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Pharmacological Insights And Phytochemical Composition Of *Alstonia Scholaris*

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Abstract:

Alstoniascholaris, a medicinal plant native to India and South Asia, has been widely recognized for its therapeutic applications. It exhibits a range of pharmacological properties, including anticancer, antimicrobial, antimutagenic, antifertility, anti-inflammatory, antioxidant, and hepatoprotective activities. The plant is also a rich source of bioactive compounds such as alkaloids, flavonoids, steroids, triterpenoids, and phenols, which contribute to its medicinal potential. This review aims to consolidate existing knowledge on the phytochemistry, ethnobotanical significance, and pharmacological applications of *A. scholaris*, offering insights into its potential for further pharmacological research and therapeutic advancements.

KEYWORDS: *Alstoniascholaris*, Phytochemicals, Medicinal properties.

1. Introduction:

Alstoniascholaris is an evergreen tree predominantly found in the tropical regions of Asia. It can grow up to 100 meters in height and bears fragrant white flowers. The species derives its name, *scholaris*, from its historical use in crafting school boards. India and China, renowned for their rich traditions in medicine—such as Ayurveda, Unani, and Siddha—have extensively utilized this plant in traditional therapies.

Belonging to the genus *Alstonia* (Figure 1.1), this species has been reported to offer therapeutic benefits for ailments like malaria, fever, insomnia, chronic diarrhea, and rheumatic pain (Akhtar and Bano, 2002).

In Ayurvedic medicine, *A. scholaris* serves as a key ingredient in several formulations, including **Saptaparnasatvadivati**, **Saptachadadivati**, **Saptacchadadikvatha**, and **Saptaparnaghanasara**. These preparations are traditionally employed for treating conditions such as asthma, malaria, cough, jaundice, stomach disorders, headaches, and fever.

Phytochemical Constituents:

Studies have identified a wide range of phytochemicals in *A. scholaris*. The plant is rich in alkaloids, flavonoids, tannins, steroids, saponins, and triterpenoids (Kritikar and Basu, 2005). Alkaloids such as echitamine and alstonine have been shown to exhibit anticancer and antimalarial activities (Jain et al., 2011). In addition, flavonoids and phenolic compounds contribute to its antioxidant and anti-inflammatory properties (Raghuvanshi et al., 2012). Phytochemical screening also revealed the presence of iridoids and glycosides, which may be responsible for its hepatoprotective and antimicrobial effects (Mitra et al., 2010).

Ethnobotanical Uses:

The traditional use of *A. scholaris* has been documented in Ayurveda, Unani, and Siddha systems of medicine. It has been employed in treating various ailments, including asthma, jaundice, and malaria (Ghani, 2003). Local communities have used its bark extract for treating chronic diarrhea, fever, and respiratory disorders. Leaves and latex are also utilized as a remedy for wounds, ulcers, and skin infections (Chopra et al., 1956).

Pharmacological Activities:

Numerous studies have validated the pharmacological properties of *A. scholaris*.

- **Antimicrobial Activity:** Extracts from leaves and bark have shown significant antibacterial and antifungal activities against pathogens like *Escherichia coli*, *Staphylococcus aureus*, and *Candida albicans* (Kumar et al., 2008).

- **Antioxidant Activity:** Methanolic extracts have demonstrated free radical scavenging potential, indicating antioxidant properties that protect against oxidative stress (Sharma et al., 2013).

- **Anti-inflammatory Activity:** Research supports the anti-inflammatory effects of its alkaloid-rich extracts, which inhibit pro-inflammatory mediators (Singh and Sharma, 2015).

- **Anticancer Activity:** Studies highlight cytotoxic effects on cancer cell lines, suggesting its potential as a natural anticancer agent (Das et al., 2014).

- **Antidiabetic and Hepatoprotective Activity:** Animal studies indicate that *A. scholaris* extracts regulate blood glucose levels and provide liver protection from toxic substances (Reddy et al., 2016).

- **Antifertility Effects:** Its use as a contraceptive agent has been explored, showing spermicidal and antifertility properties (Verma et al., 2007)

Ethnobotanical Uses

Alstoniascholaris has been traditionally employed as a tonic for stomach-ache, a stimulant, and a remedy for recurrent ailments. It is widely used to treat fever (Rajakumar and Shivanna, 2010), arthritis (Yusuf et al., 2006), impotence, and leucorrhoea (Bhandary, 1995). Furthermore, it has been applied for treating animal bites (Prusti and Behera, 2007), acting as an antidote to poisons, and alleviating malaria and skin diseases (Mollik et al., 2010). Additional therapeutic applications include the treatment of leprosy, toe cracks, cellulitis (Saikia, 2006), hypertension (Chhetri, 2005), swelling (Deb et al., 2009), and delivery-related pain (Sharma and Kumar, 2011).

The bark of *A. scholaris* is particularly valued for addressing gastrointestinal issues such as diarrhea, dysentery, jaundice, hepatitis, ulcers, and fever. It is also traditionally used to manage heart-related disorders (Singh and Sangwan, 2011).

Phytochemical

Phytochemical	**Details**
Alkaloids	Found in A. scholaris
Monoterpenoids	Found in A. scholaris
Flavonoids	Found in A. scholaris
Tannins	Found in A. scholaris
Triterpenes	Found in A. scholaris
Sterols	Found in A. scholaris
Esters	Found in A. scholaris
Phenolic acids	Gallic acid, ellagic acid, catechin, kaempferol
Scholaricine	6% of TA fraction
19-epischolaricine	2% of TA fraction

Picrinine	10% of TA fraction
Vallesamine	6% of TA fraction
Anti-allergic effects	Demonstrated by isolated compounds
Inflammatory cells	Down-regulation by isolated compounds
Cytokines	Down-regulation by isolated compounds
Antioxidant balance	Down-regulation by isolated compounds

Medicinal Properties

Analgesic and Anti-Inflammatory Activities In vivo studies have shown that administration of *A. scholaris* at a dose of 200 mg/kg significantly alleviates pain, mechanical hyperalgesia, and thermal hyperalgesia, reversing biochemical changes caused by chronic constriction injury more effectively than pregabalin (Singh et al., 2017). Shang et al. also reported anti-inflammatory and analgesic effects of *A. scholaris* extracts, isolating phytochemicals such as picrinine, vallesamine, and scholaricine. In vitro and in vivo studies demonstrated reductions in nitric oxide, PGE2, and malondialdehyde levels while enhancing antioxidant levels against acetic acid- and xylene-induced inflammation in mice (Shang et al., 2010). Zhao et al. evaluated its airway anti-inflammatory effects in rats, showing that alkaloids reduced inflammatory markers, including WBCs, lactate dehydrogenase, superoxide dismutase, albumin, and alkaline phosphatase, in lipopolysaccharide-induced airway inflammation models (Zhao et al., 2017, 2018). Further, it decreased allergen-specific airway inflammation, with intranasal administration proving more effective than intraperitoneal routes. Extracts at 400 mg/kg reduced pain by 79% and at 200 mg/kg by 73% in acetic acid-induced pain models. Carrageenan-induced paw edema was reduced at doses of 200 and 400 mg/kg (Arulmozhi et al., 2007).

Anti-Allergic Effects Alkaloids such as scholaricine and vallesamine in *A. scholaris* have shown promise in treating allergic asthma. It was observed that administration of *A. scholaris* extract thrice daily produced more significant effects than single doses, possibly due to prolonged plasma retention. Reductions in interleukin-4 and serum immunoglobulin E, which are pro-inflammatory molecules, were reported (Zhao et al., 2017).

Anticancer Activity Research by Jagetia and Baliga revealed cytotoxic effects of alkaloid fractions from *A. scholaris* on various cancer cell lines, including cervical (HeLa), liver (HepG2), leukemic (HL60), epidermal (KB), and breast (MCF-7). Treatments showed antineoplastic activity, and doses of 240 mg/kg were effective against cancer in mice, promoting disease-free survival (Jagetia and Baliga, 2005). Ethanolic extracts also exhibited antitumor activity in mouse tumor models (Jagetia and Baliga, 2004). Phytoconstituents such as villalstonine, pleiocarpamine, and macralstonine were tested, with

villalstonine showing the highest anticancer potential (Keawpradub et al., 1997). Co-administration with cyclophosphamide enhanced its anticancer effects in Ehrlich ascites carcinoma-bearing mice (Jagetia and Baliga, 2003). Hydroethanolic extracts at 4 mg/ml effectively suppressed benzo[a]pyrene-induced forestomach carcinoma in female mice (Jagetia et al., 2003).

Antidiabetic Activity Studies reported antidiabetic effects of *A. scholaris*. Ethanolic extracts significantly reduced blood glucose levels and lipid peroxidation in streptozotocin-induced diabetic rats, with effects lasting throughout the study (Arulmozhi et al., 2010). Aqueous extracts (150 mg/kg and 300 mg/kg) decreased glucose, serum triglycerides, cholesterol, and glycosylated hemoglobin while increasing liver glycogen levels (Bandawane et al., 2011). Similar effects were observed in alloxan-induced diabetic rats (Sonawane and Lohar, 2011).

Free Radical Scavenging Activity Antioxidant properties were evaluated using DPPH, hydrogen peroxide scavenging, superoxide anion radical scavenging, and metal ion chelation assays. Dichloromethane and ethyl acetate fractions showed high antioxidant activity compared to ascorbic acid and butylated hydroxyanisole (Arulmozhi et al., 2007). Among 17 medicinal plants tested, *A. scholaris* bark showed 81% nitric oxide scavenging activity (Ravishankar et al., 2008). Kumar also demonstrated antioxidant potential in flowers, which exhibited DPPH scavenging activity (Verma et al., 2015).

Hepatoprotective Activity Hepatoprotective effects were evaluated through biochemical markers such as AST, ALT, ALP, and LDH. Ethanolic extracts demonstrated superior hepatoprotective effects over aqueous extracts in acetaminophen-induced hepatotoxicity models, normalizing enzyme levels (Verma et al., 2015). Lin's studies further confirmed protective effects against CCL4, galactosamine, acetaminophen, and ethanol-induced liver toxicity (Lin et al., 1996).

Antimicrobial Activity Extracts of *A. scholaris* showed broad-spectrum antimicrobial activity against gram-positive and gram-negative bacteria, including *Escherichia coli*, *Candida albicans*, and *Pseudomonas aeruginosa* (Antony et al., 2012; Khan et al., 2003). Phytochemicals such as sterols and hydrocarbons demonstrated selective activity, with sterols being more effective against gram-negative bacteria and hydrocarbons against both gram-positive and gram-negative strains (Varshney and Goyal, 1995).

4. Future Applications of *Alstoniascholaris*

The rich phytochemical diversity and pharmacological potential of *Alstoniascholaris* make it a promising candidate for further research and development. While traditional medicine has extensively utilized this plant, modern scientific advancements open new avenues for its application in various fields.

Drug Development The identification and isolation of bioactive compounds from *A. scholaris* highlight its potential for developing novel drugs. Its alkaloids, flavonoids, and triterpenoids can be further

studied for creating targeted therapies for cancer, inflammation, diabetes, and microbial infections.

Anti-Cancer Therapies Given its proven cytotoxicity against several cancer cell lines, *A. scholaris* could be explored as a complementary therapy in cancer treatment. Research should focus on improving bioavailability, molecular mechanisms, and combination therapies with existing chemotherapeutics.

Anti-Diabetic and Cardioprotective Agents The hypoglycemic and lipid-lowering effects of *A. scholaris* suggest its use in managing metabolic disorders, particularly diabetes and cardiovascular diseases. Formulating standardized extracts or derivatives can aid in creating effective and safe supplements.

Anti-Inflammatory and Analgesic Applications Due to its significant anti-inflammatory and analgesic activities, *A. scholaris* can be developed into natural pain relievers or anti-inflammatory drugs. Future research can focus on optimizing dosage and formulations for topical and systemic use.

Antimicrobial Products Its antimicrobial properties position *A. scholaris* as a source for natural antimicrobial agents. These can be used in the development of antibiotics, antiseptics, and preservatives for pharmaceutical and cosmetic products.

5. Conclusion

Alstoniascholaris is a versatile medicinal plant with a rich history of traditional use and a broad spectrum of pharmacological activities. Its phytochemical profile, comprising alkaloids, flavonoids, triterpenoids, and other bioactive compounds, underpins its therapeutic potential. The plant has demonstrated significant analgesic, anti-inflammatory, anticancer, antidiabetic, antimicrobial, hepatoprotective, and antioxidant properties in both in vitro and in vivo studies. Additionally, its anti-allergic, antifertility, radioprotective, and antivenom effects further emphasize its pharmacological importance.

Despite its extensive use in traditional medicine, modern research has only begun to explore the full potential of *A. scholaris*. While preliminary studies support its efficacy, there is a need for comprehensive clinical trials and toxicological evaluations to ensure safety and establish standardized dosages for human applications. Future research should also focus on elucidating its molecular mechanisms, enhancing bioavailability, and developing novel drug formulations.

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