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An Ethnobotanical Review Of *Adhatoda Vasica* (L.), Nees. (Vasaka) In Context With Medicinal Importance &Phytochemistry.

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Abstract- *Adhatoda vasica* (L.) Nees is also known as ***Justicia adhatoda*** L. belongs to the family Acanthaceae is a shrub with opposite ascending branches and is considered the most significant medicinal plant in the world. It is commonly known as Vasaka, Vasica, Adusa, Malabar nut and is distributed in various regions of India as well as the world. The plant has been used in the Indigenous system of medicine in India for near about 2500 years. It is a well- known plant as a drug in Ayurvedic and Unani medicinal system. Traditionally it was used for the treatment of various acute and chronic diseases and showed strong pharmacological activity particularly for bronchial infections, cough, common cold, asthma, tuberculosis, reproductive disorders, cardiac diseases and many more. All the parts of the plant are used in medicines. Various phyto chemicals like alkaloids, flavonoides, tannins etc were obtained from *Adhatoda, vasica*. The active phyto chemical constituents of the plant are vasicine, vasicinone, vasicinol, vasicol etc. This review have updated information on the phyto constituents isolated from *Adhatoda, vasica* and their potential role in the treatment of various ailments traditionally and medically. Based on the critical review it have been concluded that there is not sufficient scientifically strong evidence to explain that this plant could be harmful to human beings especially in pregnant women. Major data on traditional uses as well as toxicological studies evaluated various correctness, relevance, importance and reliability for the overall evaluator of this drug plant. This drug plant also known to have various pharmacological properties like antispasmodic, sedative, expectorant, antitussive, antibacterial, anti-diabetic, wound healing, abortifacient, antiasthma and anti-pyorrhea.

Keywords: Vasaka**,** Ayurveda, bronchodilator, vasicine, phytochemical, alkaloids.

Introduction- *Adhatoda, vasica* (L.) Nees (Synonym-*Justicia, adhatoda* L.) is commonly called as Malabar nut, vasaka, adusa is belongs to the family Acanthaceae. This is a vital plant , native of Asia that is widely spread in the area of the Indian subcontinent like Punjab, U.P, Bengal Assam Nepal and Sri Lanka. Along with that it covers Indian plains as well as ranges of Himalaya at an altitude of 1300 meter above sea level (1). It is also found in Malaysia, Myanmar, Singapore and many more countries around the globe(2).The plant is small evergreen, with opposite branches, lance –shaped, exstipulate, dark green or yellowish green leaves and white flowers. For several decades it was used as a medicine for the treatment of various ailments due to its versatile nature This plant has been used for 2000 years to treat respiratory problems and it was

also said by ancient Indians," No man suffering from phthisis needs despairs long as the Vasaka plant exists". The leaves of this plant gives a stimulant effect on the respiratory system. In Ayurveda medicinal system it is considered a prime herb to cure diseases like cough, symptoms of cold, asthma, bronchitis. This plant is treated like a mother to doctors in the traditional medicinal system of India therefore known as Vaidyamata singhee in Sanskrit(9). The major phytoconstituents reportedly present in the *A. vasica* plant is Vasicine that is a Quinazoline type alkaloid which is of great medicinal importance (10). The plant is known to have a rich source of Vitamin C, carotene and essential oil, Phenolics, flavonoides, sterols etc. In Ayurveda medicinal system, it is used to cure various diseases like Shwasa (dyspnea), kashaya (phthisis), Kasa (cough), raktapitta (hemorrhagic disease) Kamala (jaundice) and Kushtha(13). This study updates information on about phyto constituents extracted from *A Vasica* and their potential involvement in traditional and medical therapy of various diseases. The literature says it can cure cough, bacterial infections, reproductive issues, heart issues and many more(8). This medicinal plant is known by various names in different areas/countries given in following table.

Table-1 Vernacular names of *Adhatoda vasica*

S. No.	Language	Name
1	Hindi	Adusa,Adalsa, Vasaka
2	Sanskrit	Shwetavasa,Vasa, Vasaka, Vaidyamata singhee
3	Bengali	Basak
4	Tamil	Adatodai
5	Marathi	Vasuka
6	Telugu	Adasaram
7	Malayalam	Ata- lotakam
8	Gujarati	Aradusi, Adusa
9	Punjabi	Bansa, Basuti, Bhekkar
10	English	Malabar Nut
11	China	Ya-Zui- Hua
12	Arabic	Adusha
13	Manipuri	Nang mangkha,Agouba
14	Kannada	Adusoge

Systematic position

Kingdom- Plantae

Division- Angiosperms

Class- Eudicots

Order- Lamiales

Family- Acanthaceae

Genus- Adhatoda

Species- vasica

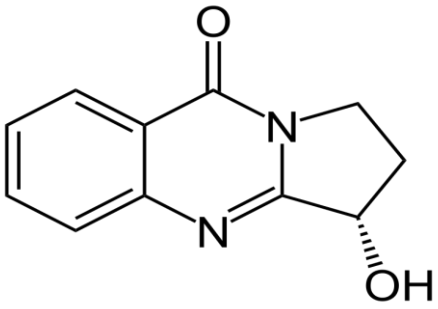
Botanical Description of *Adhatoda Vasica*-

Adhatoda vasica is a small, dense, perennial, thickly branched, evergreen shrub that belongs to the family Acanthaceae. The height of this plant reaches up to 3 to 6 meters. It contains long opposite branches. The stem is woody from the abaxial side and herbaceous from the adaxial side. Flowers are large, dense borne in terminal spikes with large bracts, bisexual, zygomorphic, small, irregular, hypogynous, white, pink or purple in appearance with length 1.9-2.2 cm and breadth 2.2 cm - 0.8 cm. The taste and smell of the plant are unpleasant and bitter. Leaves of the plant are simple, dark green, tapering base; reticulate, opposite, short peduncle, elliptic-lanceolate or ovate-lanceolate, hairy with breadth 4-7 cm and 7-19 cm long. The fruit of this plant is small, clavate and longitudinally capsulated having four globular seeds with length5-6 mm (9).

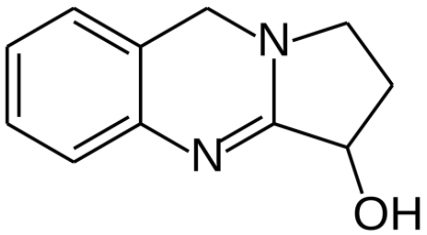
Fig- 1 Natural growth of *Adhatoda Vasica (*Photo by Ragini Singh)

Phytochemistry of the plant-

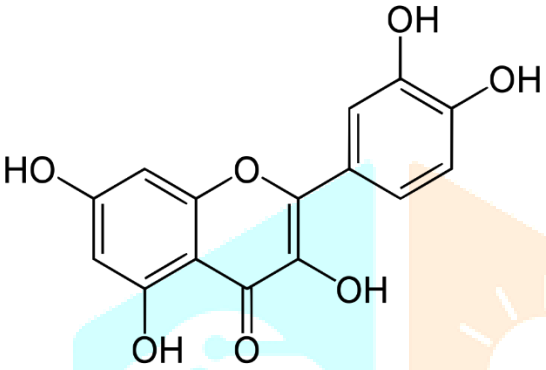
Ayurvedic medicine system uses this plant due to its mucolytic and expectorant properties. According to Charak Samhita, these activities are performed by various bioactive compounds founds in different parts of the plant. *Adhatoda vasica* contains various phytochemical such as alkaloids, glycosides, flavonoides, sterols, phenolics and vitamin –C. Pharmacologically, the most studied phytochemical constituent is bitter Quinazoline alkaloid, Vasicine. Besides it vasicinone, 7-hydroxy vasicine, vasicinolone, 3-deoxyvasicine, vasicolinone, vasicol, Vasicoline, betaine, and alkanes are the most common constituents(9).The major pharmacological actions are due to the presence of alkaloidal content specially vasicine (7.5 %) in the plant (10). Besides vasicine, the leaves include alkaloids (Vasicinone, adhatodine, vasicinol, anisotine, adhatonine and hydroxypeganine), betaine, steroids, alkanes, kaempferol and quercetin (11). The leaves are high in vitamin-C and carotene, making the plant an important essential oil source.(12). In addition amino acids and proteins are also found in the plant. Triterpenes and flavonoides are abundant in flowers. The seeds contain 25.8% deep yellow oil consisting of glycerides of behenic 11.2 percent, arachidic3.1 percent, cerotic 5 percent, lignoceric 10.7 percent, linoleic 12.3 percent, oleic 49.9 percent, and sitosterol 2.6 percent. *Adhatoda, vasica* contains minerals Ca, K, Na, and Mg in significant amount and Zn, Cu, Cr, Ni, Co, Cd, Mn and Fe in trace amount(5).



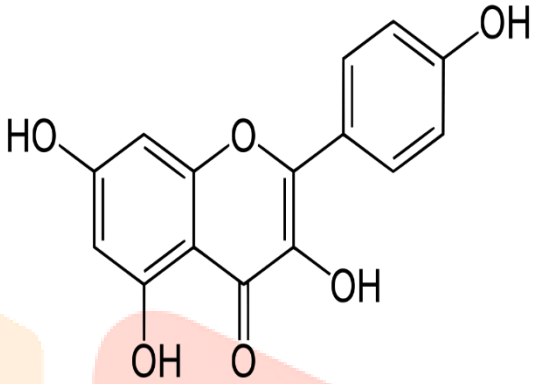
Vasicinone



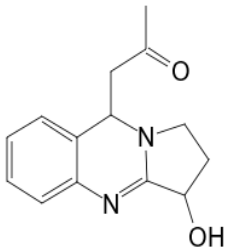
Vasicine



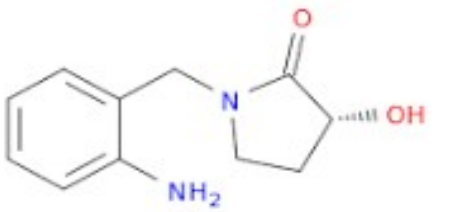
Kaempferol



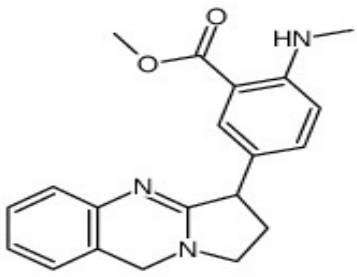
Quercetin



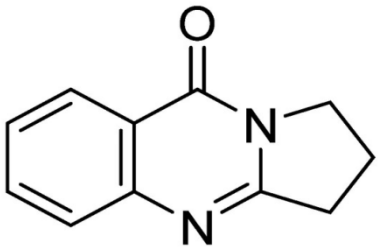
Peganidine



Vasicol



Adhatodine



Deoxy vasicine

Fig-2 Major Bio active compounds of *Adhatoda, vasica*

Ethno medicinal/ Traditional utilization –

Traditionally this plant has been utilized from centuries by indigenous people to treat various ailments. In Ayurveda, it is mentioned that vasaka has tikta, kashaya, laghu, seta and virya properties. So it may help to treat primarily heart and respiratory diseases (21). It is used to treat asthma, arthritis, sprains, cold, cough, eczema, malaria, rheumatism, swelling and sexual disorders in the Indian system of medicine(23). Leaves are used traditionally for the betterment of cough, asthma, bronchitis, hepatoprotective, tuberculosis and as a uterine tonic(24).The fluid extract was used in Europe to treat spasms, typhus, fever cough and as a febrifuge(25). The whole plant is used in Srilanka for phlegm, menorrhagia and piles. The leaves are smoked to cure asthma (26).Some times this plant is also used as an herbal remedy for allergen induced obstruction of the respiratory system along with that it also posses hepato protective activity. The Naga tribes used the decoction of leaves to get rid of intestinal worm infections and also as an anti-bacterial agent (28, 29). It is commonly utilized in south east Asia by indigenous people as a folk medicine(6).So our findings suggest that this is a wonder plant , as it is utilized to heal various ailments. Traditional use of this plant all around the world confirms the folklore claims and encourages researchers to more and more investigations. The scientists discovered that the traditional assertion of the plant by peoples of various parts for treating various ailments is true, especially in the case of respiratory diseases. Glycodin, which is a significant product isolated from the leaves of *Adhatoda vasica* is used to cure bronchitis. Reported studies revealed that the leaves of the *A. vasica* plant are used to induce abortion by70% of the pregnant women in Gora village of Lucknow (U.P.) India (9). In Sri Lanka, it is used as a sedative expectorant to treat excessive phlegm (mucus with bacteria). It acts as an antispasmodic and anthelmintic drug and is also used to treat diseases like bleeding piles, impotence and sexual disorders (10). In Ayurveda the various names and role of vasaka plant are given as following.

As per Karma (Action)-

1-Hridya- It act against heart diseases
2-Kaphapittahara- It act against digestion problem, heart, arthritis
3-Raktasangrahika- It helps in blood circulation.
4-Kasaghna- It is used against cough and cold.

Properties of vasaka plant as per use in various diseases-

1-Raktapitta- It is used to cure hemorrhagic disorder.
2-Kasa- It is used against cough and cold.
3-Jwara- It is used to cure fever.
4-Kshaya- It is used in the treatment of Phthisis.
5-Rajayakshma- It is used to cure tuberculosis
6-Parshvashula- It is used to cure pain in flanks.
7-Hritshula- It is used to treat cardiovascular diseases like angina pectoris.
8-Shotha- It is used to cure oedema.

Table-2

Ethno medicinal uses of different parts of *Adhatoda, vasica*

S. No	Part of the plant	Disease/ Disorder
1	Roots	Gonorrhea
2	Flowers	Jaundice and eye disorder
3	Leaves	Respiratory disorders (bronchitis, expectorant, antitussive, asthma), Diarrhea/ dysentery, Antiseptic, anthelmintic etc.

Pharmacological activities –

The wide range of pharmacological activities of vasaka are due to the presence of various bio- active compounds present in the plant. Out of which alkaloids are very important. Like Vasicine is an important alkaloid of the *Adhatoda, vasica* that performs various activities on Human body and can be employed as a therapeutic source. The various bioactive compounds and their pharmacological activities are given in following table.

Table-3

Pharmacological activities of various Bio active compounds of *Adhatoda, vasica*

S. No.	Bio active compounds	Part used	Pharmacological activity	References
1	Vasicine	Leaves, root, flower	Bronchodilator, respiratory stimulant, Uterine stimulant, Hypertensive, Antibacterial &anti inflammatory	(5,14,15)
2	Vasicinone	Leaves& roots	Anitussive, Bronchodilator, Anti- allergic, Hepato protective, Cardio protective, wound healing and uterine activity	(10, 14)
3	Deoxy vasicine	Roots	Acetylcholinesterase inhibitor, and Butryl cholinesterase inhibitor	(17)
4	Kaempferol	Flowers	Hepato protective, Antioxidant, &Anti-inflammatory activity.	(18)
5	Quercetin	Flowers	Cardio protective, Anti inflammatory, Neuroprotective, Anti ulcer, Anti bacterial, antiviral and anti allergic activity	(7)
6	Adhatodine	Leaves	Anti- tubercular, Anti- allergic, and cardio protective activity	(7,19)
7	Carotene	Whole plant	Anti- oxidant and cardio protective activity	(20)
8	Crystalline acid	Seeds	Muscle relaxant, Anti oxidant, Anti carcinogenic and Hepato protective activity	
9	Arachidic acid	Seeds	Muscle relaxant, Insecticidal, Hepato protective and Synthesis of prostaglandins and leukotriens.	(6)
10	Behenic acid	Seeds	Muscle relaxant, Antimicrobial activity, Hepato protective and insecticidal activity.	(6)
11	Linoleic acid	Seeds	Muscle relaxant, Insecticidal, Hepato protective, Neuroprotective, Anti osteoporotic, Anti- inflammatory and anti oxidative activity	(6)
12	Oleic acid		Anti–inflammatory, Analgesic and Gastro protective activity.	(6)

Medicinal importance of *Adhatoda, vasica*-

Various pharmacological/ medicinal importance of the plant are basically related to its primary metabolite composition, especially its alkaloid concentration a Quinazoline alkaloid vasicine and its derivatives.(26). Various pharmacological activities of *Adhatoda vasica* are as following.

Anti- asthmatic activity-

The extract of leaves and roots are used to treat bronchitis, cough and upper respiratory infections. It also act as an expectorant by loosening phlegm. in guinea pigs acetylcholine and histamine aerosol produced bronchial constriction (37). Singh et.al 2014 proposed that vasaka exerts anti asthmatic action by directly stabilizing mast cells, blocking the enzyme lipoxygenase / cyclooxygenase or by decreasing platelet activating factor. As a bronchodilator the plant's part has been utilized from centuries to treat asthma. Vasicine and vasicinone, both the alkaloid are best known for their therapeutic action on the respiratory system. But among both the alkaloids vasicinone (**an oxidized product of vasicine)** is more effective bronchodilator as compare to other alkaloids of vasaka plant(41). The alkaloid constituents mainly Vasicine and vasicinone passes medicinal properties against respiratory disorders. The extracts of leaves and roots showed soothing effects against the throat, to cure bronchitis, bronchiole and lung disorder and act as an expectorant The experiment was conducted in anesthetic guinea pigs and rabbits and unaesthetic guinea pigs that showed the anti tussive

property. Reported studies revealed the bronchodilator activity of Vasicine when experimented with both *in vitro* and *in vivo*(10**).** This plant is also a major component in numerous polyherbal formulations u sed to treat various ailments. Like Kanak asava is one of those that fight ovalbuminous asthma (43).

As an Antitussive agent- The extract of plant has an antitussive in an animal model of guinea pigs and rabbits. A recent study found revealed that vasicine is to be a bronchodilator in vitro and in vivo(10). It has a stronger antitussive impact than codeine(68). A study found that the plant chemical components including vasicine and kaempferol can act as expectorant. Kanjang oral solution is the commercial preparation of this plant used in respiratory disorders. According to Day et. al2018 this bronchodilator function of this plant is attributable due to vasicinone(50).

Anti tuberculosis activity- The anti tubercular efficiency of vasaka leaf extract was evaluated in vitro against multidrug resistant isolates. In Ayurveda various herbal remedies are used against tubercular bacteria, one of which is made from vasaka(gulkand) flowers using essential oils (2-20 g/ml) effectively inhibits *Mycobacterium tuberculosis* growth in vitro(22). Barry et. al discovered significant growth inhibitory effect of this plant against *Mycobacterium, tuberculi*(70). This action is due to the presence of vasicine by increasing the level of lysozyme and rifamycin indirectly in the bronchioles. Vasicoline, vasicolinone, vasicine, vasicinone, triterpenes and anisotine are the main anti tubercular alkaloid constituents of the plant (72).In vitro study was carried out against *Mycobacterium tuberculosis* revealed that the Bromohexine and ambroxol the two derivatives of Vasicine showed a growth inhibitory effect on *M. tuberculosis(* 9*).*

Abortifacient (Uterine activity)-This plant is known to effective in uterine activity . like the hydro alcoholic extract (175 mg/kg) of *A vasica* leaf for ten days causes positive abortion and has significant uterine tonic and abortifacient effect due to vasicine(10). The dual effect stimulates uterine contractions, which aids in child birth. The scientist discovered that it operate similarly to oxytocin and ergometrine in animals**(7).**In an in vitro study vasicine and its derivatives were found to release prostaglandin production, that has been shown to stimulate the uterus and myometrium layer to facilitate child birth.(76). Here it is seen that action and dose are concerned with the stage of pregnancy.

Anti bacterial activity- The petroleum ether and ethanolic extracts from leaves show potent antibacterial activity determined by the disc diffusion method against numerous bacteria like *Bacillus subtilis* and *Vibrio cholrae* (30).Various reported studies also revealed the antibacterial activity of *Adhatoda, vasica* against gram-positive bacteria strains *Streptococcus faecalis*, *Staphylococcus aureus*, *Staphepidermidis* and gram-negative *E. coli* (8).

Anti oxidant activity-Antioxidants are the products that inhibits the process of oxidation, by which they protect our living cells against free radicals. *Adhatoda, vasica* leaves are a rich source of various natural antioxidants, that is due to the presence of high levels of polphenolis, basically flavonoides and phenolics (3).

Antifungal activity-It have been reported from the study of Ramchandran and Sankaranarayanan 2013 (104) that phyto chemical constituents of *Adhatoda vasica* were found to inhibit the growth of various human pathogenic fungi like *Aspergillus ruber* and *Trichophyton rubrum*

Hepato protective activity-*Adhatoda vasica* extremely shows action against the toxicity of the liver. Ethyl acetate extract of the plant at a dose of 100 and 200mg/kg shows significant protective action against the carbon tetrachloride induced liver toxicity in albino rats. It elevates the liver marker enzymes which were reduced due to the injury in the liver(78). Same results were also found in another research that using the whole plant powder drug for hepatoprotective activity and other liver disorders(79). The possible activity of this plant for hepatoprotective activity are due to the presence of vasicinone, that was reported by Sarkar et. al 2014. The ethanolic extract of the leaves from vasaka (100-200mg/kg) shows significant protective action on hepatic cells in a carbon tetra chloride (CC 14) induced model (86). Extract of the plants were prepared by various solvent like alcohol chloroform and ether shows hepatoprotective action against the CC14 inducing liver damage in the rat model. Out of them alcoholic extract is more significant as compare to other solvents. It acts by reducing the different biochemical levels due to the presence of its biologically active phytochemical like alkaloids, flavonoides tannins etc. (84). Saroj and Mishra 2012 (86) selected a polyherbal formulation having *Adhatoda vasica* as a constituent and reported its protective action on the liver against paracetamol induced liver toxicity.

Wound healing activity- Methanolic, chloroform and diethyl ether extracts of *Adhatoda vasica* were evaluated for its wound healing activity in the form of Ointment dosage form in excision wound model in albino rats. The Methanolic extract of *Adhatoda vasica* showed a significant effect in excision wound model as comparable to standard drug and other two extracts of ointment, by calculating the parameters ,percentage closure of excision wound model(G.Vinothapooshan and K. Sunder, 2010). (45). This study was supported by another research in which the wound was created beside the vertebral columns of calves and afterward they are treated with the alcoholic and chloroform extract of the plant. The result of this study suggest that alcoholic study shows a significant improvement in the wound healing process than other extracts (100).

Conclusion--

So from various reported studies it have been clear that vasaka plant is known to plays a significant role in herbal and Ayurveda medicinal system. This plant is used in Ayurveda as well as Unani medicinal systems since prehistoric time. Traditional, Phytochemical and Ayurvedic review of *Adhatoda*, *vasica* is briefly discussed in this study. It is widely studied due to its chemical constituents and therapeutically properties. This plant is a rich source of Vitamin C, Vasicine, Vasicinone and other alkaloids. Various scientific studies revealed that the Vasaka plant possesses different pharmacological properties proved by many experimental studies like antifungal, antitussive, antiulcer, abortifacient, hypoglycemic, anti-tubercular, anti-inflammatory, anti oxidant, antiviral, hepatoprotective and many more. Scientific studies revealed that the formulations made from this plant are beneficial to human use especially in various respiratory diseases. The current review study may surely provide a backbone for the development of a natural product having very least side effects than the synthetic or chemical compound. It will also promote to the researcher in agro industries that basically work on herbal products.. The future perspective involves better resolution with the different bio active compounds isolated from the *Adhatoda vasica.*

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