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Adhatoda vasica: A Concise Review of Its Pharmacological and Therapeutic Potential

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ABSTRACT
Numerous natural products derived from plants possessing intrinsic biological activities have significantly contributed to the enhancement of human health since the inception of civilization. Notably, over 50% of contemporary clinical medications are derived from natural sources, which has led to marked evolution in the methodologies employed for drug discovery and development within the pharmaceutical sector. A. vasica serves as a valuable source of pyrroloquinazoline alkaloids, including vasicine, vasicol, adhatonine, vasicinone, vasicinol, and vasicinolone, which are the primary components of various plant extracts. These compounds exhibit a range of biological and pharmacological activities, including anti-malarial, antiinflammatory, antioxidant, antidiabetic, antibacterial, and anticancer effects. Additionally, the leaves of Adhatoda have been widely utilized in Ayurvedic medicine to treat conditions such as diarrhea, dysentery, tuberculosis, skin disorders, vomiting, and leprosy. Herbal medicine continues to be the primary healthcare choice for approximately 75–80% of the global population, particularly in developing nations, owing to its cultural acceptability, compatibility with the human body, and reduced side effects. However, in recent years, there has been a notable increase in the use of herbal remedies in developed countries. In the context of modern pharmaceuticals, it is essential to further characterize these substances following pharmacological screening by examining their pharmacokinetic and pharmacodynamic properties, including toxicity. This communication aims to outline the phytochemical composition and pharmacological potential of A. vasica.
Key words: Adhatoda vasica, secondary metabolites, pyrroloquinazoline alkaloids, biological activities.

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INTRODUCTION

Adhatoda vasica is popularly known as Basak in Bangla, Malabar Nut in English, Adosa in Hindi and Vasaka in Sanskrit. It has been used in the preparation of herbal medicines for the past 2000 years. It is a medicinal plant native to Asia and is widely used in the Siddha, Ayurvedic, and Unani systems of medicine. The plant's range includes Sri Lanka, Nepal, India, Pakistan, Indonesia, Malaysia, and China, as well as Panama where it is thought to have been introduced This evergreen perennial shrub has leathery leaves. The flowers are dense and large, with large bracts and a whitish pink/purple color. The herb is often grown as a hedge, and its leaves and twigs are used as green manure. Whole plants or their roots, leaves, bark, and flowers are used in various herbal preparations. They are arranged oppositely, smooth-edged, and borne on short petioles (Chakrabarty, and Brantner, 2001).

Commonly referred to as Malabar Nut, *Adhatoda vasica* is a shrub that grows to a height of about 1-2 meters. The plant is characterized by elongated, glossy green leaves, white or pale blue flowers, and fruit that contains four seeds. It thrives in both cultivated and wild environments and is often observed in hilly or disturbed areas.

The majority of medicinal plant species are rich in biomolecules, which can cope with health hazards, and the antibacterial activity of many plant species has recently been reported. The leaves and roots contain several alkaloids (the chief principle being quinazoline alkaloids, vasicine, vasicinone, vasicinolone and vasicol), which may have a bronchodilator effect on the bronchi. These alkaloids exist in combination with an acid known as adhatoda acid. It acts as a sedative, expectorant, antispasmodic, anthelmintic, bronchial antiseptic, and a bronchodilator. The leaf extract has been used for the treatment of bronchitis and asthma for many centuries. It relieves coughing and breathlessness. It is also commonly prescribed for bleeding due to idiopathic thrombocytopenic purpura, local bleeding due to peptic ulcers, piles, and menorrhagia.

Its local use provides relief in pyorrhea and bleeding gums. As the alkaloid content of plants varies with genotype, it is recommended that *A. vasica* plants be propagated using the vegetative method. *Adhatoda zeylanica medicus*, also known as *A. vasica* Nees. *Justicia adhatoda* Linn (Sayeed et al 2009).

PHYTOCHEMEMICAL AND PHARMACOLOGICAL ACTIVITY OF *Adhatoda vasica*

Water, ethanolic, and petroleum ether extracts of Adhatoda leaves enriched with alkaloids, phenols, tannins, and reducing sugars, the main constituent of vasicine, have been found to possess antibacterial activity (singularly or in combination) against S. epidermidis, *S. aureus B. subtilis, E. faecalis, E. coli, P aeruginosa, P. vulgaris, K. pneumoniae*, and *C. Albicans*. *Adhatoda vasica* possesses abortifacient and uterotonic properties, and its leaves of *Adhatoda vasica* are mostly used in the treatment of respiratory ailments in Ayurveda. The two main alkaloids present in the leaves, vasicine and vasicinone, possess respiratory stimulant activity. Vasicine at low concentrations induces bronchodilation and relaxation of tracheal muscles. *Adhatoda vasica* also has immense potential as an anti-ulcer agent that is used to treat or ameliorate peptic pustules or irritation of the gastrointestinal tract and is of great therapeutic relevance (Gupta, et al. 1977 and Sultana et al. 2005).

A wide range of phytochemical constituents have been isolated from this plant, including antitussive, abortifacient, antimicrobial, insecticidal, hepatic protective, cardiovascular protective, anticholinesterase, antioxidant, anti-inflammatory, and other important activities. Some important bioactive compounds that have been reported in various parts of *Adhatoda vasica* are essential oils and quinazoline alkaloids. Therefore, this plant is one of the best options for developing novel compounds with medicinal value. Two new aliphatic hydroxyketones, isolated from the aerial parts of *Adhatoda vasica*, have been characterized as 37- hydroxyhexatetracont-1-en-15-one and 37- hydroxyhentetracont an-19-one, respectively, on the basis of spectral data and chemical studies. 2',4- Dihydroxychalcone 4-glucoside has been identified in the flowers of *Adhatoda vasica*. A novel alkaloid and galactoside isolated from the roots of *Adhatoda vasica* have been characterized as 9-acetamido-3,4- dihydropyrido-(3,4-b)-indole and O-ethyl-α-D-galactoside, respectively, by chemical and spectroscopic methods. In addition, sitosterol β-d-glucoside, d-galactose, and deoxyvasicin have also been isolated from the roots of this plant (Jainet al., 1980). Two new pyrroloquinazoline alkaloids, viz. 1,2,3,9- tetrahydropyrrolo (2,1-b)-quinazolin-9-one-3Rhydroxy-3(2'-dimethylamino phenyl (desmethoxyaniflorine) and 7-methoxy-3R-hydroxy-1,2,3,9- tetrahydropyrrolo-[2,1-b]- quinazolin-9-one (7-methoxyvasicinone), together with several known compounds, were isolated from the leaves of *Adhatoda vasica*. Their structures were determined using spectroscopic and X-ray diffraction analyses (Maurya and Singh, 2010).

The *Adhatoda vasica* plant is characterized by a diverse array of chemical compounds, including essential oils, fats, resins, sugars, gums, amino acids, proteins, and vitamins such as vitamin C [30]. Phytochemical analyses revealed the presence of phenols, tannins, alkaloids, anthraquinones, saponins, flavonoids, and reducing sugars in plant leaves. Vasicine, a bitter quinazoline alkaloid, has garnered significant pharmacological interest. This novel alkaloid, isolated from the leaves, was identified as 1, 2, 3, 9-tetrahydro-5-methoxypyrrol [2, 1-b] quinazolin-3-ol and is found in the leaves, roots, and flowers of the plant. In addition to vasicine, the leaves also contain various other alkaloids, including vasicinone, vasicinol, adhatodine, adhatonine, adhvasinone, anisotine, and hydroxypeganine, as well as betaine, steroids, and alkanes. Notably, vasicine and vasicinone were the two predominant alkaloids in the leaves (Ogunleye and Ibitoye, 2003 and Thappa *et al,* 1996).

The pharmacological properties of vasicine and vasicinone have been extensively studied. Recent studies have demonstrated that vasicine exhibits bronchodilatory effects comparable to those of theophylline, both in vitro and in vivo. When used in combination, these alkaloids exhibit significant bronchodilatory activity. Vasicine is also known for its potent respiratory stimulatory effects. There is also evidence suggesting that vasicine possesses thrombopoietic activity, which refers to its ability to increase platelet count. Observations have indicated that these alkaloids exhibit uterine-stimulating properties and moderate hypotensive effects. Vasicine is metabolized to vasicinone, and analyses of plant leaf extracts have revealed the presence of 0.85% vasicine and 0.027% vasicinone. Compounds such as sitosterol, β-glucoside-galactose, and deoxyvasicine have been isolated from plant roots. Furthermore, the flowers contain 2'-4-dihydroxychalcone-4-glucoside, with kaempferol and quercetin as the primary constituents. A novel triterpenoid, 3-hydroxy-D-friedoolean-5-ene, along with known compounds, such as epitaraxerol and peganidine, was extracted from the aerial parts of *Adhatoda vasica* Nees (Kumar et al. 2013).

TRADITIONAL USES

Roots: In India, fresh root paste is applied to the abdomen and vagina immediately before childbirth to facilitate easier delivery. The root extract is also used by rural populations to treat diabetes, coughs, and liver disorders. Its paste is used for conditions such as tuberculosis, diphtheria, malaria, leucorrhea, eye

diseases, and even acute nightfall (in Sitapur district, Uttar Pradesh). Root decoction is used to treat gonorrhea and is an expectorant, antispasmodic, and anthelmintic agent.

Leaves: Various preparations made from the leaves of *Adhatoda vasica* are used to treat bleeding, hemorrhage, skin diseases, wounds, headaches, and even leprosy (a chronic infection). In some regions, the infusion or extract of leaves is used as an insecticide to kill white ants, flies, and mosquitoes. Fresh juice from leaves, when mixed with honey and ginger juice, is an effective remedy for acute cough, chronic bronchitis, breathlessness, and asthma. A decoction of leaves combined with *Phyllanthus emblica* fruit and honey has also been shown to be effective in treating asthma. Furthermore, crushed fresh leaves have been used to treat snake bites in India and Sri Lanka. Other local uses include leaf powder boiled in sesame oil to treat bleeding, earaches, pus from the ears, and jaundice. Leaf juice is renowned for its ability to boost platelet counts in conditions such as dengue, postpartum hemorrhage, and other viral fevers (Ayyanar and Ignacimuthu, 2008).

Flowers: *Adhatoda vasica* flowers possess expectorant, antiasthmatic, and antiseptic properties. They are used to treat ophthalmia, cold, phthisis, asthma, bronchitis, and gonorrhea. Additionally, they help improve blood circulation and can be beneficial in managing high fever and other circulatory issues (Kumar et al. 2013).

Fruits: The fruits of *Adhatoda vasica*, which are four-seeded capsules, are used in Pakistan to treat colds, bronchitis, and asthma. These fruits are also known for their laxative properties and are used in the treatment of diarrhea, dysentery, and fever.

GLOBAL PERSPECTIVES AND FUTURE APPROACHES

The information presented indicates that *A. vasica* is extensively utilized in the treatment of various ailments, as documented in both traditional and pharmacological contexts. The table outlines various parts of the plant, along with their chemical constituents relevant to biological applications. In summary, *Adhatoda vasica* holds potential as a therapeutic strategy for the development of novel drug delivery systems. Comprehensive screening and bioassays are essential to fully harness its capabilities, along with a thorough understanding of its chemical constituents and their structure-activity relationships, which are crucial for investigating its biological effects. The insights gained from this study will serve as a foundation for the development of new natural products that may exhibit fewer side effects than synthetic or chemical alternatives. Additionally, this work encourages researchers in the agro-industry to focus on herbal products. Future research will aim to achieve enhanced resolution of various bioactive compounds isolated from *A. vasica*.

CONCLUSION

The pharmacological and phytochemical properties of *Adhatoda vasica* make it a promising natural remedy for respiratory issues, inflammation, and various other health conditions. Ongoing research is likely to uncover more of its therapeutic potential, validating its traditional uses with modern scientific evidence.

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