

A Comprehensive Review of Selected Traditional Medicinal Plants: Status, Phytochemistry, Medicinal Properties, Cultivation, and Demand

Rama Rao Vendrapati^{1,*}, Suresh¹, Sulochana Bhat¹, Kaipa Hima Bindu², Shalini Ramanduru Mahadevaswamy², Safeena Subaida Abdul Latheef², Duraisamy Kalaivanan², Nagayya Shiddamallayya³, Venkateswarlu⁴, Srikanth Narayanam³, Rabinarayan Acharya³

¹Survey of Medicinal Plants Unit, Central Ayurveda Research Institute, Bengaluru, Karnataka, INDIA.

²Division of Flower and Medicinal Crops, Indian Institute of Horticultural Research, Bengaluru, Karnataka, INDIA.

³Central Council for Research in Ayurvedic Sciences, New Delhi, INDIA.

⁴Regional Ayurveda Research Institute, Vijayawada, Andhra Pradesh, INDIA.

ABSTRACT

Plant-based systems continue to play an essential role in healthcare, and their use by different backgrounds has been extensively documented. *Rubia cordifolia* L. (Manjistha), *Convolvulus pluricaulis* Choisy (Shankapushpi), *Piper longum* L. (Pippali), *Boerhavia diffusa* L. (Rakta Punarnava) and *Uraria picta* (Jacq.) Desv. (Prishniparni) are traditionally used for treating several diseases particularly dysmenorrhea, diuresis, paralysis, jaundice, amenorrhea, skin disorders of many varieties, renal stone and blood detoxification, hypertension, neurodegenerative diseases, ulcers, high blood pressure, epilepsy, vomiting, diabetes, sun stroke and bleeding, chronic bronchitis, asthma, constipation, gonorrhoea and paralysis. The present analysis aimed to provide a general review of the available literature on ethnomedical, status of traditional medicine, phytochemicals and their source of compounds with biological activity, supply and demand in herbal and pharma industries and new cultivation methods for traditional medicinal plants and their necessity in present scenario.

Keywords: Traditional medicinal plants, Traditional medicine systems, Phytochemistry, Demand in herbal industry, Cultivation methods.

Correspondence:

Dr. Rama Rao Vendrapati

Research Officer (S-3), Survey of Medicinal Plants Unit, Central Ayurveda Research Institute, Bangalore-560109, Karnataka, INDIA.

Email: vendrapati@yahoo.com

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INTRODUCTION

Plants are a rich source of potential novel medications that have been utilised medicinally throughout history and in many cultures. According to the World Health Organization (WHO), 80% of people worldwide strongly rely on botanical medicine for their basic healthcare.^[1] Indian Traditional Systems of Medicine (ITM) include those that are believed to have originated in India or those that have entered India from another country and absorbed into Indian culture.^[2] India holds the distinction of having six of these recognised medical systems. Ayurveda, Siddha, Unani, Yoga, Naturopathy, and Homoeopathy are among them. Although homoeopathy arrived in India in the 18th century, it fully integrated into the local culture and developed alongside other traditional medical systems, earning its place among the Indian Systems of Medicine.^[2] In addition to these

systems, there are several healers in the folklore stream who are not classified in any way. There is also a gold mine of medications in Traditional Chinese Medicine (TCM), which have been widely disseminated and used in more than 100 countries to treat a variety of disorders.^[2]

The most popular system of ancient Indian medicine, Ayurveda, places a strong emphasis on holistic care, which treats the body, mind, and spirit as a whole. It is founded on the idea that maintaining harmony with nature is the key to achieving human health on all levels; physical, mental, and emotional.^[3] India has a population of 1.38 billion people, more than 70% of whom reside in rural regions. The national health system is said to only be able to offer services to up to 30% of the population, with the remaining population relying on local Ayurvedic medicine, despite the government having developed a multi-level network of health institutions in states, counties, districts, and villages. In modern general hospitals are also having few traditional medical departments. 2,827 hospitals and 15,520 pharmacies practice Ayurvedic treatment, according to Minister of State Shripad Yesso Naik.^[4]



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In India, natural resources account for roughly 70% of contemporary pharmaceuticals, and several synthetic counterparts have been created using prototype chemicals extracted from plants. According to reports, more than 60% of anticancer medications either on the market or through clinical trials are derived from herbs. Currently, nearly 80% of cardiovascular, antimicrobial, immunosuppressive, and anticancer medications are derived from plants. Over 70% of the 177 licensed anticancer medications are imitations or natural compounds. There are over 121 plant-based prescription medications in use worldwide, accounting for around 25% of all pharmaceuticals.^[5] According to estimates, 1200-1800 plant species are used in Ayurvedic medicine, while more than 7500 plant species are used in various remedies by Indian folk therapists. Indian traditional medicine research is now conducted by more than 400 organisations, including the Central Drug Research Institute (CDRI), the Indian Ayurveda Scientific Research Centre, and a number of commercial research institutes like private research centers, institutions, and universities.^[5] The present research hotspot spans a variety of disciplines, including fundamental research, preclinical or clinical research, standardized research, and ITM development. The Indian government also supports many research and development (R&D) initiatives pertaining to the study of medicinal plants.

In the process of new drug development based on the ITM, we are selecting the 5 traditional medicinal plants i.e. *Rubia cordifolia* L. (Manjistha), *Convolvulus pluricaulis* Choisy (Shankapushpi), *Piper longum* L. (Pippali), *Boerhavia diffusa* L. (Rakta Punarnava) and *Uraria picta* (Jacq.) Desv. (Prsniparni) to review habitat, description, Status of traditional systems of medicine, phytochemistry of traditional medicinal plants with their reported biological properties and medicinal utility, demand of selected medicinal plants in herbal and Pharma industry, new cultivation methods in present scenario for the productions and supply of plants.

HABITAT AND DESCRIPTION OF R. CORDIFOLIA, C. PLURICAULIS, P. LONGUM, B. DIFFUSA AND U. PICTA TRADITIONAL MEDICINAL PLANTS

Table 1 shows the habitat and descriptions of traditional medicinal herbs *Rubia cordifolia* L., *Convolvulus pluricaulis* Choisy, *Piper longum* L., *Boerhavia diffusa* L., and *Uraria picta* (Jacq.) Desv. ex DC.

Indian madder, or *Rubia cordifolia*, is a species of flowering plant in the Rubiaceae family of flowering plants, which also includes coffee.^[6] It has been grown for its red colour, which comes from the roots. It can grow to 1.5-12 m height, the evergreen leaves, which are formed in whorls of four to seven star-like around the central stem, are 5 to 10 cm long and 2-3 cm wide. Tiny (3-5 mm in diameter) pale yellow-petalled blooms occur in thick racemes from June to August. They are followed by tiny

(4-6 mm in diameter) reddish-black berries. The roots may grow up to 12 mm thick and more than 1 m long. Rheumatism, menstrual discomfort, urinary system illnesses, dropsy, paralysis, amenorrhoea, and jaundice are all treated with this medication in India.^[7,8] *R. cordifolia* has been utilised in Ayurveda as a colouring agent for medicinal oils, as well as administered topically to inflamed regions, ulcers, and fractures. The root of *R. cordifolia* has been used to treat a variety of chronic inflammations.^[9,10]

Convolvulus pluricaulis Choisy (*Convolvulus prostratus*) is an herb found in northern India and Burma which commonly grows on the roadside that is used in Ayurveda medicine as therapeutic agents.^[11] The Ayurvedic pharmacopoeia of India considers the use of the whole plant of *C. pluricaulis*.^[11] The perennial plant *C. pluricaulis* resembles morning glory. Its branches, which may reach lengths of over 30 cm, are dispersed throughout the ground. The leaves are elliptic in form (2 mm) and positioned sporadically with branches or flowers. The blooms are blue in colour (5 mm). The plant, frequently referred to as "aloe weed" in English, is widespread in India, particularly in the state of Bihar.^[12]

Piper longum (family Piperaceae), sometimes known as "long-pepper" or "Pippali," is a perennial shrub or a herbaceous vine that grows as a perennial shrub or as a perennial vine. It is indigenous to the Indo-Malaya area and is found across the tropical and subtropical world, including the Indian subcontinent, Sri Lanka, the Middle East, and North America. Scandent or straggling bushes that occasionally rise and climb. Leaves oblong, sharp at apex, cordate and strongly oblique at base, 7-nerved, membranous, shiny above; nerves impressed; petiole 1-3 cm long. Female spikes are sturdy and upright, with a 1.5 cm long peduncle and peltate, orbicular bracts. Male spikes are up to 7 cm long, upright, and thin, with 2 stamens. Glabrous, black or deep crimson berry 2 mm across. The roots are primarily employed as a strong cure in several traditional medical systems for bronchitis, cough, cold, snakebite, and scorpion-sting, as well as a contraceptive.^[13] Various bioactive-phytochemicals, including alkaloids, flavonoids, esters, and steroids, were identified from plant extracts, and essential oils from the roots and fruits were reported to be antimicrobial, antiparasitic, anthelmintic, mosquito-larvicidal, anti-inflammatory, analgesic, antioxidant, anticancer, neuropharmacological, antihyperglycemic, hepatoprotective and anti-hyperlipidaemic.

Boerhavia diffusa Linn. (Family: Nyctaginaceae) is a well-known medicinal plant in traditional Indian medicine as well as in other regions of the world, such as Southern America and Africa.^[14] Flowers are tiny, measuring around 5 mm in diameter. Pollens are spherical, measuring around 65 microns in diameter. The vast spread of pollen is explained by its little fruit, which are highly sticky and grow a few inches from the ground, well positioned to hook on to small migrating birds as they pass by. A root is a creeping, perennial plant with a dense fusi shape. The leaves are opposite, oblique, oval or suborbicular, rounded, whole, with

Table 1: Morphological description, vernacular names and taxonomic classification of *R. cordifolia*, *C. pluricaulis*, *P. longum*, *B. diffusa* and *U. picta* traditional plants.

	<i>R. cordifolia</i> L.	<i>C. pluricaulis</i>	<i>P. longum</i> L.	<i>B. diffusa</i> L.	<i>U. picta</i>
Taxonomic Classification					
Kingdom	Plantae	Plantae	Plantae	Plantae	Plantae
Class	Dicotyledone	Magnoliopsida	Magnoliopsida	Magnoliopsida	Fabids (EurosidsI)
Subclass	Sympetaleae	Asteridae	Magnoliidae	Caryophyllidae	-
Order	Rubiales	Solanales	Piperales	Caryophyllales	Fabales
Family	Rubiaceae	Convolvulaceae	Piperaceae	Nyctaginaceae	Fabaceae
Genus	Rubia	Convolvulus	Piper	<i>Boerhaavia</i> L.	Uraria
Species	<i>R. cordifolia</i>	<i>C. pluricaulis</i>	<i>P. longum</i> L.	<i>B. diffusa</i> L.	<i>U. picta</i>
Vernacular Names					
Sanskrit	Manjishtha, Viksa, Yojanvalli	Sankhapuspa	Pippali	Kahtilla, Sophaghni, Varshabhu, Punarnava, Raktakanda, Shothaghni,	Citraparni, Kalasi, Dhavani, Prishniparni, Galvanina
Hindi	Manjith	Shankhapushpi, Aparajit	Pipli	Gadahpurna, Lalpunarnava, Snathikari, Biskhafra, Beshakapori	Pithava, Dabra
Marathi	Manjit	Shankhavela	Pimpli	Ghetuli, Vasuchimuli, Satodimula, Punarnava	Pithava, Prishniparni
Bengali	Manjishtha	Sankhapuspi	-	Raktapunarnava, Punarnava	Salpani, Chhalani, Chakule
Gujarati	Manjith	Shankhaveli	Pipari	Dholisaturdi, Motosatodo	Pithava
Tamil	Manjitti	Sanghupushpam, kakkurattai	Tippili	Mukurattai (Shihappu)	Oppai
Telugu	Tamravalli	Shankhapushpi	Pippallu	Atikamamidi, Erragalijeru, Punarnava	Murele Honne, Andale home, Prushniparni
Kannada	Manjishtha	Bilikanthisoppu	Kandan Lippili	Sanadika, Kommeberu, Komma, Kommegida	Kolakuponna
Malayalam	Manjithi	Vishnukranthi	Pippali, Thippali	ChuvannaTazhutawa	Oril
English	Indian madder	Speed wheel	Indian long pepper Long pepper	Horse Purslane, spreading Hog - Weed	Prsniparni
Morphological description					
Height	Growing up to 12 m long.	30 cm long	Dioecious, aromatic, evergreen, and climbing plant up to 0.9 m high with jointed stems.	Prostrate divaricately branched; branches from common stalk about 1 m in length.	Straight tree between 1 and 2.5 m tall.
Leaves	Highly variable, ovate lanceolate, 5-7 nerved, 2-10 cm long and 2-5 cm broad.	Elliptic in shape (2 mm).	Creeping branch and epiphytic branches have ovate or elliptic blade. Leaves on free branches have ovate to ovate-oblong blade and dark green.	Unequal pairs, ovate-oblong or sub orbicular, size is larger ones 25-37 mm long and smaller ones 12-18 mm long and colour is green and whitish below, glabrous above.	composed of 2-5 leaflets and pinnate pairs.

Stem	Quadrangular, divaricately branched, prickly-hispid.	Prostrate stems (10-30 cm), surface clothed with silky hairs, internodes are 10-12 mm and tasteless.	Slender in shape, with aromatic odor.	Pale greenish below and light reddish brown.	5-7, (rarely 9), 10-20 cm long, linear oblong, acute, blotched with white, minutely pubescent beneath, base rounded.
Flowers	Fragrant, minute, whitish or greenish yellow.	Blue in color (5 mm), white or red in color and round or bell shaped.	Usually grow in solitary spikes. With the spikes, male and female plants can be distinguished as the plants are morphologically similar.	very small, lower part greenish, ovoid and upper part pink in colored, funnel-shaped, nearly sessile or shortly stalked, 10-25 cm.	35 and 75 (it is 10-70 cm long on a stem 0-5 cm long), usually in dense clusters like thorns that are pink or purple 1.5 m long.
Fruits	Minute, glabrous, 1-2 seeded, dark purplish or blackish when mature.	-	Greenish-black to black in color, Cylindrical in shape. When broken, surface shows a central axis and 6-12 fruitlets Arranged around an axis.	Glandular, narrowly oblongobovoid, about 3 mm long.	Between 2 and 6 seeds and the parts are almost separated. The fruits are hairless, distinctive, and gray.
Roots	Perennial, long, cylindrical, and rusty brown in colour.	-	Roots are generally woody.	Elongated, fusiform, tapering and somewhat tuberous or somewhat tortuous, cylindrical, 0.2-1.5 cm in diameter.	Hair like structures.

somewhat pinkish, wavy edges and a rounded base. The fruit is achene-shaped and 6-ribbed. Seeds are minute, albuminous, and include endosperm. The embryo is bent.^[15] Its different components, particularly the roots, have been utilised for gastrointestinal, hepatoprotective, and gynaecological purposes in the aforementioned sections of the world, as well as in India. It is a prominent element in over 35 distinct types of ayurvedic medicines.

Prsniparni is 60-75 cm tall, upright underbrush with many branches. A typical leaf can have three to five leaves, or up to nine leaves per leaf. Leaflets are pubescent below and white-clouded above, linear-oblong, obtuse, mucronate at apex, and imparipinnate.^[16] Bone fractures can mend more quickly when the *Uraria* species is used. It possesses diuretic, expectorant, and anti-inflammatory qualities in addition to being utilised as a cardiac and nervine tonic. One of the components of Ayurvedic "dasamoola" is the plant's root

STATUS OF *R. CORDIFOLIA*, *C. PLURICAULIS*, *P. LONGUM*, *B. DIFFUSA* AND *U. PICTA* IN TRADITIONAL SYSTEMS OF MEDICINE

As stated earlier, *R. cordifolia*, *C. pluricaulis*, *P. longum*, *B. diffusa* and *U. picta* plants are important herbal constituents of various ayurvedic formulations. They have been used in various formulations meant for inflammation, skin diseases, improves glowiness of face, blood purifier, wound healing, congestion, bronchitis, cough, cold, emphysema, longevity, drowsiness, mental exhaustion, dyspnoea, intelligence, memory, strength, gastrointestinal aberrations like bowel diseases, indigestion, intestinal gas, ulcers, abdominal distension, loss of appetite, anorexia, jaundice, asthma, rheumatism, nephrological disorders, ascites, anemia, and gynecological disorders, destroys pain spasms, used for external body massaging, used in the treatment of massage in neuro-muscular conditions, depression and psychiatric conditions. Table 2 enlists various traditional formulations having above mentioned plants as the main ingredients.

Table 2: The list of *R. cordifolia*, *C. pluricaulis*, *P. longum*, *B. diffusa* and *U. picta* in traditional Ayurveda, Unani and Siddha medicinal systems against different disease conditions.

Traditional Formulations	Name of the Formulation	Used for Disease condition	References
<i>R. cordifolia</i> L. (Manjistha)			
Ayurvedic formulations	Laghu Manjisthaadi kwatha	Skin diseases.	[137]
	Madhya Manjisthaadi kwatha		
	Brihat Manjisthaadi kwatha		
	Maha Manjisthaadi kwatha	Treatment of skin diseases.	[138]
	Manjisthadhya tailam	Useful in Pidika.	[139]
	Mukhkrantimkar lepa	Improved the face glow.	
	Haridradavy tailam	Improved the face glow.	
	Kanak tailam	Cure wrinkles.	
	Manjisthadi tailam	Improves Glowness of face.	
	Kumkumadi tailam	Glowing face.	
	Manjistha with honey	Increases complexes on.	
	Raktachandan adi lepa	Improves Glowness of face.	[140]
	Raktasodhana	Blood purifier.	[139]
	Vranaropaka	Wound healing.	
	Vedanasthapana	Analgesic	
Unani formulations	Halwae Gheekwar	Anti-inflammatory effect and reduces joint swelling.	[141]
	Dawaul Kurkum kabir	Provides extra energy to kidneys and urinary bladder.	
	Safoof Khas	Men's reproductive health.	
	Safoof Musaffi khaas	Blood purifier.	
	Majoon Dabeedul ward	General weakness, loss of appetite, liver and spleen enlargement, jaundice, anorexia, enlargement of liver, swelling of stomach, cirrhosis of the liver and sluggish liver.	
	Majoon Suparipak	Leucorrhoea, general weakness, facial paleness, and anaemia.	
	Arq Anannas	Immunity booster.	
	Roghan Ahmar Jadeed	Paralysis, rheumatism, rickets and bruises. Removes weakness and pain from the tissues and joints.	[142]
	Sadri	Congestion, bronchitis, cough, cold, emphysema.	
	Aqras Mur		[143]
Majoon Alkula		[144]	
Majoon e Hafiz ul Ajsad			
<i>C. pluricaulis</i> Choisy (Shankapushpi)			
Ayurvedic formulations	Brahma Rasayana	Dirghayushya (longevity), tandra (drowsiness), klama (mental exhaustion), swasa (dyspnoea), medha (intelligence), smriti (memory), bala (strength).	[145]
	Dwitiya Brahma Rasayana	Dirghayushya, shrutagrahinya (quick comprehension), vishahara (detoxification).	

	Endra Rasayana	Smriti, medha, swarya (good voice), varna (glowing skin), vishahara, switra (leucoderma), kushtha (skin disorder), udararoga (abdominal diseases), pliha (spleen disorders), vishamajwara (intermittent fever).	
	Medhya Rasayana	Ayuprada (longevity), bala, deepana (kindle up digestion), swarya, medhya, rasayana (rejuvenation).	
	Brahmyadi	Vata kaphaja apasmara (epilepsy).	
	Medhya Rasayana	Vijnana (intelligence), dhairya (patience), samadhi (absoluteness).	
	Agastya Haritaki	Swasa (breathlessness), hikka (hiccough), arsha (piles), grahani (dysentery), hridroga (heart disease), aruchi (anorexia), pinasa (chronic coryza), vali (wrinkles), palit (grey hair), varna, bala, panchakasa (five type of cough), kshaya (emaciation).	
	Suvarnamityadi Churna	Medha, bala, buddhi, immuno-enhancer.	
	Dwipanchamuladi	Rajyakshma (similar to tuberculosis), grahani, shopha (inflammation), swarabheda (hoarse sound), kasa, pandu (similar to anaemia), swasa, shiroroga (head related problems), hridroga, hikka, vishamajwara, medha, bala.	
	Endra Rasayana	Swasa, hikka, vishamajwara, arsha, grahani, hridroga, pinasa, vali, palit, varna, bala, panchakasa, kshaya.	
	Medhya Rasayana	Ayuprada (longevity), bala, deepana (kindle up digestion), swarya, medhya, rasayana (rejuvenation).	
	Brahmyadi	Vata kaphaja apasmara (epilepsy).	[146]
	Medhya Rasayana	Vijnana (intelligence), dhairya (patience), samadhi (absoluteness).	
	Agastya Haritaki	Swasa (breathlessness), hikka (hiccough), arsha (piles), grahani (dysentery), hridroga (heart disease), aruchi (anorexia), pinasa (chronic coryza), vali (wrinkles), palit (grey hair), varna, bala, panchakasa (five type of cough), kshaya (emaciation).	
	Suvarnamityadi Churna	Medha, bala, buddhi, immuno-enhancer.	
	Dwipanchamuladi; Agastya Avaleha	Rajyakshma (similar to tuberculosis), grahani, shopha (inflammation), swarabheda (hoarse sound), kasa, pandu (similar to anaemia), swasa, shiroroga (head related problems), hridroga, hikka, vishamajwara, medha, bala.	
	Endra Rasayana	Swasa, hikka, vishamajwara, arsha, grahani, hridroga, pinasa, vali, palit, varna, bala, panchakasa, kshaya.	[147]
	Shankhapushpi Kalka	Jatakarma shirah sneha pichu (putting oil smeared cotton on head after birth) and prashana.	
	Vachadi kshirapaka	Vaka, medha, smriti, Buddhi.	
	Brahmi Ghrita	Unmada (mental disorder), kushtha, apasmara (epilepsy), vandhya (infertility), vaka, swara, smriti, medha.	
	Brahmyadi Purana Ghrita	Medhya, unmada, papma.	
	Pathyadi Ghrita	Tandra, shrama (lithargy), klama, vali, palita, medha, smriti.	
	Shankhpushpi Kalka	Ayuprada, amayanashana, bala, agni, swara, medhya.	

	Brahmi Ghrita	Jara, vyadhinashana, tandra, alasya, shrama, klama, kushtha, kilasa, gulma, visha, jwara, unmada, udararoga.	
<i>P. longum</i> L. (Pippali)			
Ayurvedic formulations	Pippalyasavam	It is a polyherbal digestive formulation dealing with gastrointestinal aberrations like bowel diseases, indigestion, intestinal gas, ulcers, abdominal distension, loss of appetite, anorexia.	[148]
	Vardhamana pippali	Decongestant, bronchodilator and expectorant effects due to its Kapha balancing properties.	
	Causasti pippali	Reduces gas and bloating. Detoxifies the body. Treats cough, asthma, and hiccups. Treats respiratory infections and disorders.	
	Pippali khanda	Its controls cough, releases mucus, clears air passages, thus allowing the patient to breathe freely.	
	Sitopaladi churna	It is prescribed for pleurodynia, intercostal neuralgia, cold, cough associated with bronchitis, pneumonia, tuberculosis, viral respiratory infection, and in pharyngeal and chest congestion.	
	Guda pippali	It is used extensively in liver disorders, splenomegaly, ascitis, chronic fever, inflammation.	
<i>B. diffusa</i> L. (Rakta Punarnava)			
Ayurvedic formulations	Punarnavadyarishta	Heart disease, anaemia, inflammation, splenomegaly, vertigo, hard stools, chronic obstructive jaundice/ chlorosis/advanced stage of jaundice, abdominal lump, fistula-in-ano, cough, dyspnoea/asthma, malabsorption syndrome, diseases of skin, and itching.	[149]
	Punarnava guggulu	Gout, inguinoscrotal swellings, sciatica, pain in calves-thighs-back-sacral and bladder region, and rheumatism.	[150]
	Punarnavasava	Dyspepsia, abdominal lump, diseases of abdomen/enlargement of abdomen, inflammation, disorder of spleen and liver, and all types of disorders with difficult prognosis.	[151]
	Punarnavadi kvathaurna	Generalized tremors, ascites, cough, colicky pain, dyspnea/asthma, and anaemia.	[152]
	Punarnavastaka kvathaurna	Ascites, anasarca, cough, dyspnea/asthma, and colicky pain.	[153]
	Punarnavadi mandura	Anaemia, malabsorption syndrome, inflammation, splenic disease, intermittent fever, haemorrhoids, diseases of skin, and helminthiasis/worm infestation.	[154]
	Sukumara ghrita	Constipation, diseases of abdomen/enlargement of abdomen, abdominal lump, splenic disease, abscess, edema, pain in female genital tract, haemorrhoids, inguinoscrotal swellings, diseases due to vata dosha, and gout.	[155]

	Maha Narayan Taila	Facial palsy, deafness, paraplegia, tremors, neck rigidity/torticollis, lock jaw, wasting of one limb, oligospermia, infertility, headache, glossal palsy, dental pain, mania/psychosis, hump-back/kyphosis, fever, senility/progeriasis, emaciation, tendon tear, and bone fracture.	[156]
	Sothaghna Lepa	All types of inflammation.	[157]
	Varuni	Rhinitis and pain.	[158]
	Nrupativallaba tailam	Timira, Patala, Kacha, Nakthandhya, Arbudam, Divandhyam, Linganasha	[159]
	Nayanasonitanjana	Timira, Patala, Puspam.	
	Kanaka taila	Caksu sula	
	Taptaraja tailam	Netra sula, Timira.	
	Karparadyanjana	Timram, Patalam, Kacam, Pushpam.	[160]
	Triphala ghrta	Naktandhya, nakulandhya, kandu, pilla, netrasrava, patala, timira, and kacha.	[161]
	Punarnava rasakriya	If Punarnava used as anjana with milk - kandu; with honey - discharge from the eyes; With ghee - puspa (corneal scars); with oil - defects of vision and with kanjika (rice-wash water) - night blindness dispels just like the sun dispels darkness.	
Charaka Samhita	Swedopaga	Adjunct to sweating therapy.	[162]
	Anuvasanupaga	Adjunct to oleating therapy.	
	Kaashara	Anti-tussive	
	Vayasthapana	Rejuvenator	
Sushruta Samhita	Pittaj ashmari	Renal stones	[163]
	Shotha	Anti-inflammatory	[164]
Ashtanga Sangraha	Kaashara mahakshaya	Antitussive	[165]
	Vayasthapana mahakshaya	Rejuvenator	[166]
Siddha formulation	Talakacenturam	Diseases due to heat/pitta humour, wheezing, jaundice, arthritis/arthritis, itching, oliguria/anuria, ascites and diseases due to vāta humour.	Anonymous, 2008
<i>U. picta</i> (Prsniparni)			
Ayurvedic formulations	Dashamoola	Remedy for inflammatory conditions.	[167]
	Amritarishta	Beneficial for the all kind of fevers, chronic fever and malaria.	
	Angamarda Prashamana Kashaya Curna	Destroys pain spasms.	
	Dashamula Taila	Used for external body massaging.	
	Vyaghrिता	Used in the treatment of cough, cold, asthma, bronchitis, fever.	
	Mahanarayan oil	Massage in Neuro-muscular conditions.	[168]
	Manasamitra vatakam	Depression and psychaitric conditions.	
	Dhanvantaram Thailam	Joint disorders and rheumatic conditions.	

Table 3: Major phyto-constituents of *R. cordifolia* L. (Root), *C. pluricaulis* (Whole plant), *P. longum* L. (Roots), *B. diffusa* (Root) and *U. picta* (Root) traditional medicinal plants with their reported biological properties and medicinal utility.

Sl. No.	Name of the phyto-compound	Category of phyto-compound	Biological and medicinal properties	References	
<i>R. cordifolia</i> L. (Roots)					
1	Griseolic acid	Pentacyclic triterpenoid	A potent cAMP phosphodiesterase inhibitor and insulin release in rat pancreatic islets.	[169, 170]	
2	Triacetyl-ganciclovir	Ganciclovir	Chemical manipulation of the heat resistance.	[171]	
3	Tetracenomycin	Polyketides and Glycosylations.	Its broad activity against actinomycetes.	[172]	
4	Aniracetam	Pyrrolidin-2-ones and a N-acylpyrrolidine	Acts to protect neurons through blockade of AMPA receptors and facilitates interhemispheric transfer through the corpus callosum.	[173]	
5	Isoorientin	Flavone C-glycoside	Radical scavenger, antihyperglycaemic effect and an antineoplastic agent.	[173]	
6	Rubiadin	Anthraquinones	Anticancer, antiosteoporotic, hepatoprotective, neuroprotective, anti-inflammatory, antidiabetic, antioxidant, antibacterial, antimalarial, antifungal, and antiviral properties.	[174-176]	
7	Alizarin		It inhibits the cell growth through cell proliferation blockade rather than induction of apoptosis and possessed significant modulatory role against the genotoxicity of mutagens.	[177, 178]	
8	Munjistin		Exhibits antiinflammatory, antiexudative effect and antiproliferative action	[179]	
9	Purpurin		It produces anti-inflammatory activity by reducing oxidative stress.	[179, 180]	
10	Techoquinone		It is a SARSCoV-2 main protease inhibitor against COVID-19 and exhibits strong mosquito larvicidal activity.	[181, 182]	
11	Xanthopurpurin		Anthraquinone glycoside	Inhibited the paraoxonase 1 enzyme activity	[174, 183]
12	1,3- dimethoxy 2- carboxy anthraquinone		Anthraquinone	Hemostatic agent for the treatment of hematorrhea, hematemesis, nose bleeding, traumatic bleeding, dysmenorrhea, and arthritis.	[184]
13	Pseudopurpurin	Affects bone mineral density and bone geometry architecture in rats.		[185]	
14	1-hydroxy-2-methylanthraquinone	-		[185]	
15	1,4-dihydroxy-2-methylanthraquinone	Coagulant activity		[186]	
16	2-methylanthraquinone	Antibacterial Activity		[33]	
17	1,4-dihydroxy-2-methyl-5-methoxyanthraquinone	-	[34]		

18	Ruberythric acid		-	[187]
19	3-methoxymollugin		Cytotoxic activity	[29]
20	Methyl 1,4-bisglucosyloxy-3-prenyl-2-naphthoate		Cytotoxic activity	[29]
21	Physcion		Antibacterial activity	[188]
22	Nordamnacanthal		-	[31]
23	Quinizarin (1,4-dihydroxy-6-methyl-anthraquinone)		Effective treatment modality for psoriasis.	[27]
24	1,4-dihydroxy-2- naphthoic acid			
25	Furomollugin		Activity against lymphoid leukemia (P338).	[189]
26	2-methyl-1, 3, 6-trihydroxy-9, 10-anthraquinone		Potential for treatment of IgE associated inflammatory diseases.	[28]
27	1- hydroxy-2 carboxy 3-methoxyanthraquinone		Recommended as a hemostatic agent for the treatment of hematorrhea, hematemesis, nose bleeding, traumatic bleeding, dysmenorrhea, and arthritis.	[184]
28	Oleanolic acid acetate		Antiviral, anti-HIV, antibacterial, antifungal, anticarcinogenic, anti-inflammatory, hepatoprotective, gastroprotective, hypolipidemic and anti-atherosclerotic activities.	[190]
29	Dihydromollugin	Naphthohydroquinones	Inhibition of Hepatitis B Surface Antigen Secretion on Human Hepatoma Cells	[191]
30	Mollugin		Inhibition of Hepatitis B Surface Antigen Secretion on Human Hepatoma Cells.	[191]
31	2-methyl-1,3,6-trihydroxy-9,10-anthraquinone	Anthraquinone	Cytotoxicity of breast and skin cancer cell lines.	[25]
32	2-carbamoyl-3-methoxy-1,4-naphthoquinone	Naphthoquinones	-	[26]
33	Rubioncolin B	naphthohydroquinones	-	[192]
34	Rubilactone	Anthraquinones	-	[191]
35	N-nonadecane		-	[193]
36	Rubiatriol		Antioxidant and anti-proliferative properties.	[24]
37	Epoxy-mollugin			
38	1,6-dihydroxy-2-methyl-9,10-anthraquinone			
39	6-methoxygeniposidic acid	Iridoid glucoside	Antioxidant and Anti-Proliferative Properties.	[24]
40	Rubiprasin A, B	Not yet classified	-	[24]
41	Rubiarbonol A-F	Triterpenoid	A novel anticancer agent that activates RIPK1-dependent cell death via ROS production.	[194, 195]

42	Hederagenin	Saponins	Antiinflammatory, antioxidative, antiviral, antiallergic, hypocholesterolemic.	[195]	
43	B-sitosterol	Phytosterol	Antinociceptive, anxiolytic and sedative effects, analgesic, immunomodulatory, antimicrobial, anticancer and anti-inflammatory.	[196]	
44	Rubiasin A	Anthracene	Antiproliferative activity.	[197]	
45	Rubiasin B				
46	Rubiasin C				
47	RA-I	Cyclic hexapeptides	Cytotoxicity and inhibiting NF- κ B signaling.	[198]	
48	[Gly-1]RA-VII			Antitumor activity and Cytotoxic activity.	[36]
49	[Gly-2]RA-VII				
50	RA-VII				
51	RA-V				[37]
52	RA-XXIV				
53	RA-VIII				[38]
54	RA-X				[39]
55	RA-XI				[40]
56	RA-XII				
57	RA-XIII				
58	RA-XVI				[41]
59	RA-XVII				[42]
60	RA-XVIII				[43]
61	RA-XIX				[43]
62	RA-XX				
63	RA-XXI				
64	RA-XXII				
65	N-heptadecane	Hydrocarbon	Antioxidant and Anti-Proliferative Properties.	[24]	
<i>C. pluricaulis</i> (whole plant)					
1	Ayapanin	Coumarin	Antinociceptive activity; acetylcholinesterase (AChE) inhibitor; fungitoxic activity.	[53]	
2	Scopoletin				
3	Scopolin				
4	Convolamine	Alkaloids	Antihypoxic, immune-modulating, and anti-inflammatory activity.	[44]	
5	Convoline			Anti-epileptic activity.	[45]
6	Convolvine			Antihypoxic, immune-modulating, and anti-inflammatory activity; blocks the M-receptors; exhibits nootropic, cytotoxic and sedative activity.	[44, 46]
7	Shankhapushpine			-	[47]

8	Convolidine		Antioxidant Activity	[48]
9	Confoline			
10	Convosine			
11	Evolvine			
12	Phyllabine			
13	Subhirsine			[48, 199]
14	Delphinidine	Anthocyanin	Antioxidant, anti-mutagenic, anti-inflammatory and antiangiogenic.	
15	Hydroxy-cinnamic acid	Carboxylic acid	Antioxidant, photooxidant activity; strong inhibitory effect on the tumour U14.	[59]
16	Cinnamic acid		Antioxidant, antifungal activity and antibacterial activities.	[60]
17	Kaempferol	Flavonoid	Activates LXR- β and suppresses SREBP-1 to enhance symptoms in metabolic syndromes; potent inhibitory effect on <i>in vitro</i> bone resorption; anti-inflammatory, anti-oxidant activity; inhibition of cancer cell invasion through blocking the PKC δ /MAPK/AP-1.	[51]
18	Quercetin		Antioxidant activity; stimulator of recombinant SIRT1 and also a PI3K inhibitor; attenuated the function VEGFR, androgen receptor and the expressions of NF- κ B, IL Receptor, FAK, ERK, Nrf2.	[52]
19	Cetyl alcohol	Fatty alcohols	-	[57]
20	N-hexacosanol		-	[158]
21	Myristic acids	Volatile acids	Cognition-boosting	[121]
22	Palmitic acids			
23	Linoleic acids			
24	2-Butanone	Hydrocarbons	-	[63]
25	1-pentyl-2-tridecanyl cyclopentyl cyclohexane carboxylate			[63]
26	1,2-benzenedicarboxylic acid			[200]
27	Heneicosane			
28	Pyrimidine			Heterocyclic amine
29	D-glucose	Carbohydrates	Antidepressant-like activity	[62, 11]
30	Sucrose			
31	Rhamnose			
32	Maltose			
33	Geranilan-3-ol-1-carboxylate-1-O- β -D-xylopyranosyl-(2' \rightarrow 1'')-O- β -D-xylopyranoside	Glycosides	-	[56]
34	20-oxodotriacontanol			Cognition-boosting

35	10-bromodecanoic acid	bromo carboxylic acid	-	[56, 63, 200, 201]	
36	2-pentanol	Secondary alcohol			
37	Ascorbic acid	Vitamin			
38	Decanoic acid	Straight chain fatty acids			
39	Tridecane	Alkane hydrocarbon			
40	Pentanoic acid	Straight chain fatty acids			
41	Phthalic acid	Benzenedicarboxylic acid			
42	Squalene	Triterpenoids			
43	Taraxerone		Anti-inflammatory; anti-cancerous activity.		[58]
44	Taraxerol				[55]
45	Tetratriacontanoic acids		Cognition-boosting	[121]	
46	α -Amyrin		The potential effects on glycemic balance; Anti-inflammatory; anti-proliferation; anti-pyretic; pro-apoptotic activity.	[54]	
47	Lupeol				
48	Stigmasterol				
49	Campesterol				
50	β -sitosterol		Phytosterols		
51	Eugenol		Phenylpropanoids		
<i>P. longum</i> L.					
1	Piperlongumine	Alkaloid	Preventive potentials of stress responses and pain.	[68, 69]	
2	Cepharadione A		Central nervous system (CNS), pesticidal, antifungal and antibacterial effects.	[70, 71]	
3	Cepharanone B				
4	Aristolactam AII		Anticancer activity	[71]	
5	Norcepharadione B		Antioxidants and inhibiting volume-sensitive Cl ⁻ channel.	[72]	
6	2-hydroxy-1-methoxy-4H-dibenzo[de, g]quinoline-4,5(6H)-dione		-	[71]	
7	Piperolactum A		-	[71, 73]	
8	Piperolactam B		-	[71]	
9	Piperadione		-	[71]	
10	Dihydrocarveol dihydrocarveol zingiberene ρ -cymene terpinolene		Terpenes	Potential Benefits in the Treatment of Obesity, Alzheimer's Disease, Dermatophytosis, and Drug-Resistant Infections.	[74]
11	α -Pinene	Essential oils	Anti-inflammatory via PGE1 and antimicrobial.	[65, 66]	
12	Camphene		Antioxidant and Antibacterial Activity.	[67]	
13	β -Pinene				
14	β -Myrcene				
15	α -Phellandrene				
16	β -Phellandrene				
17	Limonene				

18	1,8-Cineole			
19	(E)- β -Ocimene			
20	(Z)- β -Ocimene			
21	Bornyl acetate			
22	2-Undecanone			
23	Tridecane			
24	δ -Elemene			
25	Pentadecane			
26	β -Caryophyllene			
27	Furan, tetrahydro-2,5-dimethyl-, cis-			
28	2-Pentanol, 2-methyl-			
29	3-Pentanol, 3-methyl-			
30	Toluene			
31	2-Nonanone, 9-[(tetrahydro-2H-pyran2-yl)oxy]-			
32	Mesitylene			
33	Decane, 3,6-dimethyl-			
34	o-Cymene			
35	p-Cymene			
36	Benzene, 1,2,3,4-tetramethyl			
37	Azulene			
38	Caryophyllene			
39	Piperine			
40	trans-.alpha.-Bergamotene			
41	beta.-GURJUNENE			
42	Humulene			
43	alpha.-Guaiene			
44	Valerena-4,7(11)-diene			
45	Longifolene			
46	Aromandendrene			
47	trans-Verbenol			
48	Nerolidol 2			
49	Diethyl Phthalate			
50	Isospathulenol			
51	Dibutyl phthalate			
52	Retrofractamide-A			
53	gamma.-Sitostenone			
54	(E)-5-(Benzo[d][1,3]dioxol-5-yl)-1-(piperidin-1-yl)pent-2-en-1-one			
55	(Piperidine, 1-[5-(1,3-benzodioxol-5-yl)-1-oxo- 2,4-pentadienyl]-, (Z,Z)			

56	Pluriatilol	Lignins	-	[202]
57	Fargosin			
58	Sesamine			
59	Asarinine			
60	Guineensine			
61	Pipericide			
<i>B. diffusa</i> (Roots)				
1	Punarnavoside	Phenolic glycoside	Antifibrinolytic	[87]
2	Borhaavone	C-Methyl flavone	-	[203]
3	Trans-caftaric acid	Phenolic acid	-	[75, 85]
4	Boeravinones A, B, C, D, E, F	Rotenoids	Anticancer, spasmolytic.	[75]
5	Boeravinones G		Antioxidant and genoprotective effects.	[76]
6	Boeravinones H-S		Antioxidant activity and Anti-arthritic.	[77-79]
7	Boerhavisterol		-	[89]
8	Boerhavanostenyl benzoate			
9	Boerhadiffusene			
10	9-O-Methyl-10-hydroxy coccineone E		Spasmolytic effects	[75]
11	Diffusarotenoid		-	[81]
12	6-O-Demethyl-boeravinone H		Spasmolytic effects	[75]
13	10-Demethyl boeravinone C			
14	Coccineones E, B			
15	Boerhavine	Xanthone	-	[204]
16	Liriodendrin	Lignan	Ca ²⁺ channel antagonist	[85]
17	Syringaresinol mono-β-D-glucoside			
18	Hypoxanthine-9-L-arabinofuranoside	Purine nucleoside	Cardiotonic	[205]
19	Boerhavisterol	Sterol	-	[81]
20	Boeravilanostenyl benzoate	Sterol ester		
21	β-Ecdysone	Ecdysteroid	Increases protein synthesis, antidepressant, antistress and immunomodulation, antihyperglycemic, hepatoprotective.	[206]
22	Triacont-24-en-1-oic acid	Fatty acid		
23	Boeradiffusene	Hydrocarbons	-	[81]
24	2'-O-methylabronisoflavone	Isoflavone	Effect on intestinal motility.	[80]
25	2-glucopyranose-4-hydroxy-5-[P-hydroxyphenyl]-propionyl diphenyl methane	Phenolic	Antiviral potentials, diuretic, antifibrinolytic, anticonvulsant and antibacterial.	[86]
26	Ursolic acid			
27	Punarnavine			
28	Liiodendrin			
29	Quercetin-3-O-robinobioside	Flavonoid	-	[82-84]
30	Eupalitin-3-O-galactosyl (1,2)-glucoside			

31	5-methyleicos-4-ene	Lipids	Antihyperglycemic and hepatoprotective.	[89]
32	Eicos-4-ene			
33	4-methyloctadec-3-ene			
34	4-methylnonadecylbenzene			
<i>U. picta</i> (Roots)				
1	4',5-dihydroxy-2',3'-dimethoxy-7-(5-hydroxyoxychromen-7yl)-isoflavanone	Isoflavanones	Antibacterial activity of isoflavones against gram positive, gram negative and fungi.	[90]
2	5,7-Dihydroxy-2'-methoxy-3',4'-methylenedioxyisoflavanone			
3	Stigmasta-4			
4	22-diene-3-one			
5	β -Sitosterol			
6	Lupeol			
7	40,5-dihydroxy-20,30-dimethoxy-7-(5-hydroxyoxychromen-7yl)-isoflavanone	-	-	[90]
8	Rhoifolin (Apigenin-7-o-neohesperidoside)	Flavonoid	-	[91]

Phytochemistry of *R. cordifolia* L. (Root), *C. pluricaulis* (Whole plant), *P. longum* L. (Roots), *B. diffusa* (Root) and *U. picta* (Root) traditional medicinal plants with their reported biological properties and medicinal utility

Many people in developing and developed countries rely on medicinal plants as their primary source of healthcare, especially for the treatment of metabolic, chronic, neuropsychiatric, neurodegenerative, and infectious disorders. Despite the extensive usage of medicinal plants, there is a paucity of research explaining the importance and hazards of phytochemical exposure from medicinal plants. *R. cordifolia* L. (roots), *C. pluricaulis* (whole plant), *P. longum* L. (roots), *B. diffusa* (roots), and *U. picta* (roots) have traditionally been used to cure a variety of ailments in the form of pastes, decoctions, and lotions. In this review, we will discuss the phytochemical present in the five traditional plants indicated above, as well as the pharmacological value and relevance of these phytochemicals.

Phytochemistry of *R. cordifolia*

Because of the widespread usage of *R. cordifolia* in Indian traditional systems and TCM, the chemical components and pharmacological effects of *R. cordifolia* have aggravated the interest of researchers worldwide. Hundreds of components have been isolated and identified from *R. cordifolia* roots. Table 3 shows the chemical components and pharmacological effects of *R. cordifolia*.

Anthraquinones are a major class of representative compounds in *R. cordifolia* roots, including alizarin, munjistin, rubiadin, purpurin, techoquinone and xanthopurpurin.^[17-22] At present, 33 anthraquinones were isolated from *R. cordifolia* roots.^[23] (1,3-dimethoxy 2-carboxy anthraquinone and 1-hydroxy-2-carboxy 3-methoxyanthraquinone),^[24] (1,6-dihydroxy-2-methyl-9,10-anthraquinone),^[25] (2-methyl-1,3,6-trihydroxy-9,10-anthraquinone),^[26] (2-carbamoyl-3-methoxy-1,4-naphthoquinone),^[27] (Quinizarin (1,4-dihydroxy-6-methyl-anthraquinone) and 1,4-dihydroxy-2-naphthoic acid),^[28] (2-methyl-1, 3, 6-trihydroxy-9, 10-anthraquinone),^[29] (3-methoxymollugin),^[30] (Methyl 1,4-bisglucosyloxy-3-prenyl-2-naphthoate),^[31] (1-hydroxy-2-methylanthraquinone),^[32] (1,4-dihydroxy-2-methylanthraquinone),^[33] (2-methylanthraquinone) and^[34] (1,4-dihydroxy-2-methyl-5-methoxyanthraquinone) isolated 13 new anthraquinones from *R. cordifolia* root, which are showing their antioxidant, anticancer, psoriasis, coagulant, antibacterial, hematorrhea, hematemeses, nose bleeding, traumatic bleeding, dysmenorrhea, and arthritis and anti-proliferative properties.

Bicycle hexapeptides are also commonly considered as the most important bioactive compounds in *R. cordifolia* roots, which are extremely abundant after anthraquinones. So far, 18 bicyclic peptides were found in *R. cordifolia* roots. Lots of Rubiaakane series peptides (RAs) compounds with anti-tumor, cytotoxicity and inhibiting NF- κ B signaling bicyclic hexapeptides were isolated from roots of *R. cordifolia*, such as RA-I,^[35] [Gly-1]RA-VII, [Gly-2]RA-VII and RA-VII,^[36]

RA-V,^[37] RA-XXIV,^[37] RA-VIII,^[38] RA-X,^[39] RA-XI,^[40] RA-XII,^[40] RA-XIII,^[40] RA-XVI,^[41] RA-XVII,^[42] RA-XVIII,^[43] RA-XIX, RA-XX, RA-XXI and RA-XXII.^[43] Up to now, numerous cyclic hexapeptides have been discovered and isolated from *R. cordifolia* roots. Each RA compound contains an 18-membered ring and a 14-membered ring system, which includes amino acids such as n-methyl-O-methyl-l-tyrosine, pyroglutamic acid, l-alanine and d-alanine. In addition, pentacyclic triterpenoid, ganciclovir, polyketides and glycosylations, pyrrolidin-2-ones, a N-acylpyrrolidine, flavone C-glycoside, triterpenoid, saponins, phytosterol and anthracene are also present in roots of *R. cordifolia*.

Phytochemistry of *C. pluricaulis*

Thorough research studies is done on phytochemistry of whole plant of *C. pluricaulis* and huge amount of alkaloids such as convolvamine shows the antihypoxic, immune-modulating, and anti-inflammatory activities,^[44] convoline shows anti-epileptic activity,^[45] convolvine blocks the M-receptors, exhibits nootropic, cytotoxic and sedative activities,^[44,46] Shankhapushpine has anti-inflammatory, anti-proliferation, anti-pyretic and pro-apoptotic activities,^[47] convolidine, confoline, convosine, evolvine and phyllabine are have strong antioxidants,^[48,49] delphinidineanthocyanin have strong antioxidant, anti-mutagenic, anti-inflammatory and antiangiogenic activities,^[50] flavonoids like kaempferol activates LXR- β and suppresses SREBP-1 to enhance symptoms in metabolic syndromes; potent inhibitory effect on *in vitro* bone resorption and also inhibition of cancer cell invasion through blocking the PKC δ /MAPK/AP-1,^[51] and quercetin act like stimulator of recombinant SIRT1 and also a PI3K inhibitor and attenuated the function VEGFR, androgen receptor and the expressions of NF- κ B, IL Receptor, FAK, ERK, Nrf2,^[52] coumarins like ayapanin, scopoletin and scopolin are Acetylcholinesterase (AChE) inhibitor, antinociceptive and fungitoxic activity,^[53] phytosterols (campesterol and β -sitosterol) are potential glycemic balancing and anti-inflammatory agents,^[54] myristic acids, palmitic acids and linoleic acids (volatile acids) have cognition-boosting, triterpenoids have anti-inflammatory and anti-cancerous activity,^[55] glycosides,^[56] fatty alcohol^[57,58] carboxylic acid,^[59,60] heterocyclic amine,^[61] carbohydrates,^[48,62] and hydrocarbon^[63] are also present in the whole plant of *C. pluricaulis* and their biological and medicinal properties are reported in Table 3.

Phytochemistry of *P. longum*

Thorough research studies is done on phytochemistry of *P. longum* roots and enormous quantity of bioactive compounds and their biological and medicinal properties have been reported in Table 3 which are alkaloid, terpenes, essential oils, and lignins.

Based on the previous data showed that the root oil was dominated by monoterpene hydrocarbons (62.0% of the total oil) and sesquiterpene hydrocarbons (27.5% of the total oil).^[64]

More than 50 essential oils are reported in the roots of *P. longum*, some majority of essential oils are camphene, caryophyllene, cis-ocimene, eucalyptol, humulene, limonene, pentadecane, tridecane, α -phellandrene, α -pinene, β -elemene, β -myrcene, β -phellandrene, β -pinene, δ -elemene, δ -cadinol; alkaloid such as piperlongumine, cepharadione A, cepharanone B, aristolactam AII, norcepharadione B, 2-hydroxy-1-methoxy-4H-dibenzo[de, g]quinoline-4,5(6H)-dione, piperolactum A, piperolactam B, and piperadione, Lignins like pluriatilol, fargosin, sesamine, asarinine, guineensine and pipericide, terpenes like dihydrocarveol, zingiberene, ρ -cymene, terpinolene are also identified from roots in various investigations.

P. longum roots isolated above mentioned phytochemicals and bioactive compounds mainly finds its application in the treatment of essential oils for anti-inflammatory via PGE1 and antimicrobial, antioxidant and antibacterial activity,^[65-67] alkaloid are used to treat preventive potentials of stress responses and pain, Central Nervous System (CNS), pesticidal, antifungal and antibacterial effects, anticancer activity and antioxidants and inhibiting volume-sensitive Cl⁻ channel;^[68-73] terpenes are potential benefits in the treatment of obesity, alzheimer's disease, dermatophytosis, and drug-resistant infections.^[74]

Phytochemistry of *B. diffusa*

Major compounds isolated from *B. diffusa* roots are Boeravinones A, B, C, D, E, F, boeravinones G, boeravinones H-S, boerhavisterol, boerhavilanostenyl benzoate, boerhadiffusene, 9-O-methyl-10-hydroxy coccineone E, diffusarotenoid, 6-O-demethyl-boeravinone H, 10-demethyl boeravinone C and coccineones E, B (rotenoids); quercetin-3-O robinobioside, borhaavone, 2'-O-methylabronisoflavone and eupalitin-3-O-galactosyl (1,2)-glucoside (iso-flavonoids); liriodendrin and syringaresinol mono- β -D-glucoside (lignan); punarnavoside, trans-caftaric acid and 2-gluco-pyranose-4-hydroxy-5-[P-hydroxyphenyl]-propionyl diphenyl methane (phenolic and phenolic glycoside); ursolic acid (triterpenoid); punarnavine (alkaloid); xanthone, purine nucleoside, sterol, sterol ester and ecdysteroid.

B. diffusa roots isolated phytochemical and bioactive compounds mainly finds its application in the treatment of anticancer, spasmolytic, antioxidant, genoprotective effects, anti-arthritic and spasmolytic effects by using isolated rotenoids,^[75-81] iso-flavonoids are used to treat on intestinal motility;^[80,82-84] lignans are Ca²⁺ channel antagonists;^[85] phenolic and phenolic glycosides are showed antiviral, diuretic, antifibrinolytic, anticonvulsant, antibacterial and antifibrinolytic effect;^[80,86-88] lipids are act as antihyperglycemic and hepatoprotective agents.^[89]

Phytochemistry of *U. picta*

U. picta constitute available in few number of bioactive compounds such as Isoflavanones and Flavonoids are reported in

the roots (Table 3). Seven Isoflavanones namely 4',5-dihydroxy-2',3'-dimethoxy-7-(5-hydroxyoxochromen-7-yl)-isoflavanone, 5,7-Dihydroxy-2'-methoxy-3',4'-methylenedioxyisoflavanone, stigmasta-4,22-diene-3-one, β -Sitosterol, lupeol and 40,5-dihydroxy-20,30-dimethoxy-7-(5-hydroxyoxochromen-7-yl)-isoflavanone;^[90] a flavonoid rhoifolin (Apigenin-7-o-neohesperidoside).^[91]

Demand of *R. cordifolia*, *C. pluricaulis*, *P. longum*, *B. diffusa* and *U. picta* traditional medicinal plants in herbal and pharma industry

Herbal and dietary supplements are in great demand. Approximately 80% of people on the planet now utilise herbal remedies,^[92] and using dietary supplements is also prevalent.^[93] There is growing evidence on the advantages and disadvantages of supplements.^[94] Their sales have skyrocketed and they are becoming more and more popular; in 2009, the worldwide market was estimated to be worth €45-50 billion.^[95] There have been reports of growing demand in the Middle East, especially in the countries that make up the Gulf Cooperation Council (GCC).^[96,97]

A significant portion of therapies involve the use of native pharmaceuticals with natural origins; more than 1500 herbs are offered as dietary supplements or traditional medicines in various cultures.^[98] Pharmaceutical corporations have updated their strategy to support the development and discovery of drugs from natural products.^[99] For instance, AnalytiCon development has placed a focus on drug development based on the chemistry of natural products in Europe (<http://www.ac-discovery.com>). MerLion Pharmaceuticals in Singapore offers the extensive structures and skills required for natural product-based drug research in the Asia-Pacific region (<http://www.merlionpharma.com/index.html>). China has effectively used a science-based strategy to market its own treatments all over the world. The substantial rise in the number of licensed Chinese medicine practitioners in the US is indicative of TCM's rising popularity. The Chinese government has promised to establish a number of TCM medicines focused on exports in the upcoming years.^[100] TCM is now in a praiseworthy position as a result of China's ongoing efforts to promote indigenous remedies. Ayurveda is becoming more widely accepted, and demand for Indian medicinal herbs has sharply increased.^[101] The significance of traditional knowledge is also emphasised in the Pharmaceutical Research and Development Committee report of the Government of India's Ministry of Chemicals.^[102]

In terms of trade potential, India is the world's second largest herbal exporter, after only China. India and China account for 70% of herbal medication exports internationally. According to a 2017 National Medicinal Plant Board (NMPB) study, Indian people traditionally use just 1,622 medicinal plant species out of

6,500 totals. Nearly 1,178 plant species are heavily exploited in the all-India trade, including herbs (42%), trees (27%), shrubs, and climbers (31%).^[103] However, 242 herbal plants have top trade in the yearly list of over 100 MT.^[104]

Ayurveda, together with all other Indian systems and traditional systems from throughout the world, accounts for 80% of rural populations. Approximately 960 plant species are widely used by Indian herbal industry. Herbal-based businesses like as Ayurveda, Unani, Siddha, and Homoeopathy (AYUSH) generate more than 80 billion dollars in revenue.^[105] There is barely a 3% proportion in pharmaceutical exports. The annual revenue from crude drugs is around 10 billion rupees. The final items account for 30%. India accounts for less than 1% of the international market. We have an excellent chance to harness the world's natural riches. To build a solid global market, we required standard quality control methods at every stage. Our regulatory criteria for GMP (Good Manufacturing Practices) must be strict.^[106] It is necessary to integrate farming techniques for herbal crops, collecting procedures, storage, transportation, and trade operations.^[107,108] The Drugs and Cosmetics Act of 1940 must be resurrected in accordance with current GMP criteria.^[106]

India's locals refer to it as "Manjistha." The dried samples of it are marketed as "Manjith" in the market. In the Indian states of Mahabaleswar, Amboli, and Maharashtra, *R. cordifolia* is widely distributed at high elevations.^[109,110] In India, this medication is used to treat amenorrhoea, dropsy, paralysis, menstrual discomfort, urinary system disorders, Shi Feng Bi (rheumatism), and jaundice.^[111,112] In China, a formula known as "Er-Xie-Ting granule" is likewise mostly composed of *R. cordifolia* and is used to treat acute infantile diarrhoea. In addition to encouraging wound healing, a honey paste is applied to the skin to get rid of freckles, brown spots, and other skin discolorations.^[109,113] Rheumatism, hematorrhea, dysmenorrhea, and urinary problems are among the many traditional conditions for which *R. cordifolia* is used in Korea.^[114] The dark red root of *R. cordifolia* is used in Unani medicine to soothe the liver, stimulate the spleen, and treat a variety of skin ailments, blood detoxification, amenorrhoea, diuresis, paralysis, jaundice, and dysmenorrhea. The medication is used by traditional Ugandan healers to treat TB patients. *R. cordifolia* root decoction is used in Philippine medicine to treat urinary tract issues.^[115] One of the most widely used dyes in ancient Europe was *R. cordifolia*, which was used to colour cotton, wool, silk, linen, and other textiles as well as materials for basketry. One of the key components in recipes for red inks is the plant's roots. The primary component of dyes is alizarin.^[116] *R. cordifolia* is, all things considered, the world's first group of plants with known economic and therapeutic value.^[117] The medication is widely prized for its industrial, cardioprotective, and pharmacological methods. The substance has a strong therapeutic value, but it also provides a significant amount of natural colouring that is utilised in the flavour and pharmaceutical sectors. Similar to *R. cordifolia*,

R. tinctorum L. has been utilised for more than 2,000 years as a dye.^[118]

C. pluricaulis is commonly known as "Shankhpushpi" mostly utilised as a tonic for the brain. It is among the most effective and well-known natural medications for memory enhancement. It is used as a whole plant in medicine. Moreover, eating it keeps memory decline at bay.^[119,120] An Ayurvedic composition is created by combining many plant extracts or powders with two or three *Medhya* plants, including *C. pluricaulis* medications are Remem from Zydus Industries in India, are used to treat illnesses of the stomach and intestine related to acidity; Ayumemo from Welexlabs in India is used to lower mental stress; Abana from The Himalaya Drug and Co. in India is used to treat hyperlipidemia; Tejras from Sandu Brothers, India ltd is used to treat anxiety, nervousness, stress, and loss of concentration; Shankhpushpi from Unjha Pharmacy in India ltd provides a mild laxative effect and Tirukati medicines are currently available in India.^[121]

Pepper (*P. nigrum* L.) is a member of the Piperaceae family and one of the most valued spices eaten globally. Pepper is well-known for its distinct flavour and pungency due to the presence of the alkaloid piperine.^[122,123] The prefix "black," "green," and "white" is used to characterise the look of the product, although the crop plant is commonly referred to as "black pepper" to distinguish it from pepper of *Capsicum* spp. (i.e., chilli).^[124] The global commercial output of pepper has been expanding at an estimated rate of 510,184-690,467 Metric Tones (MT) yearly.^[125] Vietnam is the leading producer and exporter of pepper, with an annual production of 102,570-151,761 MT. In 2018, Vietnam produced 262 658 MT, accounting for nearly 30% of global production.^[125] Africa's pepper output is predicted to be between 22,051-25,975 MT per year, with Tanzania accounting for 395-435 MT.^[125] Pepper is grown for its fruits (berries), which serve as a cash crop with a variety of home and industrial applications. It is employed as a taste enhancer and preservative in food and beverages,^[126] essential oil manufacturing, and the pharmaceutical and fragrance industries.^[122,123]

B. diffusa Linn. based medical goods are available in the market, made by many prominent pharmacies. Products include syrup, pills, churn, mother-tincher, quath, food supplements, grains, oil, and so on. These commercial goods are either created entirely by the Punarnava plant or employed as an effective active ingredient in formulations. These products are used locally, throughout the country, and around the world to treat various disorders. For example, "Axiom Punarnava Panchang Juice" is made by *B. diffusa* and is used to cure calculi, weakness, weight loss, enlarged prostate, liver, and spleen issues.^[127] "Punarnava Capsules" by "Arogyam" are also available on the market for renal disorders, liver function enhancement, urinary tract maintenance, arthritis prevention, and digestion and metabolism improvement. The "Arjun Punarnava Jatamansi Juice" is also available for general body regeneration. Many more goods are also available on the

market, such as "Punarnava Mandur, Punarnava Sticks, Pitta Balance." Naturz Ayurveda punarnava 350mg capsule. Bliss wellness: kidney detox purifier basic Ayurveda Makoy and punarnava mixed juice, Ayur Champ punarnava kidney support. Punarnava root powder *B. diffusa*, Rencure formula. Merlion Naturals punarnava tablet and Healthvit Natural punarnava (*B. diffusa*) powder, Planet Ayurveda punarnava capsules. Ved Tattva punarnava kidney support capsule and SNC Punarnava extract capsule, Foresta Organics kidney detox includes Patharchatta, Varuna, Punarnava, and Ganoderma. Punarnava Swaras Ghan, Punarnava Swaras Ghan Vati, Punarnava Putpak Swaras, etc.,^[127] *B. diffusa* Linn. is promoted by the National Medicinal Plants Board (NMPB) and Ministry of AYUSH. It is on the list of priority medical plants that are farmed as subsidised crops, namely *B. diffusa*, 17,569 rupees was allotted by the NMPB up to 30% of the subsidy cost. It was approved by the NMPB in 2016-17.^[103]

U. picta (Jacq.) Desv. EX. DC. (Papilionaceae) is one of the most essential constituents of Dashamoola, an ayurvedic composition made up of 10 plants. Dasamula plants are the most widely traded category in ayurvedic medicine, with an annual demand exceeding 1000 metric tons.^[128] Almost all parts of *U. picta* have medicinal potential and are used in Indian medicine to treat exhaustion, mouth sores, and a variety of gynaecological problems.^[129-132] Aside from its usage in traditional medicine, it is extensively used in the medical and pharmaceutical sectors to create a variety of formulations. The quality and efficacy of herbs are determined by their physiologically active ingredient rhoifolin (Apigenin-7-o-neohesperidoside), which is employed as a chemical identifier, and the rhoifolin concentration is heavily impacted by the environment, genotype, season, and so on.^[132] Prishniparni plant sells on the market for Rs. 1,500-2000/kg, with regular adulteration and replacement of *Desmodium gangeticum*. Due to high demand and uncontrolled harvesting from the wild, the natural population of this plant is rapidly dwindling and has become a rare and critically endangered species,^[133] as well as a threatened species on the IUCN red list.^[134] WHO and modern pharmacopoeia place a high value on medicinal plant quality and efficacy in terms of physiologically active components.^[135]

New Cultivation Methods for Traditional Medicinal Plants and their Necessity in Present Scenario

According to the 2019 British Retail Consortium (BRC) study, India has 4.2 billion Rs (US\$ 56.6 million) in commerce and a target of 14 billion Rs (US\$ 188.6 million) by 2026. The global herbal business is worth around 120 billion US dollars, but India's portion is extremely tiny, at 1%. India has a promising future in the sphere of herbal commerce, with a growth rate of 14.22% reported in past tenures.^[127] Indian government is encouraging herbal-based companies and entrepreneurship as the demand for herbal-based goods, whether in medicine or food, is rising day by day. The NMPB, SMPB, Export Promotion Councils (EPCs), Forest Products Export Promotion Council (SHEFEXIL),

Pharmaceuticals Export Promotion Council (PHARMEXCIL), National Research Development Corporation (NRDC), National Bank for Agriculture and Rural Development (NABARD) and other organisations are supporting herbal-based activities-cultivation, phytochemical analysis, quality assessment, marketing etc.

Several institutions and organisations working on various areas of drug development and the preservation of medicinal plants derived from natural resources have recently been established in India. The Central Drug Research Institute (CDRI), Regional Research Laboratory (RRL), Jammu and Kashmir, and Council of Scientific and Industrial Research (CSIR) have set up initiatives to uncover novel bioactive compounds from plants, fungi, microorganisms, and other sources. The Golden Triangle Partnership (GTP) is working with the Department of AYUSH, CSIR, and the ICMR to validate conventional ayurveda medicine as a useful tool for drug development. Two micropropagation Technology Parks have been established in the recent few decades by the Department of Biotechnology and the Government of India at the Tata Energy Research Institute (TERI) in New Delhi and the National Chemical Laboratory (NCL) in Pune.^[136]

Conventional cultivation methods may not suffice the current demand, therefore various cultivation methods like soil (Cuttings, grafting, layering, and tissue culture) and soilless (hydroponic and plant tissue cultures) are to be developed and used for the selected medicinal plants.

CONCLUSION AND FUTURE REMARKS

In summary, this article provides a comprehensive review of selected traditional medicinal plants: Status of traditional medicine systems, phytochemistry with their reported biological and medicinal properties, demands in herbal and pharma industry and new cultivation methods and their necessity in present scenario. Further studies are still needed to compare the evaluation of field and hydroponic cultivation of selected traditional medicinal plants and also deeply explore the pharmacological mechanisms of these selected traditional medicinal plants and its compounds against different diseases. Meanwhile, future studies should focus on toxicity, pharmacokinetics, and clinical research. We hope that this evaluation provides some fascinating information and beneficial ideas for future research.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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