trade. Ethnomedicinal data compiled in the present study can provide valuable information for the medicinal exploration of Apocynaceae's root drug samples. Data compiled in the present study can provide a way for drug discovery of specific bioactive compounds in clinical research.

Acknowledgments

The authors thank Director IIIM Jammu for providing the necessary facilities to carry out the work. The authors are thankful to the Council of Scientific and Industrial Research (CSIR), Government of India, for financial assistance under the Major Lab Project (MLP-1007). PK acknowledges the financial support provided by CSIR in the form of JRF/SRF fellowships.

References

1. Adhikari B.S., Babu M.M., Saklani P.L., Rawat G.S. 2007. Distribution, use pattern, and prospects for conservation of medicinal shrubs in Uttaranchal state, India. J. Mt. Sci., 4(2):155–180.
2. Aminuddin, Girach R.D. 1991. Ethnobotanical Studies on Bondo tribe of District Koraput Orissa, India. Ethnobot., 3:15–19.
3. API 2001. The Ayurvedic Pharmacopoeia of India. Part-I, Vols, I to V. Government of India. Ministry of Health and Family Welfare, Department of AYUSH, India.
4. Asolkar L.V., Kakkar K.K., Chakre O.J. 1992. Second Supplement to Glossary of Indian Medicinal Plants with Active Principles. Part I (A–K) (1965–1981), CSIR, New Delhi, India.
5. Badgujar S.B., Patil M.B. 2008. Ethnomedicine for jaundice used in tribal areas of north Maharashtra. Nat. Prod. Rad., 7(1):79–81.
6. Badhe P.K., Pande V.K. 1999. Medicinal Plants of Nagpur and Wardha Forest Division, Maharashtra. New Delhi: CCRAS, Government of India, pp. 64.
7. Bakshi D.N., Sensharma, P., Pal, D.C. 1999. A Lexicon of Medicinal Plants in India. Vol. 1. Naya Prokash, Calcutta, India. pp. 346, 398.
8. Bhadane B.S., Patil M.P., Maheshwari V.L., Patil R.H. 2018. Ethnopharmacology, phytochemistry, and biotechnological advances of family Apocynaceae: A review. Phytother. Res., 32(7):1181–210.

9. Bhandary M.J., Chandrashekar K.R., Kaveriappa K.M. 1995. Medical ethnobotany of the studies of Siddis of Uttara Kannada district, Karnataka, India. J. Ethnopharmacol., 47(3):149–158.

10. Bharti V.K. 2015. An Ethnobotanical Study of Medicinal Plants in Shahdol District of Madhya Pradesh, India. Int. J. Sci. Res., 4(10):1501–1505.

11. Bhatia H., Sharma Y.P., Manhas R.K., Kumar K. 2014. Ethnomedicinal plants used by the villagers of district Udhampur, J&K, India. J. Ethnopharmacol., 151(2):1005–1018.

12. Bhatt V.P., Negi G.C.S. 2006. Ethnomedicinal plant resources of Jaunsari tribe of Garhwal Himalaya, Uttaranchal. Indian J. Tradit. Knowl., 5(3):331–335.

13. Bhushan B., Kumar M. 2013. Ethnobotanically Important Medicinal Plants of Tehsil Billawar, District Kathua, J&K, India. J. Pharmacogn. Phytochem., 2(4):14–21.

14. CCRAS 1999. An Appraisal of Tribal-Folk Medicines. 1st Ed. New Delhi: CCRAS, Government of India, pp. 128, 315, 319.

15. Choudhury H.N.R., Pal D.C., Tarafdar C.R. 1975. Less known uses of some medicinal plants from tribal area of Orissa. Bull. Bot. Surv. India, 17(1–4):132–136.

16. Das S., Dash S.K., Padhy S.N. 2003. Ethno-medicinal information from Orissa state, India, a review. J. Hum. Ecol., 14(3):165–227.

17. Devi N., Gupta A.K., Prajapati S.K. 2017. Indian tribe's and villager's health and habits: Popularity of apocynaceae plants as medicine. Int. J. Green Pharm., 11(2):S256–S279.

18. Dey A., Mukherjee A., Chaudhury M. 2017. Alkaloids from Apocynaceae: origin, pharmacotherapeutic properties, and structure activity studies. Stud. Nat. Prod. Chem., 52:373–488.

19. Dhiman A.K. 2004. Medicinal Plants of Uttaranchal State. 1st ed. Varanasi: Chowkhamba Sanskrit Series Office, pp. 306, 318.

20. DNP 2020. Dictionary of Natural Products 29.1. CRC Press, Taylor & Francis Group, an Informa Group Company (accessed on 20th June 2020).

21. Ekalu A., Ayo R.G.O., Habila J.D., Hamisu I. 2019. A Mini-Review on the Phytochemistry and Biological Activities of Selected Apocynaceae Plants. Preprints.

22. Endress M.E. 1997. Key characters at the interface of the apocynacs and the asclepiads. Amer. J. Bot., 84(6 Abstracts), 189.

23. Endress M.E., Bruyns P.V. 2000. A revised classification of the Apocynaceae s.l. Bot. Rev., 66(1):1–56.

24. Endress M.E., Liede-Schumann S., Meve U. 2007. Advances in Apocynaceae: the enlightenment, an introduction. Ann. Miss. Bot. Gard., 94:259– 267.

25. Gairola S., Sharma J., Bedi Y.S. 2014. A cross-cultural analysis of Jammu, Kashmir and Ladakh (India) medicinal plant use. J. Ethnopharmacol., 155(2):925–986.

26. Gaur R.D. 1999. Flora of the District Garhwal North West Himalaya (with Ethnobotanical Notes). TransMedia, Srinagar (Garhwal), India.

27. Ghosh A. 2008. Ethnomedicinal plants used in West Rarrh region of West Bengal. Nat. Prod. Rad., 7(5):461–465.

28. Girach R.D., Aminuddin, Ahmad M. 1998. Medicinal ethnobotany of Sundargarh, Orissa, India. Pharmaceut. Biol., 36(1):20–24.

29. Gupta A. 2007. Ashtanga Hridaya, Sutra Sthana 15/37, 39, Sodhanadiganasangraham Adhyaya. Chaukhambha Prakashan. Varanasi, India, pp. 107.

30. Hajra P.K., Baishya A.K. 1981. Ethnobotanical notes on the Miris (Mishings) of Assam Plains. In: S.K. Jain (ed.) Glimpses of Indian Ethnobotany. Oxford & IBH Publishing Co., New Delhi, India, pp. 161–169.

31. Hofling J.F., Anibal P.C., Obando-Pereda G.A., Peixoto I.A., Furletti V.F., Foglio M.A., Goncalves R.B. 2010. Antimicrobial potential of some plant extracts against *Candida* species. Braz. J. Biol., 70(4):1065–1068.

32. Islam M.S., Lucky R.A. 2019. A Study on different plants of Apocynaceae family and their medicinal uses. Universal J. Pharm. Res., 4(1):42–46.

33. Jain S.K., Banerjee D.K., Pal D.C. 1973. Medicinal Plants among certain Adivasis in India. Bull Bot. Surv. India, 15:85–91.

34. Kala C.P., Farooquee N.A., Dhar U. 2004. Prioritization of medicinal plants on the basis of available knowledge, existing practices

and use value status in Uttaranchal, India. Biodivers. Conserv., 13(2):453–469.

35. Khare C.P. 2007. Indian medicinal plants: An illustrated dictionary, Springer.

36. Kumar P., Gairola S. 2020a. Morphological and microscopic studies on fruits of *Ficus semicordata* Buch.-Ham. ex Sm. Res. Rev. Biotech. Biosci., 7(2): (In Press).

37. Kumar P., Kumar B., Batool Z., Gairola S. 2020b. Macroscopic and microscopic characterization of raw herbal drug *Mamajjaka* [*Enicostema axillare* subsp. *littorale* (Blume) A. Raynal]. Plant Archives 20(2): (In press).

38. Kumar P., Singh K., Gairola S. 2020c. Botanical standardization of raw herbal drug *Pashanabheda* [*Bergenia ciliata* (Haw.) Sternb.] used in Indian Systems of Medicine. Plant Archives 20(2): (In press).

39. Kumar R., Bhagat N. 2012. Ethnomedicinal plants of district Kathua (J&K). Int. J. Med. Arom. Plants, 2(4):603–611.

40. Kumar S., Pandey S. 2015. An ethnobotanical study of local plants and their medicinal importance in Tons river area, Dehradun, Uttarakhand. Indian J. Trop. Biodivers., 23(2):227–231.

41. Kumar, P., Kumar, B.; Singh, K., Gairola, S. 2018. Morpho-anatomical standardization of six important RET medicinal plants of Astavarga group from Western Himalaya, India. Res. Rev. Biotech. Biosci., 5: 1–14.

42. Lingaraju D.P., Sudarshana M.S., Rajashekar N. 2013. Ethnopharmacological survey of traditional medicinal plants in tribal areas of Kodagu district, Karnataka, India. J. Pharmacy Res., 6(2):284–297.

43. Mahajan V., Vaid A., Singh A.P., Kumar S. 2012. Ethnobotanical inventory on medicinal plants of North Western Himalayas. J. Krishi Vigyan, 1(1):21–26.

44. Mahalik G., Nayak S.K., Mohapatra A., Satapathy K.B. 2014. Floristic Composition and Ethnobotanical Observation in Angul-Talcher Mining Area, Odisha, India. Int. J. Sci. Res., 3(12):890–893.

45. Misra M.K., Mohanty M.K., Das P.K. 1993. Studies on the method–ethnobotany of *Calotropis gigantea* and *C. procera.* Ancient Sci. Life, 13(1):40–56.

46. Murthy K.S., Sharma P.C., Kishore P. 1986. Tribal remedies for snakebite from Orissa. Anc. Sci. Life, 6(2):122–123.

47. Nayak A., Das N.B., Nanda B. 1998. Utility of some Tribal Drugs of Keonjhar & Similipal Area. J.T.R. Chem., 5(2):53–59.

48. Nazar N., Goyder D.J., Clarkson J.J., Mahmood T., Chase M.W. 2013. The taxonomy and systematics of Apocynaceae: where we stand in 2012. Bot. J. Linn. Soc., 171(3):482–90.

49. NMPB, 2020. Traded Medicinal Plant Database. http://envis.frlht.org/traded-medicinal-plants-database.php (accessed 11 March 2020).

50. Padal S.B., Murty P.P., Rao D.S., Venkaiah M. 2010. Ethnomedicinal plants from Paderu Division of Visakhapatnam district, A.P, India. J. Phytol., 2(8):70–91.

51. Parveen, Upadhyay B., Roy S., Kumar A. 2007. Traditional uses of medicinal plants among the rural communities of Churu district in the Thar Desert, India. J. Ethnopharmacol., 113(3):387–399.

52. Patil M.V., Patil D.A. 2005. Ethnomedicinal practices of Nasik District, Maharashtra. Indian J. Tradit. Knowl., 4(3):287–290.

53. Pereira D.M., Ferreres F., Oliveira J.M.A., Gaspar L., Faria J., Valentao P., Sottomayor M., Andrade P.B. 2010. Pharmacological effects of *Catharanthus roseus* root alkaloids in acetylcholinesterase inhibition and cholinergic neurotransmission. Phytomedicine, 17(8–9):646–652.

54. Poonam K., Singh G.S. 2009. Ethnobotanical study of medicinal plants used by the Taungya community in Terai Arc Landscape, India. J. Ethnopharmacol., 123(1):167–176.

55. Pullaiah T. 2002. Medicinal Plants in India. Vol. I. Regency Publication, New Delhi, India, pp. 75.

56. Rajakumar H.N., Shivanna M.B. 2010. Traditional Herbal Medicinal Knowledge in Sagar Taluk of Shimoga District, Karnataka, India. Indian J. Nat. Prod. Res., 1:102–108.

57. Rashid A. 2012. Medicinal plant diversity utilised in the treatment of gastrointestinal disorders by the Gujjar–Bakerwal tribe of district Rajouri of Jammu and Kashmir state. Indian J. Sci. Res., 3(2):115–119.

58. Salai S.M.S.D., Vaidyanathan D., Sivakumar D., Basha M.G. 2014. Diversity of ethnomedicinal plants used by Malayali tribals in Yelagiri hills of Eastern ghats, Tamilnadu, India. Asian J. Plant Sci. Res., 4(1):69–80.

59. Samvatsar S., Diwanji V.B. 2000. Plant sources for the treatment of jaundice in the tribals of Western Madhya Pradesh of India. J. Ethnopharmacol., 73(1–2):313–316.

60. Sarkhel S. 2014. Ethnobotanical survey of folklore plants used in treatment of snakebite in Paschim Medinipur district, West Bengal. Asian Pac. J. Trop. Biomed., 4(5):416–420.

61. Sekharan R., Jagadeesan M. 1997. An ethnobotanical survey of Javvadhu hills, Tamil Nadu. Ancient Sci. Life., 16(3):206–214.

62. Sen S., Chakraborty R., De Biplab, Devanna N. 2011. An ethnobotanical survey of medicinal plants used by ethnic people in West and South district of Tripura, India. J. Forestry Res., 22(3):417–426.

63. Singh K., Kumar P., Kumar B., Lone J.F., Sharma P.R., Gairola S., 2020. Morpho-anatomical and palynological standardization and DNA barcoding of *Fritillaria cirrhosa* D. Don (Syn. *Fritillaria roylei* Hook.). Plant Arch., 20:1304–1313.

64. Shanmugam S., Manikandan K., Rajendran K. 2009. Ethnomedicinal survey of medicinal plants used for the treatment of diabetes and jaundice among the villagers of Sivagangai district, Tamilnadu. Ethnobot. Leaflet., 13:189–194.

65. Sharma J., Gairola S., Gaur R.D., Painuli R.M., Siddiqi T.O. 2013b. Ethnomedicinal plants used for treating epilepsy by indigenous communities of sub-Himalayan region of Uttarakhand, India. J. Ethnopharmacol., 150(1):353–370.

66. Sharma J., Gairola S., Sharma Y.P., Gaur R.D. 2014. Ethnomedicinal plants used to treat skin diseases by Tharu community of district Udham Singh Nagar, Uttarakhand, India. J. Ethnopharmacol., 158:140–206.

67. Sharma J., Gaur R.D., Gairola S., Painuli R.M., Siddiqi T.O. 2013a. Traditional herbal medicines used for the treatment of skin disorders by the *Gujjar* tribe of Sub-Himalayan tract, Uttarakhand. Indian J. Tradit. Knowl., 12(4):736–746.

68. Sharma L., Khandelwal S. 2016. Ethnobotany of genus *Calotropis* in Rajasthan. Indian J. Environmental Sci., 20(1,2):43–46.

69. Shil S., Choudhury M.D., Das S. 2014. Indigenous knowledge of medicinal plants used by the Reang tribe of Tripura state of India. J. Ethnopharmacol., 152(1):135–141.

70. Shukla A.N., Srivastava S., Rawat A.K.S. 2010. An ethnobotanical study of medicinal plants of Rewa district, Madhya Pradesh. Indian J. Tradit. Knowl., 9(1):191–202.

71. Singh A.K., Raghubanshi A.S., Singh J.S. 2002. Medical ethnobotany of the tribals of Sonaghati of Sonbhadra district, Uttar Pradesh, India. J. Ethnopharmacol., 81(1):31–41.

72. Sonawane V.B., Saler R.S., Sonawane M.D., Kadam V.B. 2012. Ethnobotanical studies of Mokhada, district Thane. Int. J. Plant Sci. Pharma Res., 2(2):L88–L93.

73. Thirumalai T., Elumalai E.K., Therasa S.V., Senthilkumar B., David E. 2010. Ethnobotanical Survey of Folklore Plants for the Treatment of Jaundice and Snakebites in Vellore Districts of Tamilnadu, India. Ethnobot. Leaflet., 14:529–536.

74. Thomas B., Rajendran A. 2013. Less Known Ethnomedicinal Plants Used by *Kurichar* Tribe of Wayanad District, Southern Western Ghats Kerala, India. Bot. Res. Int., 6(2):32–35.

75. TPL 2013. The Plant List. Version 1.1. Published on the Internet; http://www.theplantlist.org/ (accessed 26 August 2020).

76. Trivedi P.C. 2006. Medicinal Plants: Ethnobotanical Approach. Jodhpur: Agrobios, pp. 147, 259.

77. Upadhyay B., Parveen, Dhaker A.K., Kumar A. 2010. Ethnomedicinal and ethnopharmaco-statistical studies of Eastern Rajasthan, India. J. Ethnopharmacol., 129(1):64–86.

78. Wong S.K., Lim Y.Y., Chan E.W.C. 2013. Botany, uses, phytochemistry and pharmacology of selected Apocynaceae species: A review. Phcog. Commun., 3(3):2–11.