



Adhatoda Vasika (NEES.): A Review on its Phytochemistry, Pharmacological Action and Traditional Utilization

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ABSTRACT

Adhatoda vasica L. Nees (family Acanthaceae) is an evergreen shrub with opposite ascending branches, simple large leaves and terminal spike inflorescence, is a well-known plant drug in Ayurvedic and Unani Medicine. *Adhatoda vasica* plant is widely used for variety of purposes which form part of many other traditional herbal medicines. The plant has been found to possess diverse number of pharmacological activities. The present paper gives an account of updated information on its phytochemical and pharmacological activities. The Review reveals that wide range of phytochemical constituents have been isolated from the plant and it possesses important activities like antitussive, antibacterial, abortifacient, anti-inflammatory and Antiulcer. All the parts of the plant are used in medicines. Vasicine is the main chemical constituent present in this plant which possesses various medicinal properties and is used in different Ayurveda formulations. The review reveals that wide range of phytochemical constituents isolated from the *vasaka* plants and its possesses various review focuses on the Phytochemistry and pharmacological actions of the plant.

Keywords: *Adhatoda Vasika*, Phytochemistry, Pharmacological action, Traditional utilization.

1. Introduction:

The plants are significant natural providers of pharmaceuticals and medical supplies. The herb can be used to treat cough, respiratory tract disorders, and asthma. In order to treat asthma and other throat infections, the species is crucial. *Adhatoda vasica* is commonly referred to as Adosa (ARDUSO) in English, Malabar Nut in Bangla, and Basak in Hindi and Sanskrit Vasaka. For the past 2000 years, it has been utilized to prepare herbal medicine. This plant is essential and native to Asia; it can be found throughout the Indian subcontinent, including Bengal, Punjab, Nepal, Assam, and Shri Lanka. It can be found in Konkan, Marathwada, Vidarbha, and other parts of Maharashtra. Also Malaysia, Ceylon, Singapore, and numerous more nations are home to it as well. It is well-known for its effectiveness in treating respiratory issues and is a member of the acanthaceae family. It is an evergreen perennial shrub that has been used for in addressing issues such as chronic bronchitis, asthma, and other Ayurvedic centuries ago. This little perennial is evergreen. Shrub with a maximum height of three meters on average descending and oblique branches. It is the main herb used to treat respiratory tract conditions, including bronchitis asthma, common colds, and cough. There are several medical applications for this plant, including antispasmodic, oxytocic, anti-inflammatory, anti-diabetic, anti-bleeding, bronchodilator, disinfectant, and anti-jaundice ⁽¹⁾.

The leaves, flowers, and roots of this plant are used in herbal drugs against tubercular activities, cancer, and possess anti-helminthic properties. The fresh juice of the leaves mixed with honey and ginger juice cures all types of acute cough, chronic bronchitis, breathlessness, and liquefies sputum and asthma. It is also used as an expectorant, antiperiodic, astringent, diuretic, and purgative. Herb powder combined with sesame oil in a boiling mixture is used to treat ear infections and stop bleeding. Boiled leaves are used to treat urinary tract infections and rheumatoid arthritis pain. Abortifacient properties are also thought to exist in it. Some regions of India use it to accelerate labor by inducing uterine contractions.



Fig 1. Image of *Justica Adhatoda L.*

1.1 Plant Description:

Adhatoda vasica Nees, part of the *Acanthaceae* medicinal family, is a perennial shrub ranging from 1 to 3 feet in height, characterized by numerous lengthy opposite branches. Its leaves are large and lance-shaped, while the stem exhibits herbaceous qualities above and becomes woody below. The leaves are arranged in an opposite fashion and are without stipules. The small, irregular, zygomorphic, bisexual flowers are organized in spikes or panicles and are positioned below the ovary (2). It produces fruits with four seeds per cap. The flowers are colored either purple or white. The Sanskrit name *Vasaka* is the basis for its trade name (3).

Vernacular names: Hindi: Adosa, adalsa, vasaka, Sanskrit: Amalaka, bashika, Bengali : Basak, Tamil : Adatodai, Marathi : Vasuka, Telugu : Adasaram, Malayalam : Ata-lotakam

Classification: Kingdom: Plantae, Division: Angiosperms, Class: Eudicots, Order: Lamiales, Family: Acanthaceae, Genus: *Justicia*, Species: *Adhatoda* (*Adhatoda vasika*)⁽⁴⁾

1.2 Properties and action according to Ayurveda:

The taste is bitter (Tikta) and astringent (Kashaya), with qualities of being light (Laghu) and dry (Ruksha). It has a cold potency (Sheeta) and a post-digestive effect that is pungent (Katu) and light (Laghu) (5).

1.3 Chemical Constituents:

Alkaloids:

Vasicine, also known as peganine, is the primary alkaloid found throughout all parts of a particular plant. In addition to vasicine, the leaves of the plant boast a diverse array of compounds, including vascisinone, adhatodine, betaine, and several others. These components collectively form the chemical profile of the plant. Noteworthy alkaloids present in the leaves encompass vasicinone, vasicinol, adhatonine, and various N-oxides and glycosides. The chemical complexity extends to include derivatives like 7-methoxyvasicinone, 5-methoxyvasicinone, and 3-hydroxyanisotine. The plant's composition showcases a rich diversity of alkaloids, glycosides, and related substances, each contributing to its unique biochemical makeup⁽⁶⁻⁹⁾. The root contains vasicinol, vasicinolone, vasicinine, adhatonine^(10,11) and vasicol⁽¹²⁾.

1.4 Phytosterols and triterpenes:

Three-hydroxy-oleanane-5-eneepitaraxerol, β -carotene, daucosterol, α -amyrin, and three-hydroxy-hexatetracont-1-en-15-one⁽¹¹⁾ are all present⁽¹³⁾.

Flavonoids:

The leaf and flower contain apigenin, astragenin, kaempferol, quercetin, vitexin, isovitexin, and violanthin, as well as 2''-O-xylosylvitexin, rhamnosylvitexin, and 2'-hydroxy-4 glucosyloxichalcone⁽¹⁴⁾.

Essential oil:

The primary component of the flower volatile oil is a ketone known as 4-heptanone, which is present in at least 36 other components, including 3-methylheptanone⁽¹⁴⁾.

Fatty acids and hydrocarbons:

The leaf oil is a complex mixture of more than fifty compounds, the main one being decane. Other compounds include linolenic, arachidonic, and hydroxyalkanes such as 37-hydroxy hexatetracont-1-en-15-one and 29-methyl triacontan-1-ol and the acids oleic, palmitic, and linoleic^(15,16).

Chalcone:

Adhatoda vasica leaves are used to extract 2'4-dihydroxychalcone-4-O- β -D-glucopyranoside, hydroxyoxychalcone, and 2'glucosyl-4-hydroxyoxychalcone⁽⁷⁾.

Steroid:

Leaf extract is used to extract epitaraxerol⁽⁷⁾.

Galactose& Glucose:

Leaf extracts contain B-glucoside-galactose, β -sitosterol-D-glucoside, D-glucose, D-galactose, O-ethyl- α -D-galactoside, and sitosterol- β -D-glucoside⁽⁷⁾.

Amino Acids:

Amino-n-butyric acid, Glycine, proline, serine, and valine are extracted from leaves⁽⁷⁾.

2. Phytochemistry:

Adhatoda's high concentration of alkaloids is thought to be the cause of its wide range of pharmacological applications (17,18). The main alkaloid present in Adhatoda leaves is vasicine, a quinazoline alkaloid (19). Besides vasicine, the alkaloids l-vasicinone, deoxyvasicine, maiontone, vasicinolone, and vasicinol are also present in the leaves and roots of Adhatoda (20). Studies suggest that the bronchodilatory effect is caused by these chemicals (21,22).

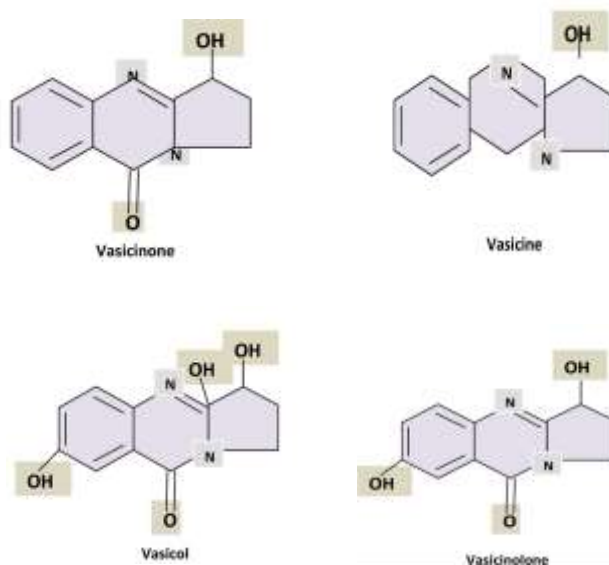


Fig.2: Phytochemistry of *Adhatoda vasica*.

3. Pharmacological action:

The pharmacological effects of Vasaka in water and alcohol extracts are noteworthy because of the active ingredients present, such as Vasicinone and Vasicinone Acetate. The medicinal properties of vasicine and vasicinone are significantly more as in contrast with their racemic forms. Numbers of reports of activities are ⁽²³⁾

3.1 Antibacterial activity:

Adhatoda vasica leaf extract has a moderately strong antibacterial effect. Paper discs and the dilution method were used to test the antibacterial activity of Adhatoda leaf extract. The alkaloids in this plant were discovered to have potent resistance to *Pseudomonas aeruginosa* through antibacterial action. Along with antimicrobial activity against gram-negative For example, *E. coli* and Gram-positive bacteria strains i.e. *faecalis streptococcus* ⁽²⁴⁾.

3.2 Anti-inflammatory activity:

The primary alkaloid of Adhatoda vasica, vasicine, exhibited anti-inflammatory properties. The modified hen's egg chorioallantoic membrane test was used to assess the anti-inflammatory activity of the methanol extract, the non-alkaloid fraction, the saponins, and the alkaloids.

3.3 Anti-tussive:

In an animal model using rabbits and guinea pigs, adhatoda extract exhibits antitussive properties. A recent investigation discovered that vasicine is bronchodilatory both in vivo and in vitro. Compared to codeine, it is more effective as an antitussive ⁽²⁵⁾. A study discovered that the plant contains chemical components like vasicine and kaempferol, which exhibit expectorant properties. The commercial preparation Kan Jang oral solution, proven effective in placebo-controlled research, demonstrates efficacy in treating upper respiratory infections ⁽²⁶⁾.

3.4 Anti-ulcer activity:

Vasica leaf ethanolic extract has a strong effect on stomach ulcers brought on by pylorus ligation, aspirin, and ethanol. But the superior outcomes were obtained using the rats' gastric ulcer model produced by ethanol. Additional research on the syrup made from the plant extract indicates potent anti-ulcerogenic activity and suggests its potential use in treating dyspepsia ⁽²⁷⁾.

3.5 Anti-allergic activity:

The vasicinone constituent of the *J. adhatoda* plant has been found to demonstrate anti-allergic properties in studies conducted on mice, rats, and guinea pigs, according to reported findings⁽²⁸⁾. The plant's Methanolic extract, when tested on guinea pigs, exhibits anti-allergic and anti-asthmatic effects when either inhaled or administered at doses of 6 mg per animal or 2.5 gm/kg, respectively⁽²⁹⁾.

3.6 Insecticidal activity:

India has been using *Adhatoda vasica* as a pesticide for generations. Its leaves have been demonstrated to effectively manage insect pests in oil seeds in both laboratory and storage settings⁽³⁰⁾. Studies have demonstrated that vasicinol, an alkaloid found in *Adhatoda*, inhibits the ability of many insect species to reproduce by obstructing the oviduct. Additionally, studies have demonstrated how efficient *Adhatoda* is at keeping insects away⁽³¹⁾.

3.7 Anti-diabetic activity:

Adhatoda vasika leaf and root extracts are widely utilized by the rural population to treat liver diseases and diabetes. Using sucrose as a substrate, the methanolic extract of *Adhatoda vasica* (Acanthaceae) leaves exhibited good sucrose inhibitory activity. The primary component of the plant, vasicine, is important for the metabolism of sucrose, according to a different study. Control of hyperglycemia is essential in the treatment of not only, according to epidemiological studies and clinical trials, individuals with impaired glucose acceptance in addition to diabetic patients. According to this recent report, vasicine can also function as an irreversible α -glucosidase (sucrose). As a result, *Adhatoda vasica* may be investigated as a powerful natural diabetic agent^(32,33).

3.8 Radioprotective activity:

Exposure to ⁶⁰Co radiation induced sickness in Swiss albino mice, characterized by significant histological changes in the testis and chromosomal aberrations in bone marrow cells, resulting in a 100% mortality rate within 22 days. However, oral administration of the ethanolic extract of *Adhatoda vasica* leaf at a dose of 800 mg/kg body weight per mouse for 15 consecutive days prior to radiation exposure reduced the death rate of *Adhatoda*-pretreated irradiated mice to 70% within 30 days. This *Adhatoda* pretreatment effectively prevented radiation-induced chromosomal damage in bone marrow cells, highlighting the substantial radio-protective effects on the testis conferred by the *Adhatoda* plant extract⁽³⁴⁾. Cardio protective activity: The concurrent use of vasicine and vasicinone led to a significant reduction in the depressant effects on the heart. Vasicinone in its DL-form exhibited no impact, whereas the L-form showed a modest stimulation of cardiac muscles, though less potent in comparison⁽³⁵⁾.

3.9 Wound healing activity:

Buffalo calves, upon the topical application of alcoholic and CHCl₃ extracts of *Adhatoda vasica* leaves, exhibited a notable enhancement in wound healing rate, tensile strength, energy absorption, and extensibility. This improvement, accompanied by an increase in collagen, elastin, hydroxyproline, and zinc levels, was observed from the 3rd day of treatment compared to the control group⁽³⁶⁾.

3.10 WBC increasing activity:

In another instance, it was discovered that the *Adhatoda vasica* plant demonstrated efficacy in elevating total white blood cell count, blood lymphocytes, splenic lymphocytes, and peritoneal macrophages. Additionally, it exhibited significant protective effects against *Escherichia coli*-induced abdominal peritonitis⁽³⁷⁾.

3.11 Anti-tubercular activity:

Barry conducted research on the anti-tubercular properties of *Adhatoda vasica*. His findings revealed that bromohexine and ambroxol, both derived from vasicine in *Adhatoda vasica* demonstrate inhibitory effects on the growth of *Mycobacterium tuberculosis*. This discovery suggests potential implications for the treatment of tuberculosis. Vasicine, a chemical component of *Adhatoda* alkaloids, gives rise to bromhexine and ambroxol, commonly employed mucolytics. These compounds exhibit a growth inhibitory impact on *Mycobacterium tuberculosis*, influenced by pH. *Adhatoda*'s indirect effects on tuberculosis involve elevated lysozyme and rifampicin levels in bronchial secretions, lung tissue, and sputum. This implies a potential significant role for *Adhatoda* as an adjunct in tuberculosis treatments.

3.12 Abortifacient and uterotonic activity:

Adhatoda vasica is useful for inducing abortions and for accelerating uterine contractions due to its abortifacient and uterotonic properties giving birth⁽³⁸⁾. Vasicine, an alkaloid, has been shown to have strong uterotonic activity in human subjects' studies. This behavior seems to be impacted by the existence or lack of specific estrogens. When studying the activity human vasicine's ability to induce uterine contractions myometrial strips extracted from each pregnant woman's uterus and *Adhatoda* was used to treat non-pregnant women. It was discovered that the herb caused uterine contractions, with efficacy comparable to the medication oxytocin⁽³⁹⁾. Throughout the research phase, local women reportedly observed the anti-reproductive effects

of *Adhatoda vasica* based on anecdotal evidence. While these observations are intriguing, it's essential to conduct additional scientific studies for more conclusive results ⁽⁴⁰⁾.

4. Traditional utilization:

Adhatoda vasica commonly known as *vasica* or *Justica adhatoda* is the most important Ayurvedic herb which is mainly used in respiratory diseases including chronic bronchitis, whooping cough and asthma for both children and adults (41). Glycodin, which is a significant product isolated from the leaves of *Adhatoda Vasica* is used to cure bronchitis. It was initially used to treat respiratory diseases, but its use has grown steadily over time (42). In the Indian System of medicine, it is employed for addressing conditions such as asthma, arthritis, sprains, colds, coughs, eczema, malaria, rheumatism, swelling, and sexual disorders (43). Leaves are used traditionally for the betterment of Cough, asthma, hepato-protective, bronchitis, Tuberculosis, and as a uterine tonic (44). It was an expectorant and antispasmodic in Germany. Sweden people used to treat cough. The whole plant is used in Sri Lanka for phlegm, menorrhagia, and piles. The leaves are smoked to cure asthma (45). In another investigation, ethanolic leaf extract was employed to Suppress pathogenic organisms (46). In addition, it has been utilized as a herbal remedy for respiratory system blockage caused by allergens. Hepatoprotective qualities. The tribes of Naga make use of the preparing a leaf infusion to treat intestinal worms Infection (47). Traditional usage of plant Components and their pharmacological action (48).

Part of the plant	Disease/Disorder
Roots	Gonorrhoea
Flowers	Jaundice eye disorders
Leaves	Respiratory disease (bronchitis, expectorant, anti-tussive, asthma) Diarrhea/Dysentery, antiseptic, anthelmintic, etc.,

Table 1. Different parts of *A. vasica* and their traditional uses

Various parts of the plant play a significant role to cure different diseases.

- **Roots:**

In India paste of the fresh root applied on abdomen and vagina minutes before childbirth facilitates easy delivery. The extract of roots of *Adhatoda vasica* is commonly used by rural population against diabetes, cough and Certain liver disorders ⁽⁴⁹⁾.

- **Leaves:**

The various preparations of leaves has been used for curing bleeding, hemorrhage, skin diseases, wounds, headache and leprosy (chronic infection) while their infusion or the solvent extract has been observed to be an excellent agent for the destruction of white ants, flies, and mosquitoes. The combination of fresh leaf juice with honey and ginger juice for respiratory issues is a traditional remedy known for its potential benefits in managing cough, bronchitis, breathlessness, and asthma. Natural remedies like these have been used for their potential therapeutic properties. Always consult with a healthcare professional for personalized advice on health matters ^(50,51).

- **Flowers:**

Expectorant, antiasthmatic, antiseptic, and cold-related symptoms, as well as phthisis, asthma, bronchitis, cough, high fever, and gonorrhoea, have all been treated with flowers ⁽⁵²⁾.

- **Fruits:**

Fruits of the *Adhatoda vasica* are four seeded capsules. In Pakistan, fruits of the plant are used for cold, antispasmodic and bronchitis. The fruit of the plant are also used for Diarrhea, Dysentery, Fever and as laxative ⁽⁵³⁾.

5. Conclusion:

From various reported studies it is clear that *Adhatoda vasica* plays a significant role in the herbal medicinal system. *Adhatoda Vasica* has been an important medicinal herb well known for its applications in different traditional medicinal system such as Ayurveda, Siddha and Unani etc. *A. vasica* also showed many pharmacological activities viz. Antibacterial activity, anti-inflammatory activity, anti-tussive, anti-ulcer activity, Anti-allergic activity, insecticidal activity, Anti-diabetic activity, Radioprotective activity, Cardioprotective activity, Wound healing activity, WBC increasing activity and Anti-tubercular activity. This plant is a rich Source of Vitamin C, Vasicine, Vasicinone and other alkaloids Components.

6. Future Perspectives:

From the above details, it is clear that the plant *Adhatoda vasica* is widely used for the treatment of various diseases that are well documented and mentioned in traditional and pharmacological uses. The different parts of the plant and their chemical constituents are also mentioned in the table for biological use. In conclusion, it can be used as a treatment strategy and for the development of a novel drug delivery system. For its use in multiple aspects screening and bioassay are must along with that we have to collect sufficient knowledge of the chemical constituents and their structure-activity relationship studies are needed to explore its further actions. The widespread use of herbal medicines has seen a notable surge. Research findings indicate an annual increase in the sales of herbal products, ranging between 3% and 12%, during the period from 2000 to 2008. The increasing desire for herbal products comes with a higher risk for herbal medicines. This heightened risk is attributed to a decline in the quality of the final product caused by contaminated raw materials containing toxic metals, microbes, and other residues. Furthermore, problems like adulteration, which involves adding fake or substandard plant material, conventional drugs, or foreign substances, lead to a subpar quality of both the raw materials and the end product.

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