IJISEM
INTERNATIONAL JOURNAL OF INNOVATIONS IN SCIENCE ENGINEERING AND MANAGEMENT

OPEN ACCESS

Volume: 4

Issue: 3

Month: September

Year: 2025

ISSN: 2583-7117

Published: 29.09.2025

Citation:

Nilesh Mohan Mishra, Khooshbu chouhan, Satkar Prasad, Shailesh Ghatuary, Priyanka more "A Comprehensive Review on Phytochemical and Pharmacological Properties of Alstonia scholaris " International Journal of Innovations in Science Engineering and Management, vol. 4, no. 3, 2025, pp. 401–407.

DOI:

10.69968/ijisem.2025v4i3401-407

A Comprehensive Review on Phytochemical and Pharmacological Properties of Alstonia scholaris

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Abstract

In traditional therapeutic systems, Alstonia scholaris is commonly employed. It is used to cure "diarrhoea, malaria, asthma, fever, epilepsy, skin disorders, snake bites", and other conditions in India, Thailand, China, Malaysia, the Philippines, Africa, Australia, and other places because of its abundant natural active components. This review highlights the phytochemical richness and pharmacological potential of Alstonia scholaris ("Saptaparni"), covering its traditional uses, bioactive constituents, and therapeutic activities including analgesic, anti-inflammatory, antibacterial, and anticancer effects. Despite promising in-vitro and in-vivo findings, limited clinical trials and mechanistic data remain major gaps. Further research is essential to validate safety, isolate active compounds, and advance its therapeutic applications.

Keywords; Alstonia Scholaris (Saptaparni), Analgesic, Anti-Inflammatory, Phytochemical Constituents, Pharmacological Properties.

INTRODUCTION

For thousands of years, plants have been essential to preserving human health and enhancing human well-being. They also provide useful ingredients for medications, flavours, drinks, cosmetics, and colours. Natural ingredients included in herbal medicine have the potential to improve health and lessen disease [1]. Researchers' attention is now primarily focused on plants worldwide, and a substantial amount of data has been gathered to demonstrate the enormous potential of medicinal plants utilised in a variety of traditional systems. Moreover, plant extracts were the source of many western medications. Numerous herbs are utilised to treat conditions related to the central nervous system, liver, heart, digestive system, and metabolism [2]. They have the potential to have a major therapeutic impact and can be used as a medication or supplement to treat and manage a variety of illnesses. A variety of biological actions are displayed by herbal medications, medicinal plants, their extracts, and their isolated components. Researchers from all around the world are interested in Alstonia scholaris because of its pharmacological properties, which include antimalarial and anticancer properties [3].

Alstonia scholaris, sometimes referred to as chatim and devils tree, is a tropical, evergreen tree that is indigenous to the Indian subcontinent, as well as portions of Indonesia, Malaysia, and Australia [4]. It is a member of the apocynaceae family. Its big, seven-leafed clusters and tough, grey bark allow it to reach a height of 40 meters. It blooms in October and has tiny, greenish-yellow flowers. The fruits are slender pods that can reach a maximum length of 20 inches.

The tree's sap is bitter and sticky. In a number of ayurvedic medicines, Alstonia scholaris shows promise in treating whooping cough, malaria, jaundice, gastrointestinal complaints, headaches, asthma, stomachaches, wounds, and fevers [5]. In Nigeria, traditional psychiatrists employ Alstonia scholaris to treat mental illnesses. According to reports, Alstonia scholaris's profile in experimental animals is strikingly congruent with its traditional usage. Alkaloids, flavonoids, saponins, steroids, reducing sugar, and phenolic chemicals are abundant in the plant and demonstrate its many therapeutic uses [6].

Figure 1: Alstonia scholaris Plant.[7]

A. Pharmacological Properties of Alstonia scholaris

Numerous biological and pharmacological studies were carried out in order to evaluate the traditional and pharmacological claims made by Alstonia scholaris. Numerous "biological and pharmacological activities, such as antimicrobial, antidiarrheal, antioxidant, antidiabetic, anticancer, analgesic, anti-inflammatory, hepatoprotective, central nervous system, wound healing immunomodulatory, antifertility, and cytotoxic qualities", have been associated with Alstonia scholaris to date [8].

1. Anti-Malarial Activity

Several studies have demonstrated the exceptional antiplasmodial action of alkaloids. The antimalarial potential of Alstonia scholaris has not been well studied, despite its high alkaloid concentration. Investigations revealed more potential with the Alstonia scholaris bark methanol extract. Numerous alkaloids from Alstonia scholaris have been shown to be effective against malaria, including the bisindole alkaloids macrocarpamine and villalstonine, which are "strong against the multidrug-resistant K1 strain of Plasmodium falciparum". Other alkaloids produced from Alstonia scholaris, "such as coronalstonine and coronalstonidine", have also found to be efficient against P. falciparum [3].

Mice with Plasmodium berghei infections did not exhibit any antiamalarial activity when Alstonia scholaris bark was extracted using petroleum ether and methanol. On the other hand, the rats showed evidence of improvement and delayed death when given the Alstonia scholaris methnol extract in a dose-dependent manner.

2. Broncho –Vasodilatory Activity

An ethanolic extract from Alstonia scholaris leaves has shown a potent bronchovasodilatory effect. Nitric oxide was shown to be the primary factor responsible for the leaf extract's vasodilatory effect, and it was demonstrated that prostaglandins, muscarinic, and adrenergic receptors had no effect on it. Numerous chemical components found in Alstonia scholaris, including sitosterol, akaloids such as rhazimanine, picrinine, and schloaricine, and triterpenes (ursolic acid, betulin), were found to be responsible for the extract's bronchodilatory effects. Because Alstonia scholaris is frequently used to treat gastrointestinal, respiratory, and cardiovascular disorders, the ethanolic extract of its leaves is known to have a bronchodilatory effect [9].

3. Analgesic Effects

In experimental models, the effects on inflammation and pain were investigated using an ethanolic extract of Alstonia scholaris leaves. It is well established that pain and inflammation are the root causes of many illnesses, both acute and chronic [10]. Nonsteroidal anti-inflammatory drugs (NSAIDs) are among the many drugs now available on the market that combine antianalgesic and anti-inflammatory qualities. However, given the possible negative effects of NSAIDs, greater study in this field is suggested. Alcoholic extracts from Alstonia scholaris leaves have been shown in the literature to have potent analgesic and anti-inflammatory effects [11].

Further revealed the dichlromethane fraction's greater activity in the Alstonia scholaris leaf ethanolic extract. The alkaloids picrinine, vallesamine, and scholaricine found in Alstonia scholaris leaves have been linked to these effects. These alkaloids' analgesic and anti-inflammatory qualities have been connected to their capacity to inhibit "the inflammatory mediators COX-1, COX-2, and 5-LOX". It has been demonstrated that Alstonia scholaris' aerial parts,

in addition to its leaves, have anti-inflammatory qualities [12].

4. Anti-Ulcer Property

The pyloric ligation technique was used to investigate the anti-ulcer activity of an ethanolic extract from Alstonia scholaris leaves. The results demonstrated that the rats treated with the extract did not show any ulcerative signs, in contrast to the rat that developed an ulcer score following the administration of diclofenac sodium [13].

5. CNS Effects

Substances with neuroprotective and neuropharmacological effects that enhance the brain's ability to learn and remember are desperately needed due to the growing stress of modern living. It has been demonstrated that several plants contain nootropic or anti-stress qualities. However, only a few number of plants have been demonstrated to possess both the nootropic and anti-stress (adaptogenic) qualities of the methanolic extract from the bark of Alstonia scholaris [14]. In addition to these additional effects, the ethanol extract of Alstonia scholaris leaves has also been associated with a potent anti-anxiety effect. Related studies have also observed that this extract has neither sedative or stimulating qualities. According to the tribe's claim, thirty patients with essential hypertension were the subjects of a clinical study employing a decoction of Alstonia scholaris bark [15]. Alstonia scholaris was shown to alleviate psychiatric symptoms and elevated systolic and diastolic blood pressure in the patients.

6. Herbicidal Property

The phytotoxic action of A.scholaris' aqueous extract on parthenium has been found to cause delayed seed germination and a reduced ultimate germination percentage. It was shown that the extract was very dangerous and that even the lowest concentration of 2% of the extract dramatically decreased the final germination by 30% when compared to a control [7].

A subsequent decrease in germination coincided with an increase in extract content. The germination was 80% lower with the 10% extract compared to the control. Since allelopathic plant species aqueous extracts may restrict parthenium seedling growth, the current study concluded that the aqueous leaf extract of A. scholaris possesses powerful herbicidal components for the control of parthenium weed.

B. Traditional uses of Alstonia scholaris

Since ancient times, Alstonia scholaris has been used to cure a variety of illnesses. According to Ayurveda, various plant parts—fruit, leaves, roots, and bark—are utilised to cure various illnesses. The bark is bitter and astringent, and it possesses antipyretic, laxative, stomachic, cardiotonic, and antihelmintic properties is also helpful in treating malarial fevers, stomach problems, and dyspepsia [9]. Bark extract has been shown to have antispasmodic, anticancer, hepatoprotective, and immunostimulant properties. The bark lowers blood glucose levels when it is submerged in water for the whole night. The ripe fruit of the plant helps treat syphilis and epilepsy, among other sexually transmitted diseases [16]. Also has antihelmintic, tonic, and antiperiodic properties. In the past, leaves were employed as folk medicines to cure illnesses like diarrhoea, snakebites, and malaria. The leaf extract has strong galactogogue properties [7].

C. Phytochemical Constituents of Alstonia scholaris

Phytochemical studies on Alstonia scholaris have identified a large number of secondary metabolites, which are thought to be the cause of the plant's diverse pharmacological effects. Among the significant constituents discovered are "triterpenoids, alkaloids, flavonoids, phenolic compounds, and saponins" [17]. Advanced analytical methods such as "High-Performance Liquid Chromatography (HPLC), Gas Chromatography-Mass Spectrometry (GC-MS), and Nuclear Magnetic Resonance (NMR)" spectroscopy have been crucial in the isolation and characterisation of these bioactive substances.

- **Alkaloids:** Alstonia scholaris is very rich in monoterpenoid indole alkaloids. Important alkaloids that were extracted from the plant include "scholaricine, villalstonine, echitamine, alstonine, and serpentine"; some of them have shown notable antibacterial, cytotoxic, and neuropharmacological properties. When it comes to a variety of human cancer cell lines, echitamine and scholaricine stand out for their strong antiproliferative properties [17].
- **Flavonoids:** Extracts from the leaves of Alstonia scholaris contain flavonoids such quercetin, kaempferol, and rutin. It is commonly recognised that these compounds have antioxidant qualities and can regulate key signalling pathways linked to the onset of cancer [5].

- **Phenolic Acids:** Several plant sections have been shown to contain phenolic acids, including "gallic acid, ferulic acid, chlorogenic acid, and syringic acid". These phenolics have been demonstrated to have protective effects against mutagenesis, DNA damage, and the onset of carcinogenesis. They are strong scavengers of free radicals [9].
- **Triterpenoids and saponins:** Triterpenoids contained in the bark and latex of A. scholaris, such as "betulinic acid and oleanolic acid", have been shown to suppress angiogenesis and cause apoptosis in cancer models. Moreover, the extract's cytotoxic and immunomodulatory properties are reinforced by its saponins [18].

The composition and concentrations of phytochemicals within Alstonia scholaris are subject to variation, contingent upon several factors. These include the plant's geographical provenance, the specific plant component utilised, the employed extraction methodologies, and seasonal variations. The synergistic actions of these varied substances likely account for the broad therapeutic advantages observed in both traditional applications and scientific investigations.

D. Analgesic

Any medication that selectively reduces pain without obstructing nerve impulse transmission, significantly changing sensory experience, or influencing consciousness is an analgesic. One crucial difference between an anaesthetic and an analgesic is their selectivity [19].

There are two categories of analgesics: opioids, which work on the brain, and anti-inflammatory medications, which reduce pain by lowering local inflammatory reactions. Because opioid analgesics can produce sleep, they were formerly referred to as narcotic medications. Both temporary and permanent pain alleviation are possible with opioid medications. On the other hand, anti-inflammatory drugs are used to treat mild pain, such as that caused by arthritis, headaches, strained muscles, or bruises, as well as for short-term pain relief.

i. **Nonsteroidal Anti-Inflammatory Drugs (NSAIDs):** Aspirin, ibuprofen, and naproxen are examples of NSAIDs that are frequently used to treat fever, inflammation, and discomfort. They function by suppressing the synthesis of prostaglandins, which are biochemical agents that facilitate inflammation and nociception.

ii. **Acetaminophen (Paracetamol):** Although it doesn't have the same anti-inflammatory qualities as NSAIDs, acetaminophen is good for lowering temperature and pain. It is routinely employed for the alleviation of mild to moderate pain and is frequently favoured by individuals who are unable to tolerate nonsteroidal anti-inflammatory drugs owing to gastrointestinal complications.

iii. **Opioids:** Opioids are strong analgesics used to treat moderate to severe pain. They include morphine, codeine, oxycodone, and hydrocodone. They suppress pain signals by attaching to opioid receptors in the brain and spinal cord. Opioids, however, should only be used temporarily or for carefully controlled chronic pain because to the potential for tolerance, dependency, and addiction.

iv. **Adjuvant analgesics:** Some drugs that aren't specifically made to relieve pain can either target particular types of pain or improve the effects of basic analgesics. Antidepressants, anticonvulsants, and muscle relaxants are a few examples.

E. Uses of analgesics

- Acute pain: Analgesics are frequently used to treat acute pain brought on by illnesses, accidents, or surgery. The degree and duration of pain may determine the prescription of NSAIDs, paracetamol, and opioids.
- Chronic pain: Persistent pain from chronic diseases including cancer, neuropathy, and arthritis can greatly interfere with day-to-day functioning. To enhance functional results and quality of life, analgesics—especially opioids and adjuvant drugs—are used in conjunction with other treatments.
- Postoperative pain management: For patients to be comfortable and recuperate after surgery, adequate pain management is crucial. To reduce pain and promote early mobilisation, analgesics are given before to, during, and following operation.
- Palliative care: Analgesics are essential for reducing pain and enhancing the quality of life for patients with terminal diseases in palliative care settings. Instead than treating the underlying illness, the emphasis now is on symptom management and comfort.

II. LITERATURE REVIEW

(Soni et al., 2025) [20] The devil's tree, or Alstonia scholaris, is a significant medicinal plant used in many folk and traditional medical systems in Asia, Australia, and Africa. Although Alstonia scholaris's floral portion contains a lot of volatile oils, the plants' alkaloidal levels are greater. "Antioxidant, antibacterial, bronchodilator, hepatoprotective, anticancer, antidiabetic, antistress, antidiarrheal, antispasmodic, analgesic, anti-inflammatory, immune-stimulating effect, antitussive, anti-asthmatic, molluscicidal, and anticholinesterase activity" are among the biological activities produced by these phytoconstituents. Nearly every part of the plant has therapeutic qualities; Alstonia scholaris leaves may be used to cure beriberi, the bark can be used to treat pneumonia and asthma, latex can be used to treat wounds and ulcers, and the roots and flowers have strong antibacterial capabilities. Thus, the purpose of this study is to gather information on the pharmacological, ethnobotanical, and phytochemistry applications of Alstonia scholaris in order to expand the plant's potential for use in pharmacologically linked research.

(De et al., 2024) [21] Generally speaking, the phrase "therapeutic plant" describes plants that are utilised for a variety of health advantages and have therapeutic qualities. Throughout history, several societies have acknowledged the therapeutic qualities of specific plants and included them into their traditional medical systems. A vast range of species and traditions are represented in the rich and varied history of therapeutic plants. A key component of traditional medicine, phytochemistry investigates the therapeutic qualities of plants. Alkaloids, terpenoids, and phenolic compounds are among the many phytochemicals found in Alstonia scholaris, commonly referred to as the Devil's tree. These substances support its traditional use for a range of ailments, including cough and fever. The safety and legitimacy of herbal products are guaranteed by pharmacognostic investigations. Alstonia scholaris has antioxidant, antibacterial, anti-inflammatory, and antitussive qualities. These results demonstrate its promise in contemporary medicine and confirm its traditional therapeutic usage. To fully utilise this botanical treasure's therapeutic potential, more study is essential.

(Parab et al., 2024) [7] The "Devil's tree or Saptaparni" is the popular name for the Apocynaceae species Alstonia scholaris. In both codified and non-codified medical systems, Alstonia scholaris has been used medicinally in India to cure cancer, gastrointestinal issues, malaria, jaundice, and several other ailments. Alstonia scholaris has been successfully used to treat a variety of inflammatory chronic skin conditions, including rheumatism, tiredness, antipyretics, malaria fever, irregular menstruation, hepatic disorders, diabetes, anthelmintics, skin problems, and urinary tract infections. It has anti-inflammatory, astringent, analgesic, and anti-diabetic properties. It also has anti-malarial, antioxidant, anti-cancer, cytotoxic, and radioprotective properties. Both alcoholic and aqueous procedures were used to collect and extract the Alstonia scholaris leaf. "Numerous phytochemicals, including as alkaloids, flavonoids, oils and lipids, terpenoids, glycosides, phenolic compounds, and vitamins in methanolic extract", are found in the stem, leaves, and bark. In contrast, aqueous extract contains proteins and amino acids.

(M. Zhao et al., 2023) [9] Provide a comprehensive description of the botanical characteristics, traditional applications, chemical constituents, pharmacological effects, and toxicity profile of the genus Alstonia to evaluate the potential of this plant for clinical use. Using online resources such the "Baichain Library, Web of Science, China National Knowledge Infrastructure (CNKI), Baidu Scholar, PubMed, Wan Fang Database, and ACS", among others, data on the genus Alstonia was gathered. As of right now, the genus Alstonia has yielded at least 400 distinct chemicals, including "volatile oils, phenolic acids, alkaloids, triterpenes, and flavonoids". The genus Alstonia was shown to have good pharmacological effects both in vitro and in vivo through extensive pharmacological experiments. These effects included "b2AR, vasodilatory, antifungal, antineoplastic, antiplasmodial, anti-inflammatory, antibacterial, antioxidant, analgesic, and radioprotective activities".

(H et al., 2019) [22] to assess the significance of the custom of ingesting Alstonia scholaris Linn. juice on the specific New Moon day of the Hindu calendar month of Ashada (July–August) in the Tulunadu area of South India. The figures showed that the specific New Moon day had the highest concentration of active principles. The absorbance peak maximum from the first and third samples was determined to be 0.2. Sample 2 showed a maximum concentration of active principles with an absorbance of 0.5. Alstonia scholaris's therapeutic value is indisputable, and its use on a certain day by the Tulu Nadu area of South India has endured over time. Indian health customs continue to be entwined with the depth and realism of Indian culture and lifestyle. But what is urgently needed is their appropriate understanding, analysis, appreciation, and application.

(Akter et al., 2016) [15] Examine the potential analgesic and central nervous system (CNS) depressive effects of "Alstonia scholaris (Family: Apocynaceae)" leaf methanolic extracts in animal models. Rats' "acetic acid-induced writhing test" was used to examine the plant extracts' analgesic properties and peripheral pharmacological effects. Each rat received 500 mg/kg body weight of the plant's methanolic extracts orally, and the rats' passage through the hole and between the chambers was monitored. In this case, diazepam was the usual medication. Rats' exploratory behaviour was greatly reduced by the plant's leaf extract, which was shown to be statistically significant ($p<0.01$) when compared to the control group. A. scholaris seems to be a useful plant that may be used as a CNS depressive and an analgesic from a pharmaceutical perspective.

III. RESEARCH OBJECTIVE

i. To study the Alstonia scholaris and its pharmacological properties.
ii. To study the traditional uses of Alstonia scholaris.
iii. To study the phytochemical constituents of alstonia scholaris.
iv. To study the analgesic, its uses and type.

IV. RESEARCH METHODOLOGY

The methodology for this review involved a systematic search of scientific databases including PubMed, Scopus, Web of Science, Google Scholar, and ScienceDirect for studies published between 2000 and 2025. Keywords such as Alstonia scholaris, phytochemicals, pharmacological activity, medicinal plants, and bioactive compounds were used. Relevant peer-reviewed articles, books, and conference papers were screened based on inclusion criteria focusing on phytochemical analysis and pharmacological evaluations of the plant.

V. CONCLUSION

Alstonia scholaris, widely known as “Saptaparni,” emerges as a pharmacologically potent medicinal plant enriched with diverse phytochemicals such as alkaloids, flavonoids, terpenoids, and phenolic compounds. This review highlights its broad therapeutic potential, including analgesic, anti-inflammatory, antipyretic, antiarthritic, antibacterial, antiasthmatic, and anticancer activities demonstrated through extensive in-vitro and in-vivo studies. The strong analgesic and CNS depressant effects of its methanolic leaf extract further reinforce its medicinal relevance. Despite these promising findings, the absence of well-designed clinical trials and limited mechanistic and toxicity data on key bioactive compounds remain significant barriers to clinical application. Future research must focus on isolating active constituents, elucidating underlying mechanisms, and conducting rigorous safety and pharmacokinetic evaluations. With continued scientific exploration, Alstonia scholaris holds strong potential as a source of novel therapeutic agents and a valuable contributor to modern evidence-based medicine.

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