IJBPAS, April, 2022, 11(4): 1616-1626

ISSN: 2277–4998

International Journal of Biology, Pharmacy and Allied Sciences (IJBPAS)

'A Bridge Between Laboratory and Reader'

www.ijbpas.com

PHYTOCHEMICAL AND PHARMACOLOGICAL CHARACTERISTICS OF *Adhatoda vasica*: A REVIEW

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Received 6th May 2021; Revised 5th June 2021; Accepted 2nd July 2021; Available online 1st April 2022

https://doi.org/10.31032/IJBPAS/2022/11.4.5987

Abstract: In our country [India], as well as in other countries, the *Adhatoda vasica* plant plays an important medicinal role. This herb has long been employed in the Ayurvedic medical system. *Adhatoda vasica* Nees [Acanthaceaceae] is a well-known medicinal plant that has yielded alkaloids, phenolics, flavonoids, sterols, and glycoside derivatives. As a result, the current communication is a review of *Adhatoda vasica*, a therapeutic plant. This plant contains a wide range of phytochemical elements with antitussive, abortifacient, antimicrobial, insecticidal, hepatic protection, cardiovascular protection, anticholinesterase, antioxidant, antiinflammatory, and other significant actions. Essential oils and quinazoline alkaloids are two significant bioactive substances found in various parts of *Adhatoda vasica*. As a result, this plant may be one of the most promising candidates for the development of novel therapeutic chemicals.

Keywords: *Adhatoda vasica,* Phytochemical properties, Pharmacological Properties, Herbal Medicine, Ethnopharmacology

INTRODUCTION

Nature serves as a primary source of new and innovative treatments **[1]**. The growth of drug-resistant infections and the rise in immune-related disorders has heightened the need to research novel bioactive metabolites for potential pharmaceutical and commercial applications **[1, 2]**. Ayurvedic classics contain a unique variety

of medicinal plants as well as extensive traditional herbal medicine expertise for the treatment of many ailments. Nearly 49,000 plant species are recognised to have medical potential in India's flora **[3]**, with 8000 of these species having medicinal potential **[4]**. Ayurveda, the Indian system of medicine, lists over 2500 plant species belonging to over 1000 genera for treatment **[5]**. *Adhatoda vasica* [Nees] [AV], often known as Malabar nut tree, is a shrub native to the Indian peninsula and belongs to the Acanthaceae family. *Adhatoda zeylanica* Medic. is a botanical name for *Adhatoda zeylanica. Justicia adhatoda* L. is a plant that belongs to the family Justiciaceae. Both terms are interchangeable.In both the Ayurvedic and Unani systems of medicine, *Adhatoda vasica* is a well-known expectorant **[6, 7]**. Vasaka leaf juice [*Vasa swarasa*] is used in more than 20 different Ayurvedic compositions **[8]**. Because of its widespread use, *Adhatoda vasica* has been included in the WHO guideline. The Use of Traditional Medicine in Primary Health Care. The WHO designated *Adhatoda vasica* as a worthy plant for fertility regulation research in The Special Programme of Research in Human Reproduction in the 1980s **[9, 10]**. As a result, substantial research on the chemical components of AV has been carried out. In a nutshell, the purpose of this paper is to review the ethanopharmacological evidence of therapeutic uses of AV **[11]**.

General Description:

Adhatoda vasica [AV] is a member of the Acanthaceae family **[12]**. The quinazoline alkaloids vasicine, 7-hydroxyvasicine, vasicol, vasicinolone, 3- deoxyvasicine, vasicoline, triterpenes, vasicolinone, anisotine] betaine, steroids carbohydrate, and alkanes are found in the leaves, roots, and young plants of *Adhatoda vasica*.Triterpenes [a-amirine] and flavonoids [Apigenin, astragalin, kaempferol, quercetin, vitexin] have been discovered in the blooms of *Adhatoda vasica*, widely known as Malabar nut tree **[13, 14]**. It's a little evergreen, sub-herbaceous bush found all over India, notably in the lower Himalayas [up to 1300 metres above sea level], India, Sri Lanka, Burma, and Malaysia. It reaches a height of 1.5-2.0 metres, with leaves that are 10- 15 centimetres long and 5.0 centimetres wide, white or purple blooms, and four-seeded fruits. The leaves are dark green on top and pastel yellow on the bottom. The flowers are white and placed in a pedunculated spike. Tender stem cuttings are used to propagate it. Planting stem cuttings with 3-4 nodes and a length of 15-20 cm are good. Adhatoda is harvested from open fields or purchased from commercial sources. Seeds are the most common method of propagation, but hardwood cuttings can

also be used in the spring and early summer **[15]**. Because plant alkaloid content varies by genotype, vegetative propagation of *A. vasica* is advised **[16]**. Synonyms of *Adhatoda zeylanica* Medicus are *A. Vasica* Nees. *Justicia adhatoda* Linn **[12]**.

Reported Phytochemical Properties:

Essential oils, lipids, resins, sugar, gum, amino acids, proteins, and vitamins 'C' are among the chemical components present in *J. adhatoda* plants **[17, 18]**. The leaves of *J. adhatoda* contained phenols, tannins, alkaloids, anthraquinone, saponins, flavonoids, and reducing sugars, according to the phytochemical study **[19]**. However, vasicine [1, 2, 3, 9-tetrahydropyrrole [2, 1-b] quinozolin-3-ol, $C_{11}H_{12}N_2O$], a bitter quinazoline alkaloid found in the leaves, roots, and flowers, is the pharmacologically most researched chemical component in *J. adhatoda*. Vasicine can be made by adding 2-aminobenzylamine to the vicinyl vicinal trycarbonyl reagent, which results in a quick synthesis **[20]**. The leaves also include alkaloids [Vasicinone, Vasicinol, Adhvasinone, Adhatodine, Adhatonine, Anisotine, and Hydroxypeganine], betaine, steroids, and alkanes in addition to vasicine **[21, 22]**. Vasicine is converted to vasicinone, and leaf extract from *J. adhatoda* had 0.85 percent vasicine and 0.027 percent vasicinone, according to study.On the basis of X-ray examination of the alkaloid hydrobromides, the absolute stereochemistry of [-]-Vasicine and [-] – Vasicinone has been proven to be in the 3S configuration. Similarly, the 3S arrangement should be used for Vasicinol and Vascinolone, which are related **[23]**. The new alkaloid 1, 2, 3, 9-tetrahydro-5-methoxypyrrol [2, 1-b] was extracted from leaves. quinazolin-3-ol is a kind of quinazolin[Chowdhury and Bhattacharyya, 1987]. Alkaloids [vasicinal, vasicinone, vasicinolone, and adhatonine], a steroid [daucosterol], sugars, and alkanes are also found in the roots **[17]**. Triterpenes [-amyrin], flavonoids [Apigenin, Astragalin, Kaempferol, Quercetin, Vitexin], and alkanes [Apigenin, Quercetin, Astragalin, Kaempferol, Vitexin] have been discovered in the flowers **[17, 24]**.

The bitter quinazoline alkaloid vasicine [1, 2, 3, 9-tetrahydropyrrole [2, 1-b] quinozolin-3-ol, $C_{11}H_{12}N_2O$] found in the leaves, roots, and flowers of A. vasica is the most investigated chemical component **[25]**. Adhatodine, adhatonine, anisotine, adhavasinone, vasakine, vasicine, vasicinol, deoxyand N-oxide vasicine, vasicinone, vasicol, vasicinolone, and 6-hydroxy preganine are among the alkaloids found in the leaves. Leaves also include betaine, the steroid -sitosterol, and alkanes **[22, 26, 27]**. Vasicine is converted to vasicinone in the body. On the basis of X-ray analysis of the alkaloid hydrobromides, the absolute stereochemistry of [-]- vasicine and [-] –

vasicinone has been shown to be 3S configuration. Similarly, the 3S configuration may be found in vasicinol and vascinolone, which are related **[15, 23]**. The new alkaloid 1, 2, 3, 9-tetrahydro-5-methoxypyrrol [2, 1-b] was extracted from leaves. quinazolin-3-ol is a kind of quinazolin **[22]**. Adatodine, vasicine, vasicinol, vasicinone, vasicinolone, deoxyvasicinone **[27]**, a steroid, daucosterol, sugars, and alkanes are also found in the roots. In the flowers alkaloids vasicine, vasicinine triterpenes [α-amyrin], kaempferol, flavonoids [apigenin], alkanes, astragalin, quercetin, vitexin], steroid, β-sitosterol, daucosterol have been found **[25]**.

Reported Pharmacological Properties:

a. Uterine activity

The uterotonic activity of vasicine was examined in depth both in vitro and in vivo using uteri from different species of animals and under diverse hormonal influences[12]. Similar to oxytocin and methyl ergometrine, uterotonic action was observed **[12]**. Under the priming influence of oestrogens, the abortifacient action of vasicine, as well as its uterotonic impact, was more pronounced **[28, 29]**. Vasicine-induced abortion in rats, guinea pigs, hamsters, and rabbits was investigated. According to the findings, vasicine works by releasing PGs. In vitro experiments demonstrated that synthesised vasicine and vasicinone derivatives had oxytocic action at doses greater than 1 mg/ml **[12, 30]**.

b. Antimicrobial Activity

According to Duraipandiyan *et al*., vasicine acetate, which is made by acetylating vasicine, has a good zone of inhibition against bacteria such as *Enterobacter aerogenes, Staphylococcus epidermidis*, and *Pseudomonas aeruginosa* **[11, 32]**.Furthermore, vasicine revealed substantial antibacterial action against *Escherichia coli* at a dose of 20 g/ml, as well as maximum antifungal activity against *Candida albicans* at a dose of >55 g/ml **[33]**. Gram-positive *Staphylococcus aureus, Micrococcus luteus*, and Gram-negative *Pseudomonas aeruginosa* were found to have antibacterial action in a methanolic extract of *Adhatoda vasica*. Using the agar well diffusion method, four different doses of dimethyl sulfoxide were investigated **[33]**.According to Bose and Chatterjee, green manufactured silver nanoparticles made from *Adhatoda vasica* leaf extract have the ability to suppress bacterial development **[11]**. The procedure was both cost-effective and environmentally beneficial, as well as lowering the amount of capping chemical used. The disc diffusion method, agar cup assay, and serial dilution turbidity measurement assay were used to assess the antibacterial activity of these nanoparticles against *P. aeruginosa* MTCC 741 **[11]**. The

nanoparticles have a well-defined form, with an average particle size of 20 nm in the 5–50 nm range **[34]**. Karthikeyan *et al*. backed up the previous findings by showing that *Adhatoda vasica* leaf extracts exhibit antibacterial action against *S. aureus, S. epidermidis, Bacillus subtilis, Proteus vulgaris*, and *Candida albicans* **[35]**. Vasicine has a moderate bactericidal activity and a strong DPPH inhibitory action **[11, 31]**. Bacterial quorum sensing activity reduces microbial pathogenicity by disrupting the bacterial communication system. Quorum sensing allows bacteria to govern all important functions and could be an attractive and innovative target for anti-pathogenic medications, particularly in the fight against resistant forms of bacteria. To combat MDR, researchers have recently concentrated their efforts on producing antipathogenic medicines that block bacterial transmission and thereby control bacterial illnesses. The anti-quorum sensing activity of Adhatoda leaves extract was tested against *Chromobacterium violaceum* strain and found to be effective **[11, 36]**.

c. Antibacterial

Preliminary phytochemical and antibacterial investigations were carried out of the crude extracts obtained from the leaf of *Adhatoda vasica*, using solvents of varied polarity **[12]**. The tests revealed the presence of phenols, tannins, alkaloids, anthraquinones, saponins, flavanoids, amino acids, and reducing sugars **[12]**. On *Staphylococcus aureus*, *Bacillus subtilis*, *Staphylococcus epidermidis, Escherichia coli, Enterococcus faecalis, Pseudomonas aeruginosa, Klebsiella pneumoniae, Proteus vulgaris*, and *Candida albicans*, the effects of ethanol, petroleum ether, and water extracts were investigated **[12]**. For diverse organisms, the lowest inhibitory concentration of crude extracts was established **[12, 37]**.

d. Antifungal Activity

Plants have been shown to be prospective sources of novel and biologically active natural compounds with enhanced therapeutic efficacy **[12]**. Natural goods and active plant extracts have been more popular in recent years, and new medications are being developed thanks to technical breakthroughs **[12]**. The present study investigates the phytochemical elements of *Adhatoda vasica* and their human pathogenic fungal effective agent **[12]**. The phytochemical extract's minimal inhibitory activity is determined. The extract is further investigated for partial characterisation by TLC and antifungal activity as measured by agar disc diffusion and germ tube formation inhibition activities **[12]**. The goal of this investigation on the effect of *A. Vasica* on the pathogenic fungi *Aspergillus ruber* and *Trichophyton rubrum* was to determine the antifungal activity of *A. Vasica* **[12, 38]**.

e. Insecticidal activity

Adult male wistar rats received 400 mg/kg of methanolic, chloroform, and diethyl ether extracts of leaves of the Indian medicinal plant *Adhatoda vasica* orally, which significantly improved neutrophil adherence to nylon fibres [p0.001] and positively modulated immunity **[25, 39]**. With Ki values of 82 M and 183 M, respectively, the major alkaloids from AV inhibited sucrose hydrolyzing activity of rat intestine -glucosidase competitively **[25, 40]**.

f. Antioxidant activity

The two significant medicinal plants endemic to India are *Adhatoda vasica* Nees and *Sesbania Grandiflora* [L.] Pers **[12]**. The DPPH radical scavenging activity, hydroxyl radical scavenging activity in $Fe^{3+/}$ascorbate/EDTA/H_2O_2 system, suppression of lipid peroxidation generated by $FeSO_4$ in egg yolk, and metal chelating activity of the aqueous leaf extracts of these two plants have all been investigated in vitro **[12]**. Standard antioxidants such as butylated hydroxy toluene [BHT], ascorbic acid, and EDTA were examined to see how effective they were at scavenging free radicals **[12]**. The reduction of Mo [VI] to Mo [V] by the extract and subsequent production of green phosphate/Mo [V] complex at acid pH, as well as reducing power by Fe^{3+} - Fe^{2+} transition in the presence of extracts, were used to calculate total antioxidant activity **[12]**. Total phenolics [measured in milligrammes of gallic acid equivalents per gramme] and total flavonoids [measured in milligrammes of quercetin equivalents per gramme] were measured, as well as antioxidant enzymes **[12]**. In vitro, *A. vasica* and *S. Grandiflora* demonstrated significant antioxidant activity, according to the findings **[12]**. *A. Vasica* has higher enzymatic and non-enzymatic antioxidants than *S. Grandiflora*, and its antioxidant and radical scavenging capabilities are also greater than *S. Grandiflora* **[12, 41]**.

g. Anti-inflammatory

In Ayurvedic and Unani medicine, *Adhatoda vasica* [L.] Nees is a well-known plant medication. It's been used to treat a variety of ailments, most notably inflammatory and cardiovascular illnesses **[12]**. The scientific reason and processes by which it works in certain disorders, however, are unknown **[12]**. The goal of this study was to see if *Adhatoda vasica* aqueous and butanolic fractions could inhibit arachidonic acid [AA] metabolism **[12]**. Aqueous and butanolic fractions of *Adhatoda vasica* were screened for activity against arachidonic acid [AA] metabolites, and their efficacy was further assessed by examining platelet aggregation produced by AA, adenosine diphosphate [ADP], platelet activating factor [PAF], and collagen **[12]**. A thin layer chromatography system was

used to study AA metabolism, while a dual channel Lumiaggrego metre was used to assess platelet aggregation. Through the COX [TXB2] and LOX pathways, the aqueous fraction of *Adhatoda vasica* inhibited the AA metabolites, but not the butanolic fraction [LP1 and 12-HETE] **[12]**. However, in platelet aggregation assays, butanolic extract of *Adhatoda vasica* inhibited AA, PAF, and collagen-induced aggregation, but not ADP-induced aggregation **[12, 42]**.

h. Anticholinesterase

Vasicinone, derived from the roots, caused transitory hypotension in cats, as well as contraction of the isolated gut and depression of the isolated heart in guinea pigs, indicating that it has anticholinesterase activity **[21, 43]**.

i. Antiulcer property

When compared to a control, *Adhatoda vasica* leaf powder demonstrated a significant amount of anti-ulcer efficacy in experimental rats **[43]**. In the ethanol-induced ulceration model, the highest level of activity [80%] was seen **[44]**. The findings show that, in addition to its well-known pharmacological properties, the plant has enormous promise as an antiulcer agent with significant therapeutic implications **[43]**.

j. Wound healing effect

In an excision wound model in albino rats, methanolic, chloroform, and diethyl ether extracts of *Adhatoda vasica* were investigated for wound healing activities in the form of Ointment dosage form **[45]**. By measuring the parameters, percentage closure of excision wound model, the methanolic extract ointment of *Adhatoda vasica* demonstrated a substantial effect on excision wound model as comparable to standard drug and other two extracts of ointment **[43, 45]**.

k. Insecticidal effect

After 26 days of unsubstantial growth, feeding on fresh leaves resulted in 100 percent mortality of larvae **[46]**. When applied on leaf discs or included into an artificial diet, the extract had a severe antifeedant and toxic effect on the larvae **[43, 46]**.

CONCLUSION

According to the literature review, *Adhatoda vasica* Nees has been extensively explored for its pharmacological properties. Many medicinally essential compounds, such as Vasicine, Vasicinone, Vasicoline, and other minor alkaloids, can be found in it. The development of therapeutically useful compounds from *Adhatoda vasica* should be prioritised as researchers adopt a worldwide scenario for drug discovery from plant sources.

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