

Exploring the pharmacognostic, phytochemical and therapeutic profile of *Justicia adhatoda*.

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Abstract- *Justicia adhatoda*, widely recognized Vasaka, is a medicinal shrub belonging to the family Acanthaceae. It has been extensively used in traditional Ayurvedic and Unani medicine for managing respiratory problems such as asthma, bronchitis, cough, and other pulmonary conditions. The plant is rich in various bioactive compounds, the most prominent being vasicine, a quinazoline alkaloid known for its strong anti-asthmatic, bronchodilatory, and expectorant properties. Vasicine acts by relaxing the bronchial muscles, promoting airway dilation, and enhancing mucociliary clearance, thereby improving breathing efficiency. Scientific investigations have revealed that vasicine and its oxidized derivative, vasicinone, exhibit complementary effects that help reduce bronchial constriction and support respiratory health. Besides its role in respiratory therapy, *J. adhatoda* demonstrates notable anti-inflammatory, antioxidant, and antimicrobial activities, further validating its medicinal importance. Hence, *Justicia adhatoda* stands as a potent herbal resource for the development of natural remedies and pharmaceutical formulations aimed at treating asthma and other respiratory disorders.

Index Terms— *Justicia adhatoda*, Vasicine, Traditional Ayurvedic Medicine, Anti-asthmatic.

1. INTRODUCTION:

Justicia Adhatoda (L.) Nees, a member of the Acanthaceae family, grows abundantly in tropical regions of Southeast Asia.^[1] The plant is also known by the synonym *Adhatoda zeylanica* Medic, and is commonly called Malabar nut or Vasaka. It is an evergreen shrub reaching around 1 to 2.5 meters in height, characterized by a strong, unpleasant odour and a bitter flavor. The species has opposite, upright branches and produces attractive flowers that may appear white, pink, or purple.^[2] In Ayurvedic medicine, it is regarded as an important herb for treating respiratory ailments such as asthma, cough, cold, and tuberculosis.^[3] Its major pharmacological effects are bronchodilation and facilitation of mucus expulsion. Additionally, the plant is rich in Vitamin C and is known for several medicinal properties, including anti-inflammatory, antipyretic, antidiabetic, anti-bleeding, anti-jaundice, and oxytocic effects.^[4]

Table 1. Taxonomy of *Justicia adhatoda*. ^[5-12].

Kingdom	Plantae
Subkingdom	Tracheobionta
Sub division	Spermatophyta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Asteridae
Order	Scrophulariales
Family	Acanthaceae
Genus	Justicia
Species	adhatoda

Vernacular Names ^[13]:

- Hindi - Adosa, adalsa, vasaka
- Sanskrit - Shwetavasa, Vaidyamatasinghee, vasa, vasaka
- Bengali - Basak
- Tamil - Adatodai
- Marathi - Vasuka
- Telugu - Adasaram vasa,

7. Malayalam - Ata- lotakam
8. Gujarati - Aradusi, adusa
9. Punjabi - Bansa, basuti, bhekkar
10. English - Malabur nut
11. China - Ya-Zui-Hua
12. Manipuri - Nongmangkha-agouba
13. Kannada - Adusoge

2. Tradition and medicinal uses :

Justicia adhatoda has been valued since ancient times for its medicinal properties, particularly in treating respiratory disorders. In Ayurvedic medicine, different parts of the plant are traditionally administered to both children and adults for conditions affecting the respiratory system. Across India, the plant has been used to relieve asthma, joint and lower-back pain, sprains, colds, coughs, eczema, malaria, rheumatism, inflammation, and certain sexually transmitted diseases. Its therapeutic reputation extends beyond India. European physicians have also incorporated *J. adhatoda* into their medical practice. In England, its fluid extracts and tinctures were historically employed as antispasmodic, expectorant, and fever-reducing agents, particularly in cases of intermittent and typhus fever and diphtheria. In Germany, the leaves are used to ease bronchial spasms and promote mucus expulsion. In Sweden, the species is recognized as a natural medicinal product, and cough remedies containing *Justicia adhatoda* extract are available commercially. ^[14]

3. Botanical description of *Justicia adhatoda*:

Justicia Adhatoda is an evergreen shrub from the Acanthaceae family, usually 1–6 meters tall with many opposite branches. ^[15] Its stem is woody on the outside and soft inside. The plant has dense clusters of white, pink, or purple bisexual flowers that are about 2 cm long. It has dark green, bitter-tasting leaves that are lance-shaped, slightly hairy, and 7–19 cm long. The fruit is a small capsule containing four round seeds, each around 5–6 mm. ^[16]

4. Geographical distribution: *Justicia Adhatoda* is a perennial evergreen shrub originating from the Indo-Malayan region. It is widely distributed in countries such as Sri Lanka, Nepal, Pakistan, Malaysia, Southern China, Myanmar, Laos, and across the Indonesian islands. In India, it grows mainly in tropical and subtropical areas, especially along the lower Himalayan foothills up to 1350 m altitude, and is commonly seen in regions like Punjab, Bengal, Manipur, and Kerala. ^[17]

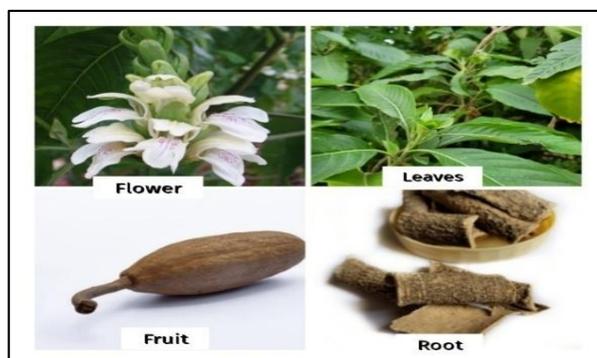


Fig.No.1. *Justicia Adhatoda*

5. Phytochemistry :

Adhatoda vasica contains multiple bioactive substances across all parts of the plant—leaves, roots, seeds, flowers, fruits, and stems. These include essential oils, fats, sugars, gums, resins, amino acids, proteins, and vitamin C. Studies show that the leaves especially are rich in phenols, flavonoids, alkaloids, anthraquinones, saponins, and reducing sugars. ^[18] The most widely researched compound is vasicine, a bitter quinazoline alkaloid (C₁₁H₁₂N₂O), found in significant amounts in the leaves, flowers, and roots. It is produced by reacting 2-amino benzylamine with vasicinone precursors. The aerial parts of the plant also contain various

triterpenoids like 3-hydroxy-D-friedoolean-5-ene, along with epitaraxerol and peganidine. Elemental analyses have detected key minerals (K, Na, Ca, Mg) and trace elements such as Zn, Cu, Cr, Ni, Co, Cd, Pb, Mn, and Fe by atomic absorption spectrometry.^[19]

- Leaves: The leaves hold major alkaloids including vasicine (0.85%) and vasicinone (0.027%), along with others like vascinol, adhatodine, adhatonine, adhavaquinone, anisotine, and hydroxypeganine. In addition, they contain minimal amounts of essential oil, crystalline acids, betaine, steroids, and alkanes.^[20]
- Flowers: The flowers feature triterpenes such as α -amyrin and a variety of flavonoids—astragalin, kaempferol, quercetin, vitexin, and apigenin—along with dihydrochalcone glucosides and alkanes.^[21]
- Roots: Root extracts include vitamin C (5.2%), fats (2.5%), carbohydrates, fibers (5.2%), and steroid daucosterol. They also consist of alkaloids like vasicine (7.5%), vasicinone (3.5%), vasicinolone, and adhatonine. Other compounds like β -glucoside-galactose, sitosterol, and deoxy vasicine are also present.
- Seeds: Seeds contain 25.8% yellow oil rich in fatty acid glycerides—oleic acid (49.9%), linoleic acid (12.3%), behenic (11.2%), lignoceric (10.7%), cerotic (5%), and arachidic acid (3.1%)—along with 2.6% β -sitosterol.^[22]

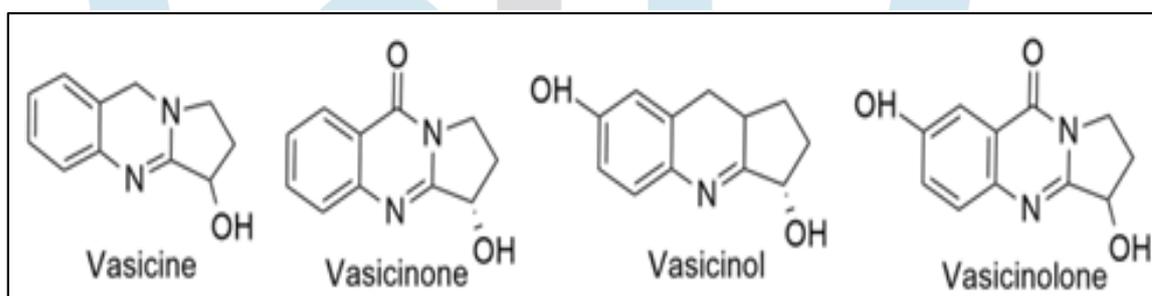


Fig.No.2. The chief phytoconstituents of *Justicia adhatoda*.

6. Pharmacological activities :

i. Antiasthmatic activity : The key alkaloids vasicine and vasicinone are responsible for the plant's beneficial effects in respiratory conditions. Leaf and root extracts help soothe throat irritation, support treatment of bronchitis, bronchiolar and pulmonary disorders, and function as effective expectorants. Studies using both anesthetized and conscious guinea pigs, as well as rabbits, have demonstrated notable cough-suppressing activity.^[23] Research further confirms that vasicine exhibits significant bronchodilator effects in both in vitro and in vivo experiments.^[24] Both in vivo and in vitro studies have shown that vasicine and vasicinone possess bronchodilatory properties. The ethanolic extract of *Adhatoda vasica* was evaluated for its ability to counteract bronchoconstriction triggered by histamine aerosol and acetylcholine in guinea pigs. Its bronchodilatory response was comparable to that of ketotifen. Therefore, pyrrolo-quinazoline alkaloids such as vasicine and vasicinone demonstrate significant anti-asthmatic potential.^[25]

ii. Anti tussive: Vasicinone, the primary metabolite of vasicine and also found in *Justicia adhatoda* extracts, has demonstrated bronchoconstrictive effects in vivo. However, when vasicine and vasicinone are used together, they exhibit significant bronchodilatory activity in both in vitro and in vivo studies. This dual action is likely attributed to their specific interaction with neuronal receptors in the medulla, which helps suppress cough reflexes. Their antitussive efficacy has been shown to be comparable to codeine in experimental models involving irritant aerosols and citric acid-induced coughing. Traditionally, various parts of the plant—including leaves, roots, flowers, and bark—have been utilized for treating respiratory conditions such as cough, cold, asthma, bronchial congestion and bronchitis.^[26]

iii. Anti-inflammatory: The major alkaloid in *Justicia adhatoda*, vasicine, is recognized for its anti-inflammatory potential. This activity was examined using a modified hen's egg chorioallantoic membrane (HET-CAM) assay, where the methanolic extract containing both alkaloidal and non-alkaloidal components, including saponins, was tested. The study showed that the alkaloid fraction produced a strong anti-inflammatory response at a dose of 50 mg/kg, exhibiting an efficacy similar to that of hydrocortisone, while the whole methanolic extract demonstrated comparatively weaker anti-inflammatory activity.^[27]

iv. Respiratory stimulant and bronchodilatory: In traditional Ayurvedic practice, the leaves of this plant are widely used to manage breathing-related disorders. The alkaloids, particularly vasicine and vasicinone, present in the leaves contribute to their ability to stimulate the respiratory system. Lower levels of vasicine help ease the tracheal muscles and widen the airways, while higher doses provide strong defense against histamine-triggered bronchospasms in guinea pigs. Vasicinone, which is produced through the oxidation of vasicine, has also shown effective bronchodilatory action in both laboratory and animal studies. Overall, both vasicine and vasicinone demonstrate notable antihistamine and airway-relaxing properties.^[28]

v. Anti-diabetes: *Adhatoda vasica* possesses strong anti-diabetic properties. Its extracts, particularly the methanolic leaf extract, help reduce high blood sugar levels in diabetic animal models. Alkaloids like vasicine and vasicinol also demonstrate notable antihyperglycemic activity.^[29] In alloxan-induced diabetic mice, the leaf extract not only decreased glucose levels but also improved diabetes-related depression. *Adhatoda vasica* can be used for diabetes treatment in various forms, including the plant extract, isolated compounds, herbal preparations, and eco-friendly nano formulations, which show enhanced anti-diabetic and antimicrobial effects.^[30]

vi. Anti-oxidant: *Justicia adhatoda* shows antioxidant activity by protecting against oxidation caused by lipid peroxides and xanthine oxidase. Vasicine, a key alkaloid in *Justicia adhatoda*, is mainly responsible for these effects, including its strong antioxidant action. Additionally, the plant can stimulate mitochondrial ROS production and alter mitochondrial membrane permeability, which supports the maturation of megakaryocytes.^[31]

vii. Wound healing activity: G. Vinothapooshan and K. Sundar studied the wound-healing potential of *Justicia adhatoda* by formulating its extracts into an ointment and testing it on an excision wound model in albino rats.^[32] The methanolic extract ointment showed notable wound closure, performing similarly to the standard drug and more effectively than the other extract-based ointments. Another preclinical study reported that the shoots of *Justicia adhatoda* helped enhance wound repair in mice. Overall, the methanolic leaf extract demonstrated strong wound-healing properties and may serve as a beneficial treatment for various wounds and injuries in animals.^[33]

viii. Anti-viral activity: The plant's aqueous and methanolic extracts have shown notable antiviral action against influenza by blocking the virus from binding to host cells and disrupting its replication. This indicates that the plant could potentially be used as a preventive measure against viral infections.^[34]

ix. Anti-cancerous: The anti-cancer potential of *Justicia adhatoda* is attributed to bioactive compounds such as l-vasicinone, deoxyvasicine, maiontone, vasicinolone, and vasicinol, known for diverse pharmacological properties.^[35] Duraipandiyan et al. reported that vasicine acetate, derived from vasicine, exhibited strong cytotoxicity against A549 lung cancer cells. Identified a new alkaloid, 2-acetyl-benzylamine, which induced cell cycle arrest in MOLM-14 and NB-4 cancer cells. Scientists demonstrated that ethanol leaf extracts showed anti-metastatic effects in ovarian cancer models by reactivating tumor-suppressor genes *p53* and *p21*. Nonetheless, further in vivo research is essential to confirm its therapeutic potential in humans.^[36]

x. Anti ulcer activity: *Justicia adhatoda* L. has been investigated for its antiulcerogenic properties against ulcers induced by pylorus ligation, ethanol, and aspirin. In experimental rat models, the plant's leaf powder demonstrated significant anti-ulcer activity, particularly in ethanol-induced ulceration. These findings suggest that, alongside its wide range of pharmacological effects, *J. adhatoda* L. possesses strong potential as an effective anti-ulcer agent.^[37]

7. Conclusion: *Justicia adhatoda* is a significant medicinal herb known for its strong anti-asthmatic properties. The main active compound, vasicine, along with vasicinone, demonstrates powerful bronchodilating, expectorant, and anti-inflammatory effects that help ease asthma symptoms and promote better respiratory function. By relaxing bronchial muscles, clearing mucus, and reducing inflammation in the airways, the plant effectively supports respiratory health. Scientific studies have confirmed its traditional use and suggest that *J. adhatoda* can serve as a natural and safe option for managing asthma compared to synthetic drugs. Continued research on its bioactive components, pharmacological mechanisms, and formulation approaches could lead to the development of effective plant-based treatments for respiratory diseases. Therefore, *Justicia adhatoda* holds great promise as a valuable herbal remedy for asthma and other breathing disorders.

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