

# Ethnopharmacological review on versatile herbal medicament *Alstonia scholaris*

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## ABSTRACT

Herbal therapies are the oldest type of medicine in the world and recent studies indicate that these herbal remedies are very popular, particularly in underdeveloped countries, where the use of modern and expensive medicinal system is lacking. In the earlier medicinal system of some countries, *Alstonia scholaris* belonging to family: *Apocynaceae* and is an important medicinal plant. The common name of *A. scholaris* is Saptaparna and devil's tree. The plant is used in alternative medicinal systems of Ayurveda, Unani, and Siddha. In India, the therapeutic use of *A. scholaris* has been described in both codified and non-codified drug systems for the treatment of malaria, jaundice, gastrointestinal troubles, cancer, and in many other ailments. Pre-clinical studies have shown that it possesses antimicrobial, anti-diarrheal, anti-plasmodial, antioxidant, anti-inflammatory hepatoprotective, nootropic, anti-stress, anti-fertility, immunomodulatory, analgesic, anti-ulcer, wound healing, anti-cancer, chemopreventive, radiation protection, radiation sensitization, and chemosensitization activities. Through qualitative analysis, *A. scholaris* is reported to contain numerous phytoconstituents such as alkaloids, flavonoids, iridoids, saponins, tannins, and steroids; some of them are erythrodiol, uvaol, and betulin; oleanolic acid and ursolic;  $\beta$ -amyrin acetate and  $\alpha$ -amyrin acetate;  $\beta$ -sitosterol and stigmasterol squalene;  $\beta$ -sitosterol-3 $\beta$ -glucopyranoside-6'-O-fatty acid esters; and chlorophyll, etc. Three new indole alkaloids, nareline ethyl ether, 5-*epi*-nareline ethyl ether, and scholarine-N (4)-oxide, in addition to nareline methyl ether, picrinine, and scholaricine were isolated from the leaf extract of *A. scholaris*. The present study summarizes various ethnopharmacological and common uses along with the report on phytochemical and pharmacology of *A. scholaris* which can be helpful to the researchers in nearby future.

**Keywords:** *Alstonia scholaris*, devil tree, ethnobotanical, pharmacological activities, phytochemical

## Introduction

*Alstonia scholaris* R.Br. (Family: *Apocynaceae*) (otherwise called devils tree and dita bark tree) has long being utilized as a conventional medication to fix different human and animals infirmities.

The plant is developed in the marsh and mountain rainforests of India, the Asia-Pacific, Southern China, and Queensland.<sup>[1]</sup> The plant develops all through the sticky districts in India, particularly in West Bengal and South India. The plant is utilized in Ayurveda

system, Unani system, and Siddha/Tamil sorts of different traditional systems.<sup>[2]</sup> The earlier conventional name of the plant was *Echites scholaris* given by Linnaeus. In any case, to celebrate the incredible Professor C. Alston (scientist in botany), the conventional name of the plant was replaced by *Alstonia*, while the name of species scholaris was held to mean its use in South East Asia schools, where its trunk is customarily used to make writing boards and wooden records [Figures 1-7].

Different equivalent words of the plant incorporate *Tabernaemontana alternifolia*, *Echites pala*, and *Pala scholaris*.<sup>[3-8]</sup> In Sanskrit, this plant is called as *phalagaruda*, *sapthaparna*, and *saptaparni* because when we see its leaves, they are found in whorls of 7 (Sapta – 7 and parna - leaves).

This plant is a local of India along with other number of countries such as Nepal, Thailand, Malaysia, Africa, Sri Lanka, and South East Asia.<sup>[3-8]</sup>

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Figure 1: Plant of *Alstonia scholaris*



Figure 4: Inflorescence of *Alstonia scholaris*



Figure 2: Bark of *Alstonia scholaris*



Figure 5: Flowers of *Alstonia scholaris*



Figure 3: Leaves of *Alstonia scholaris*



Figure 6: Fruits of *Alstonia scholaris*

The plant is an enormous green tree, approximately has 17–20 m height with a straight regularly fluted and buttressed stem of a tree, around 108–112 cm in distance across. Bark is gray-earthy colored, harsh having small, corky, oval area on the surface, and unpleasant taste discharging smooth latex of white color.

Leaves are 4–7 out of a whorl and elliptical-oval in shape. Blossoms are little, greenish-white in color with numerous umbellate panicles, short corolla tube, emphatically scented. Fruits of *A. scholaris* have hair follicles with 30–60 cm length. Seeds have earthy hair at both ends.<sup>[9–12]</sup>





**Figure 7:** Seeds of *Alstonia scholaris*

The bark, additionally known as dita bark, is generally utilized by numerous tribal gatherings of North East India and also globally in different regions to cure infectious disease caused by bacteria, malaria, dental pain, snakebite, diarrhea, bowel issue, and so on. In addition, the latex is utilized in giving relief from cough, bruises, and fever.<sup>[13,14]</sup> It is a lovely foliage tree with an enormous shelter, and along these lines, it also becomes a well-known fancy tree in the scenes and nurseries in hot and calm districts of the United States.<sup>[3]</sup>

## Morphological Characteristics

Saptaparna is a normal-sized evergreen tree, generally 12–18 m high, in some cases up to 27 m high. Bark is harsh, grayish-white, yellowish inside, and oozes latex when harmed. Leaves are 47 of every a whorl, and are thick, elliptical, with a dull tip. They are dim green on the top, pale, and secured with caramel pubescence on the dorsal surface.<sup>[16]</sup>

### Habitat

A predominant shaded tree found in coastal mesophyll plant woods with approx. 17–20 m height, in palm-ruled woodlands and in notophyll forests.

### Bark

Bark yellowish and gray rough from inner side, whorled branches, young branches lenticellate. When the bark is injured, a milky type juice oozes out.

### Leaves

4–7 in whorls, coriaceous, elliptical lanceolate, insensitive or obtusely sharpen, dim green above, pale and secured with greenish white blossom underneath, base tightening, principle nerves various, almost even, equal, joining in intramarginal nerve.

### Inflorescence

Capitate cymes.

## Flowers

Little, pleasant smelled, greenish-white, in umbellate, stretched many – bloomed, pubescent capitate cyme, peduncles 2.6–5 cm long, short pedicels, bracts elliptical.

## Fruit

Follicles are generally 35–65 cm in length and 0.2–0.4 cm in diameter, cylindrical, hanging down in bunches, completely turned away after bursting open of pod.

## Seeds

Seeds are generally 0.5–0.7 cm in length, linear-oblong, flat, round shape with earthy hair at both ends.

## Flowering and fruiting time

Flowering and fruiting time of *A. scholaris* is generally in December–March and May–July month of the year.<sup>[17]</sup>

## Climate and soil

Trees just bloom after stamped times of dry climate. The species can be developed in an assortment of climatic conditions in India, going from dry tropical to sub-temperate. Nonetheless, it blossoms well in territories where yearly rainfall is around 100–150 cm, as moist habitat is favorable for its growth. The species develops well in the red alluvial soil having optimum air circulation. It can sprout in dark cotton soils also, yet the development is delayed because of more moisture in soil during rainy season.<sup>[16]</sup>

## Different Parts of *A. scholaris* Linn. R.Br

*A. scholaris* (L.) R.Br is not a new name in the medicinal system but it has been used for treating various diseases and disorders in conventional systems of medicine for long time ago. The plant's mature fruits are found useful in the treatment of syphilis and epilepsy. In addition, it is used as a tonic, antiperiodic, and anthelmintic to expel worms from the stomach. The smooth milky secretion of *A. scholaris* (L.) R.Br was found to be effective in ulcers.<sup>[19-21]</sup> The bark is the most commonly used component and is used in the preparation of many herbal compounds.<sup>[4]</sup> Bark is used as bitter tonic, febrifuge and has been found to be helpful in case of malaria, diarrhea, and dysentery.<sup>[6]</sup> The leaf extract was also recently found to have antimicrobial properties of its own.<sup>[22]</sup> *A. scholaris* (L.) R.Br has also been documented to inhibit acetaminophen, carbon tetrachloride, alcohol, and  $\beta$ -d-galactosamine-induced liver injuries as noted by the decreased levels of serum transaminase and reduced histopathologic changes such as breakdown of cells and infiltration of inflammatory cells.<sup>[23]</sup>

## Bark

### Chemical constituents

Bark contains Ditamine, Echitamine, Echitenine, Echicerin, Echitin, Echitein, Ditain, Losbanine, 6, 7-secoangustilobine B, N

demethylechitmaine, 17-Oacetylechitamine, picraline deacetyl, lupeol, and  $\beta$ -sitosterol.

#### Traditional uses

Bark is mainly used part of the plant as it contains number of chemical constituents. Different extracts of bark are prepared and used in various illness conditions as mentioned in the table.

### Latex of bark

#### Chemical constituents

Latex of bark contains caoutchouc and resins in it.

#### Traditional uses

Latex is found to be useful in dental caries, pimple, pyorrhea. Also found to be effective in ulcers and pain associated with rheumatoid arthritis, relieves earache when used by mixing with oil.

### Tender leaves

#### Chemical constituents

Tender leaves contain picrinine, nareline, akuammidine, picralinal, akuammigine, betulin, ursolic acid,  $\beta$ -sitosterol, flavonoids, phenolic acids, scholarine.

#### Traditional uses

Used to treat ulcers, given after delivery to women, in case of scorpion bite and snakebite.

### Leaves

#### Chemical constituents

Alscomine, Isoalscomine, Tubotaiwine, N<sup>b</sup> – methyl scholaricine, pseudoakuammigine N<sup>b</sup> oxide, Akuammidine, N<sup>a</sup>-methylburnamine, Picraline, Picrinine, Picrarinal, Areline, Angustilobine B acid, 6, 7-seco angustilobine B, Losbanine, Vallesamine.

#### Traditional Uses

Used in the treatment of ulcer, rheumatoid arthritis, and asthma.

#### Tribal use

Used in rheumatoid arthritis and diabetes (tribals of Western Ghats).

### Flower

#### Chemical constituents

Flowers contain tetrahydroalstonine, n-hexacosane, lupeol,  $\beta$ -amyryn, palmitic acid, ursolic acid, picrinine, and strictamine.

#### Traditional uses

Used in the treatment of asthma, respiratory problems.

### Roots

#### Chemical constituents

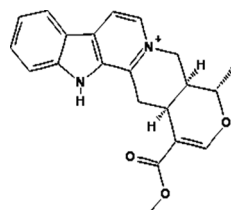
Picaline diacetyl.

#### Traditional uses

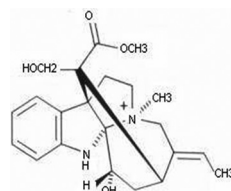
Used in case of enlarged liver.

### Active constituents of *A. scholaris*

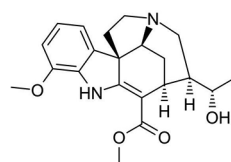
#### Alstonine



#### Echitamine



#### Scholarine



Along with these active constituents, number of alkaloids extracted from *A. scholaris* but only some of these are investigated for their pharmacological properties.<sup>[24]</sup> Almost every part of the plant contains useful chemical constituents in it as discussed above. *A. scholaris* is also main herb used in Ayush 64, a commercial formulation.<sup>[21]</sup>

#### Traditional Uses

The bark is used to enhance the appetite, for contraction of tissues, in case of excess acid secretion in stomach, helps in digestion, constipation, vermifuge, to reduce body fever, as purification agent, in lactation and as tonic for cardiac muscles. It is useful in malaria, influenza, diarrhea, dyspepsia, Hansen's disease, skin disease, ulcers, weakness, and other stomach-related problems. The oozes milky juice is bitter in taste and is mostly used in case of ulcers.<sup>[25]</sup>

A fresh bark extract is prepared and given by adding milk to leprosy patients. It has anthelmintic activity as well.<sup>[4]</sup>

Milk exudate is used to treat ulcers and rheumatoid arthritis-related pains; it relieves earache when used along with oil and by putting this drop in ear. Prepared tincture found as a powerful galactagogue.

Juice prepared from the leaves is given to women after delivery along with fresh ginger-root or zedoary. This herb is also found useful in case of snakebite.<sup>[4]</sup> The plant shows antimalarial, anticancer, antituberculosis, and anti-dysenteric along with galactopoietic activity [Tables 1-3].<sup>[4,21-25]</sup>

**Table 1: Taxonomy of *Alstonia scholaris***<sup>[15]</sup>

Taxonomy	<i>Alstonia scholaris</i>
Kingdom	Plantae, Planta
Subkingdom	Tracheobionta, vascular plants
Division	Magnoliophyta, flowering plants
Class	Magnoliopsida, Dicotyledon
Subclass	Asteridae
Order	Gentianales
Family	Apocynaceae
Brief history	After Charles Alston, the plant was named in 1811 by Robert Brown. The original name of <i>Alstonia scholaris</i> was <i>Echites scholaris</i> coined in 1767 by Linnaeus. The tree is utilized to make blackboards for students, and hence, the species name scholaris is given.

**Table 2: Indian names of *Alstonia scholaris***<sup>[18]</sup>

Language	Common name
Hindi	Saptaparni, Shaitankajhar, Chitvan
Bengali	Chattim
Sanskrit	Saptaparna
Marathi	Satvin
Kannada	AeleleHaale, Bantale, Doddapala
Malayalam	Daivappala
Telugu	Daivasurippi
Marathi	Satvin
Tamil	Ezilaipillai, mukumpalai
Gujarati	Satvana

**Table 3: Traditional uses of bark of *Alstonia scholaris***

Ayurveda	Antipyretic and to restore health
Infusion and tincture preparation	To promote milk secretion (lactation)
Fresh extract of bark along with milk	Hansen's disease, used in indigestion
Decoction	After effects of malaria
In the Philippines	Antipyretic and diarrhea
In Cambodia	Astringent, in dysentery and trigger menstruation
Unani	Used as ingredient of Unani preparation-“Kashim”
Homeopathy	Used in malaria, anemic conditions, digestion problems, general weakness, and other gastric problems
Commercial Ayurvedic preparation (Ayush-64)	Microfilariasis or influenza
Ethanollic stem bark extract	Used in the treatment of leishmaniasis

## Reported Pharmacological Activities

### Antimicrobial activity

Goyal *et al.* studied<sup>[25]</sup> and reported that the plant constituents of *A. scholaris* have sufficient activity against microorganisms. Khan *et al.*<sup>[26]</sup> studied the antimicrobial activity of leaves (methanolic extract), stem

and root bark extract of *A. scholaris* and observed that fraction of butanol has found to be effective against number of microorganisms and hence shown wide range of antimicrobial property.

### Antidiarrheal activity

Patil *et al.* studied the antidiarrheal property of bark of *A. scholaris* in mice. The alcoholic and aqueous extracts of bark were prepared and both extracts were found to effective in the treatment of diarrhea. Through this study, it was found that *A. scholaris* possess antidiarrheal activity.<sup>[27]</sup>

### Anticancer Activity

*Alstonia macrophylla*, *Alstonia glaucescens*, and *A. scholaris* were gathered from various regions of Thailand and their root barks were collected to assess activity against cancer. Methanolic extract of these root barks was prepared and tested individually to check its activity against lung cancer cell lines, using the sulforhodamine B assay. Villalstonine which is isolated from *A. scholaris* was found to be more active than the chemical constituents isolated from macrophylla and glaucescens species.<sup>[28]</sup>

### Antidiabetic Potential

Numerous studies were carried out by scientists to evaluate antidiabetic property of *A. scholaris*. Effectiveness of *A. scholaris* against diabetes was studied to assess its  $\alpha$ -glucosidase inhibitory and hypoglycemic effects.<sup>[29,30]</sup> Potent antidiabetic activity was reported till date from the active constituents obtained from leaves extract and stem bark of *A. scholaris*.<sup>[30,31]</sup> The powder of *A. scholaris* leaves found to effective in lowering blood glucose level in patients having Type-II diabetes.<sup>[32]</sup>

### Analgesic and anti-inflammatory activities

Experimental models of pain and inflammation were used to investigate the effectiveness of ethanolic leaves extract of *A. scholaris*.<sup>[33]</sup> 200 and 400 mg/kg body weight extracts showed marked effect in mice. The percent of pain inhibition was found to be 73.9% and 79.5%, respectively, in hot plate method. Marked anti-inflammatory effect in paw edema induced by carrageenan was also observed with same dose of the leaves extract.

### Anti-ulcer activity

Along with numerous properties of leaves of *A. scholaris*, the ethanolic extract was also studied for its activity in the treatment of ulcers.<sup>[33]</sup> For assessing this anti-ulcer activity, pyloric ligation method was used and rats were used as animal model. Ethanolic extract was given to rat and further its effect was compared with diclofenac sodium. After that, the ulcer score was observed which was high in case of diclofenac sodium while the rat treated with extract showed no ulcer. Hence, this study supported that *A. scholaris* also possess anti-ulcer activity.

### Anthelmintic activity

*A. scholaris* alcoholic extract was prepared and further examined for its anthelmintic activity using *Ascaridia galli*, a type of worm. They

were incubated for desired period of time and different activities such as uptake of glucose, glycogen concentration, production of lactic acid, motility rate, and the enzyme acetylcholine esterase of the worms were investigated. Decrease in glucose absorption and glycogen content of the worms with *A. scholaris* alcoholic extract was observed. At the same time, reduction in gross motility was also observed which signifies that the extract is sufficiently effective and it affects the normal activities of the parasites. ATP production also gets inhibited and lactic acid gets accumulated. Hence, the extract found to have anthelmintic activity which generally acts by inhibiting energy metabolism reaction.<sup>[15]</sup>

### Antioxidant activity

*A. scholaris* was evaluated for its antioxidant property on various antioxidant parameters. *A. scholaris* when extracted with ethanol show sufficient antioxidant activities.<sup>[34-36]</sup> The extract was observed to prevent peroxidation and free radical based reactions. The outcomes were found to be comparable to other antioxidants such as BHA, BHT, ascorbic acid, and tocopherol.<sup>[37]</sup>

### Immunomodulatory activity

The immune-modulating activity of bark extracts of *A. scholaris* was investigated by Lwo *et al.*<sup>[38]</sup> The aqueous extract shows increased immune response against *E. coli* bacteria. The aqueous extract showed no or negligible impact on primary antibodies level at 50 and 100 mg/kg body weight dose. At 50 mg/kg, the aqueous extract shows the immune response at cell line. On the other hand, 100 mg/kg prevent delayed type of allergic reactions.<sup>[38]</sup>

Along with all these pharmacological activities, *A. scholaris* also possess anti-tuberculosis,<sup>[39]</sup> antibacterial,<sup>[40,41]</sup> radioprotective properties,<sup>[42]</sup> anti-asthmatic,<sup>[11]</sup> wound healing,<sup>[43]</sup> free radical scavenging properties, antiplasmodial activity<sup>[44,45]</sup> hepatoprotective activity,<sup>[23]</sup> anti-fertility activity,<sup>[46]</sup> and anti-mutagenic activity.<sup>[47-48]</sup> Furthermore, its hydroalcoholic extract shows teratogenic activity.<sup>[49]</sup>

### Conclusion

There is a wide variety of pharmacological activities of *A. scholaris*. Several pharmacological investigations have validated the conventional use of this plant. The plant was documented as anti-cancerous, antimicrobial, anxiolytic, and antipsychotic agent. Consequently, ethnopharmacology can fill the gap between the tribal and traditional uses of *A. scholaris* with its real pharmacological efficacy.

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