Journal of Rare Cardiovascular Diseases
ISSN: 2299-3711 (Print) | e-ISSN: 2300-5505 (Online)
www.jrcd.eu
RESEARCH ARTICLE

Phytochemical and Pharmacological Properties of Adhatoda Vasica Nees: A Comprehensive Review

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Article History
Received: 18.02.2025
Revised: 21.03.2025
Accepted: 05.04.2025
Published: 10.04.2025

Abstract: AdhatadaVasicaNees (family Acanthaceae), commonly known as Vasaka or Malabar nut, it is an important medicinal plant extensively used in Ayurvedic and Unani systems of medicine for centuries. This review compressively summarizes its ethnomedicinal significance, photochemical profile and pharmacological activities. The plant is rich in bioactive compounds, particularly quinazoline alkaloids such as vasicine and Vasicinone, which exhibit potent bronchodilator, anti – inflammatory, and antioxidant properties. Traditionally the A. Vasica has been employed in treating respiratory disorder, which including the asthma, bronchitis, and chronic cough, and recent studies have demonstrated its antimicrobial, antidiabetic, hepatoprotective and wound healing effects. The phytochemical composition encompasses alkaloids, flavonoids, tannis, phenols and essential oils, contributing to its diverse pharmacological actions such as an antispasmodic, antitussive, cardioprotective, and immunomodulatory effects. Emerging research highlights its antiviral and enzyme – inhibitory activities, suggesting potential therapeutic applications infectious and metabolic disorders. This review aims to provide a consolidated insight into the therapeutic potential of AdhatadaVasica, which emphasizing its role as a promising source for developing novel phytopharmaceuticals.

Keywords: AdhatodaVasica, vasicine, phytochemistry, pharmacological activity, traditional medicine, respiratory disorders.

INTRODUCTION

VasicaAdhatadaNees, sometimes called *Adosa*, is a tiny, evergreen shrub that grows across India and the rest of the world. The Acanthaceae family represents the ninth largest pantropical family of dicotyledonous plants, comprising over 200 genera and approximately 2,000 species. Among these, the *Adhatoda*and *Justiça*are recognized as two of the largest and most significant genera within the family, which known for the ecological diversity and medicinal importance. This genus is important source of therapeutic drugs and its species are distributed in all countries and mainly in tropical and subtropical regions. In America only three species *Justiciaspicigera*, *Justiciasecunda* and *Justicia pectoralis* are most widely used for medicinal purposes but in this very few studies related to their chemical composition and pharmacological properties which have been done yet. Asian species *JusticiaAdhatoda*, *Justiciabeddomiei*and *JusticiaAdhatoda*are most favourable species of this genus. *JusticiaAdhatoda*is also known as *Adhatodavasica*. It is a member of the *Acantheceae* family and has numerous traditional Ayurvedic uses[13,25].

The most well-known use of vasica is for the treatment of respiratory disorders. Vasica leaves have an exhilarating effect on the respiratory system. Asthma, chronic bronchitis, and other respiratory disorders[22] have been successfully treated with vasica for millennia due to its antispasmodic and expectorant properties. The most well-known use of vasica is for the treatment of respiratory disorders. When cooked with sesame oil, herb powder is used to stop bleeding and treat ear infections. Boiled leaves are used to ease urinary tract pain and rheumatism. The plant used in the indigenous system of medicine in India for over 2000years. It also using for drug in Ayurvedic and Unani medicine[21,23].

ChueMue, also known as Adhatodavasica (acanthaceae), is a robust, straggling, prostate shrubby plant with compound leaves that become sensitive to touch, spinous stipules, and globose, pinkish flower heads. It has been observed to grow as a weed in practically every part of the plant and contains the alkaloid mimosine. The leaves also contain mucilage, and the roots contain tannis. Alcoholic extract of Vasaka leaves studied for its wound curative effect in buffalo calves, a significant increase in the rate of healing, tensile strength, breaking strength, energy absorption, and extensibility observed[5].

BOTANICAL DESCRIPTION AND TAXONOMY

Figure 1: AdhatadaVasicaNees

AdhatadaVasica (L.) Nees (**Figure 1)** (family Acanthaceae)[15]known commonly as Malabar nut tree[17,27] and it is an evergreen shrub (2.2 – 3.5m) which is highly branched, woody and opposite ascending branches (i.e. 1.0 – 2.5 m) with white, pink or purple flowers. The leaves are simple, opposite – 7 – 19 cm long and 4 – 7 am wide and the flowersare white, pink or purple flowers and four – seeded fruits[22,25]. Oval stomata seen in the leaves while examining under the microscope. Most popular and common name of this plantAdulaVasaka or Arusha[15], Vasaka Sanskrit name for this plantand which is most popular in India. Vasaka is widespread throughout India and tropical region of Southeastern Asia[5]. The plant grows throughput the Indian peninsula up to an altitude of 1300m. It also known under the common name Malabar nut tree (**Figure 2)**. It's a very small evergreen shrub that is geographically distributed throughout India and mainly found in sub – Himalayan areas and it also distributed in Nepal, Pakistan, Myanmar and Germany[13].

Adhatodavasica is well known in Bangladesh for its medicinal properties and traditional used for treatment of many diseases, and pharmacological activities like antimicrobial activity, anticholinesterase activity, wound healing activity , immunomodulatory activity, anti - allergy activity, abortifacient, uterotonic activity, antitussive activity, cardioprotective activity, anti – bleeding, bronchodilator, anti – diabetic, anti – inflammatory activity, hepatoprotective activity, antiulcer activity, antiperiodic, anti – jaundice, antimutagenic and antioxidant activity, insecticidal activity, oxytocic properties, HIV- protease inhibitor activity, anthelmintic activity and anticestodal activity[6,23,29]

Figure 2: Adhatodavasica plant **a)** Whole aerial part[13] **b)** Flowering twig[13]

TAXONOMIC CATEGORIZATION OF ADHATODA VASICA

- Kingdom: Plantae
- Order: Lamiales
- Family: Acanthaceae
- Genus: Justicia
- Species: J. Adhatoda
- Common name: Adulsa (Vasaka)[20,22]

PLANT PARTS USED OF *ADHATODA VASICA*

The leaves, roots, flowers and stem bark of this plant are used in medicinal application[20].

Figure 3 –*AdhatodavasicaNees*. Plant and roots[25]

ETHNOBOTANICAL AND TRADITIONAL USES

AdhatadaVasica is well known plant drug in Ayurvedic and Unani medicine[5,13,17]. It used for the treatment of various diseases and disorders, specifically for the respiratory tract's ailments. and According to WHO manual the use of Traditional Medicine in Primary Health Care[13], which is intended for health workers in South East Asia to keep them informed of the therapeutic utility of their surrounding flora.According to this manual *AdhatadaVasica*is recommended for making sputum more fluid and for the treatment of cough, asthma and bleeding piles and it can use for both adults and children for a long period. A Vasica has long been used for both adults and children to cure cough, asthma, and bleeding piles as well as to make sputum more fluid. Adhatodavasica (Nees) is used in the Southeast tropical zone as it efficacious against headache, colds, cough, whooping cough, fever, asthma,dyspnea, phthisis, jaundice, chronic bronchitis, heart problems, blood disorders, vomiting, thirsty, memory loss and diarrhea. Plant's fruit aid in the treatment of brochities, and while the flower promotes blood circulation, whereas Rheumatism also treated by using these leaves. The leaves, flowers, and the roots have antispasmodic, bitter and aromatic properties. In Mysore, the powdered roots used for traditional healer to cure Malarial fever. This plant is beneficial for treating snake bites and regular massage by using leaf extract which reduces gum inflammation and bleeding[5].

Figure 4: Flower and leaves of Adhatodavasica

In Ayurveda due to its properties like Tikta – Kashaya rasa, katuvipaka and sheetavirya its known for use to cure diseases like Gulma, Raktapitta, Swasa – kasa etc. Herbal basak tea prepared from its leaves can be developed for good expectorant for the treatment of asthma. A decoction of leaves boiled in water is used for alleviate rheumatic pain and urinary tract infections. Leaves of Adhatodavasica is important drug used for expectorant. Vasicine helps condensing sputum and vital component for throwing sputum out of the body. Quinazoline alkaloids[22] are active principles for this property. Traditionally the leaves juice – swarasa is obtained by subjecting a bolus of crushed fresh leaves to heat followed by squeezing out juice and extraction of leaves is used to stimulate uterine contractions the (**Figure 4**: Flower and leaves of Adhatodavasica)[14]speeding child birth in various parts of India. Use of the roots for easy to removal of foetus or helping of giving birth[7].This plant is used in Ayurvedic and Unani medicine to treat conditions including smallpox, bilious, fever, piles, jaundice, leprosy, ulcers, and disorders caused by tainted blood and bile. This plant's roots, leaves, and turgor ins are used to cure fistulas and piles, while the leaf paste is used to treat hydrocele. Cotton infused with leaf juice is used to treat sinuses. This plant is also used as a blood purifier and to cure gum disease.[25]

PHYTOCHEMICAL CONSTITUENTS AND CHEMICAL COMPOSITION

*AdhatadaVasica*is also rich in alkaloidal[17,23] compounds among them vasicine[17,23] is very well known for its pharmacological value. Vasicine a quinazoline alkaloid is key compound of JusticiaAdhatada which powerful bronchodilator, anti – inflammatory and antioxidant[5,23].*A. vasica*includes essential oils, fats, resins, sugar, gum, amino acids, proteins, and vitamins C. phytochemical analysis shows that phenols, tannis, alkaloids, anthraquinone, saponins, and flavonoids, and reducing sugars were found in the leaves of the plant.

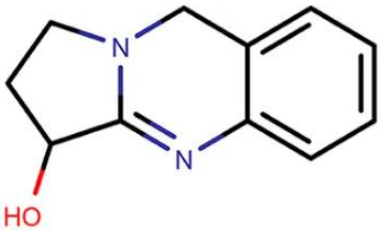

Figure 5: Chemical structure of Vasicine[1]**Pharmacological Properties**

Leaves contain pyrroloquinoline alkaloids chiefly vasicine (1,2,3,9 – Tetrahydropyrrole [2,1 – b] quinazoline – 3-ol, $C_{11}H_{12}N_2O$), and Vasicinone (3 –hydroxy -2,3 – dihydropyrrole [2,1 – b] quinazoline- 9 (1H) – one, $C_{11}H_{10}N_2O_2$)[11,23] (**Figure 5).** The leaves, roots and flowers of the plant contain the alkaloid vasicine which is responsible for the persistent bronchodilatation and essential oil which is main responsible for the expectorant action[12].

Plant widely explored for its medicinal and therapeutic activities such as antibacterial, antimicrobial, hepatotoxicity, antitubercular, anthelmintic, antispasmodic, antiasthmatic. The pharmacological action of whole plant is extensive range of activities and it possesses demonstrated its medicinal values[5]. A. vasica leaves is potent bioactive compound with a potential for the treatment of microbial infection, oxidative stress, inflammation, diabetes, viral infections and cancer investigated by various in vitro studies[14]. The leaves used to treat malarial fever, chronic fever, intrinsic haemorrhage, cough, asthma, leprosy, skin disease and piles.

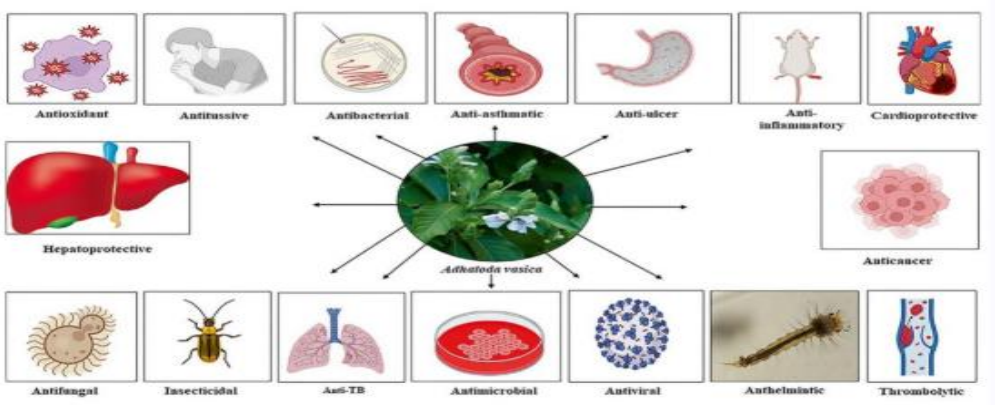

Figure 6: Pharmacological activity of *Adhatoda vasica*[28]

Plant is used as abortifacient, antimicrobial, and antitussive activities. Crude extract of *A. Vasica* leaves was found have conspicuous antifeedant and toxic effects on the larva of Littorales[17,23](**Figure 6)**

RESPIRATORY BENEFITS AND PULMONARY PHARMACOLOGY

*AdhatadaVasica*holds medicinal significance particularly in treating respiratory ailments such as bronchitis and tuberculosis[22]. *AdhatadaVasica* has been used for thousands of years in various traditions for inflammatory conditions of respiratory tract without any adverse effects[9].*Adhatoda Vasica*used in traditional Indian medicine for thousands of years to treat respiratory disorders[10].Vasicinone which is extracted from the leaves which acts as bronchodilator in healthy lungs while in the guinea pigs' lungs it acts as a potent bronchodilator on histamine – induced bronchoconstriction.The traditional use of A.vasica as herbal medicine has been well documented. One of the most frequent used medicinal plants in the Indian peninsula for upper part respiratory tract problems mainly in cough. This drug used for long period but no serious adverse effects reported or documented[5].*A. Vasica*is used for treatment of respiratory disorders which mainly acute and chronic cough, bronchitis and asthma. It also used for cough medicine in the treatment of acute and chronic bronchial catarrh and pulmonary disease. The leaves of this plant , flower, fruits and roots are mainly used for the treatment of cold, whooping

cough, asthma and anthelminthic and the extract of leaf is known for cure the diarrhea, dysentery and glandular tumor and the different part of the plant is used for the Indian traditional medicine for the treatment of various diseases like asthma , joint pain, lumber pain and sprains, cough, eczema, malaria, rheumatism, swelling, venereal diseases[23].

ANTI-INFLAMMATORY AND ANALGESIC EFFECTS

Inflammation is short- term biological reaction of tissues and achieve clearing and eliminating the stimulus and repairing the damage tissue and ultimately leading to regeneration or return to equilibrium as result of injury which is exogenous and endogenous antigens and other unpleasant stimuli. Leukotrienes, prostaglandins and histamines which binds to their respective receptors on endothelial cells during the early stages of inflammation which resulting the endothelial cell vasodilation and contraction which increase the blood vessel permeability[5].

ANTIMICROBIAL, ANTIFUNGAL, AND ANTIVIRAL PROPERTIES

*Adhatodavasica*is source of vitamin C and have a medicinal usei.e. antispasmodic, fever, reducer, anti – inflammatory. *AdhatadaVasica* contains essential oil, fragrant substance with a range of therapeutic uses and these oils has additional health benefits[22] and these leaves of *A. Vasica*is known to contain ketone, terpene and phenolic ether which may have antitumor, antioxidant, antiaging, antimutation and sedative effects which have the high phenolic content of essential oils which contributes their antimicrobial properties[17]. The investigated by Pa and Mathew (2012) demonstrated that the JustiçaAdhatoda exhibits the potent broad – spectrum antimicrobial effects and may serve as a valuable source of phytochemicals for the development of antimicrobial therapies aimed at controlling infectious disease[18]. In vitro studies demonstrated that A. Vasica extracts exert moderate inhibition of the key carbohydrate- digesting enzymes α - amylase and α – glucosidase which upto 56% inhibition at higher extract concentrations[19].This review examines the antiviral efficacy of crude extracts from the *JusticiaAdhatada*which is against the influenza viruses, using the hemagglutination (HA) inhibition assays in both simultaneous and post – infection treatment setups. The methanolic extract demonstrated potent antiviral activity which is achieving complete. HA inhibition at a concentration of 10mg/mL in both assay types, while the aqueous extract produced a 33% reduction in the simultaneous assay. At concentration of 10mg/mL and 5mg/mL reductions of 33% and 16.687% respectively were observed in HA underscoring the strong prophylactic potential of these extracts in countering influenza virus infection[22,23].

ANTIDIABETIC AND HYPOGLYCAEMIC ACTIVITY

Adhatodavasica has cytotoxic, anti-hyperglycaemic, anti-diarrheal, and anti-convulsant qualities and employed in Unani and Ayurvedic systems is rich in alkaloids such as vasicine, vasicinol and Vasicinone and these bioactive have been implicated in modulatory effects on glucose metabolism and insulin secretion[19].*Adhatoda vasica*is a traditionally used medicinal plants. In many literatures of review shows that the anti – ulcer, antidiabetic, antioxidant, muscle relaxant, anti – allergic, hepatoprotective, and cardioprotective activities of different parts of *Adhatodavasica*. Although the in vivo antidiabetic activity of *Adhatodavasica*leaves and roots has been extensively investigated. Gao H.et L (2008) demonstrated that vasicine and vasicinol inhibits α – glucosidase activity by more than 50% in Goa et al's 2008 study, which likely explains the extract's antidiabetics properties[21].*Adhatoda vasica*leaves for its phytochemical composition and antioxidant activity. Antioxidant activity of methanol extract of *A. Vasica*estimated by total antioxidant activity 2,2 diphenyl - picrylhydrazyl radical scavenging activity, reducing power potential and iron chelating activity. Leaves of *A. Vasica*found to possess saponins, oils and fats, phytosterol, phenolic compounds, tannins, carbohydrate, alkaloids, flavonoids and proteins. Extract of this plant shows high antioxidant activity in various antioxidant experiments. Extract of *A. Vasica*shows the presence of high levels of polyphenolic compounds which is main cause behind the antioxidant activity of the plant. Extract demonstrated the antimicrobial and cytotoxic activity[3].Around 1977 it was discovered that vasicine possess uterine stimulating activity with similar effect as oxytocin. After this discovery and due to the fact that there are great new drugs for fertility regulation, and a lot of effort. After this discovery and fact that there are great need new drugs for fertility regulation for this research put lots of efforts for develop vasicine as a new abortifacientagent. Farnsworth et al., In 1980's WHO included A. Vasica in The Special Programme of Research in Human Reproduction as a plant worthy of study for fertility regulation. Ancient times people used plant extract as traditional herbal remedies but unable to find the individual compounds that responsible for the biological effects[14].

ANTICHOLINESTERASE ACTIVITY

Vasicinone derived from the roots showed good anticholinesterase activity by causing temporary hypotension in cats, isolated intestinal contraction, and isolated cardiac depression in guinea pigs[28].

ANTICANCER ACTIVITY

Adhatodavasica shows anticancer potential through its antioxidant properties and bioactive compounds. Vasicine acetate from ethanolic extract exhibited cytotoxicity in A549 lung cancer cells while the leaf

extracts show the protective effects which against the cervical cancer cells. Nanoparticles incorporating plant extract and metal oxides demonstrated enhanced the anticancer activity. Additionally, the extract inhibited the lung cancer cell proliferation through the oxidative stress, apoptosis and mitochondria disruption and methanolic extract showed the effects in MCF – 7 cells[28].

CONCLUSION

AdhatodavasicaNees, is an important medical plant of the Acanthaceae family, possesses a diverse phytochemical profile that underpins and its wide range of pharmacological activities. Traditionally valued for treating respiratory aliments such as asthma, bronchitis, and chronic cough, modern studies have further highlighted its antimicrobial, antidiabetic, hepatoprotective, antioxidant and wound- healing properties. The bioactive compounds, particularly vasicine and Vasicinone, which demonstrate the significant therapeutic potential which making the plant a promising the source for future drug development. Overall *A.Vasica*servers as a vital link between traditional medicine and modern pharmacological research, warranting continued scientific exploration to fully harness its medicinal benefits.

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