

Review

Therapeutic use of *Adhatoda vasica*

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Abstract: *Adhatoda vasica* Nees belonging to family Acanthaceae, commonly known as Adosa, is found many regions of India and throughout the world, with a multitude of uses in traditional Unani and Ayurvedic systems of medicine. It is also called “Vasaka”. It is a well-known herb in indigenous systems of medicine for its beneficial effects, particularly in bronchitis. Vasaka leaves, bark, the root bark, the fruit and flowers are useful in the removal of intestinal parasites. Vasaka herb is used for treating cold, cough, chronic bronchitis and asthma. In acute stages of bronchitis, vasaka gives unfailing relief, especially where the sputum is thick and sticky. It liquefies the sputum so that it is brought up more easily. For relief in asthma, the dried leaves should be smoked. The juice from its leaves should be given in doses of 2 to 4 grams in treating diarrhea and dysentery. A poultice of its leaves can be applied with beneficial results over fresh wounds, rheumatic joints and inflammatory swellings. A warm decoction of its leaves is useful in treating scabies and other skin diseases. In olden times its leaves were made into a decoction with pepper and dried ginger. But the modern medicine searched its active ingredients and found out that vasicine, oxyvasicine and vasicinone are the alkaloids present in vasaka and in which vasicine is the active ingredient for expelling sputum from the body.

Keywords: *Adhatoda vasica*; alkaloids; vasicine; bronchial and radioprotective activity

1. Introduction

Unani medicine (The Wealth of India, 1948) and the plant has been used in the indigenous system of medicine in India for more than 2000 years (Atal, 1980). It is commonly known as Malabar nut tree and local names in some areas are Ya-Zui-Hua in China, Vasaka (Sanskrit), Adusha (Arabic), Arusha (Hindi), Basak (Bengali), Nongmangkha-agouba (Manipuri), Alduso (Gujarati), Adasaramu (Telugu), Adadodai (Tamil), Adusoge (Kannada) and Atalotakam (Malayalam) in India. *Adhatoda vasica* is a small, evergreen, perennial shrub, which reaches an average height of three meters. Its branches are opposite and ascending. The broad, leathery leaves, which are sometimes used as an insecticide, measure from 10 to 15 centimeters in length, and are about 4 centimeters in width. They are pubescent; light green on top and darker green beneath. The leaves grow in an opposite formation, and are entirely lanceolate, and shortly petiolate, tapering towards both apex and base. The leaves become brownishgreen when dry and taste bitter with a smell similar to strong tea. Its stem is soft and makes a good charcoal. The flowers are large, dense, terminal spikes with large, attractive white petals, streaked with purple on the lower lip. The fruit is a small, clavate, longitudinally channeled capsule, containing four globular seeds. *Adhatoda vasica* is useful in treating bronchitis, tuberculosis and other lung and bronchiole disorders. A decoction of the leaves of *Vasaka* may be used to help with cough and other symptoms of colds. The soothing action helps irritation in the throat and the expectorant will help loosen phlegm deposits in the airway. A poultice of the leaves of *Vasaka* may be applied to wounds for their antibacterial and anti-inflammatory properties. The poultice is also helpful in relieving rheumatic symptoms when applied to joints. *Vasaka* has been used to control both internal and external bleeding such as peptic ulcers, piles and bleeding gums. *Vasaka* exhibits antispasmodic, expectorant and blood purifying qualities. It is a very well known remedy

available everywhere and it is especially popular in rural areas. Acknowledging its medicinal properties, it has been adopted by modern medical practitioners also. This bush grows in all parts of the worlds and the bark, flowers, roots and leaves are used in medicine. The leaves enjoy a reputation as a useful remedy in the cure of coughs and bronchitis. The plant has pungent and astringent taste. It is cold in action. It normalizes kapha and pitta and improves the voice. It is useful in ridding the patient of coughing and asthma and can be given as a cure in any disease with which these symptoms are associated. It is beneficial to the tuberculosis patient. Vasaka's special virtue is stopping bleeding due to the aggravation of pitta, through the mouth, nose, genitals, or the urinary systems. The leaves are dampened and then pounded, and one teaspoon of the resultant juice is useful in cases of chronic bronchitis, asthma and tuberculosis. This is not to say that it always cures all these diseases but it does give immediate relief. Being a very good expectorant, it draws out all kapha (phlegm) accumulated in the lungs. In many cases where bronchitis is due to lack of appetite and poor digestion, the juice of Vasaka is mixed with the juice of ginger and honey and given in the early morning on an empty stomach. Given in the early stages of tuberculosis, the juice of Vasaka, thrice a day, helps a patient who is prone to incessant coughing. In many of the cough syrups that are available, Vasaka has been used either as a base or as an ingredient. Boiled and put on the bladder region, the leaves produce a diuretic action, reduce the swelling of the kidney and lead to clear urination. Persons suffering from bleeding piles or diarrhea, accompanied by bleeding, or women suffering from menorrhagia can take the juice of Vasaka 2 to 3 times a day to great advantage. Dried and powdered leaves also form a remedy for bronchitis in the dose of 40 grains twice a day. In liquid form the dose is about half to one teaspoon. In excessive doses of 1 to 2 ozs, an emetic action results inducing vomiting in which all the kapha is removed. In ancient times the root of the Vasaka was tied on the back below the navel region and it is said that it produced safe, painless delivery. Vasa avaleha, useful in easing all sorts of coughs, especially in the case of asthma, and bronchial congestion, is made in the following manner: the juice of 1 seer of Vasaka leaves is boiled with $\frac{1}{4}$ seer of white sugar, 4 tolas long peppers and 4 tolas pure ghee, until the mixture is reduced to a jelly form. After cooling, $\frac{1}{4}$ seer of honey is added and the preparation is mixed thoroughly. The mixture is given in $\frac{1}{2}$ ounce doses. A liquid preparation of Vasaka known as Vasasav given in half ounce measures after the principal meals, reduces production of kapha (phlegm) and relieves excessive coughing. The juice of Vasaka leaves softens the bronchial tube. It is also useful in reducing aggravation of pitta and discomfort due to jaundice. The roots and bark possess a virtue well-known for their expectorant properties. If well-known patented expectorant remedies have failed to give you relief, by all means try this home remedy. *Vasica* has also been used to speed delivery during childbirth (Sampath *et al.*, 2010).

2. Plant description

Adhatoda vasica Nees belongs to the medicinal family Acanthaceae. It is an evergreen shrub of 1-3 feet in height with many long opposite branches. Leaves are large and lance-shaped. Stem herbaceous above and woody below. Leaves opposite and exstipulate. Flower spikes or panicles, small irregular zygomorphic, bisexual, and hypogynous (Shinwari *et al.*, 1995). It has capsular four seeded fruits. The flowers are either white or purple in colour. Its trade name Vasaka is based on Sanskrit name (Kumar *et al.*, 2010). Inflorescences in axillary spicate cymes, densely flowered; peduncles short; bracts broadly ovate, foliaceous. The leaves, flowers, fruit and roots are extensively used for treating cold cough, whooping cough, chronic bronchitis and asthma, as sedative, expectorant and antispasmodic (Pandita *et al.*, 1983).

2.1. Vernacular names

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

2.2. Classification of *Adhatoda vasica*

Kingdom	: Plantae
Order	: Lamiales
Family	: Acanthaceae
Genus	: Justicia
Species	: J. adhatoda
Common name	: Adulsa (Vasaka)

2.3. Important formulations

Important Unani and Ayurvedic formulations containing Asgard are as follows:

Sarbat Ejaz

Sarbat Tulsi

Sarbat Sadar

Sarbat Vasac

Syrup Basakarista

Basadi kwath

Basaboleho

(BNUF and BNAF, 2010)

3. Biochemical properties

The phytochemical studies of the various parts of *Adhatoda vasica* revealed the presence of alkaloids, phytosterols, polyphenolics and glycosides as a major class of compounds. Its principal constituents are quinazoline alkaloids with vasicine as its chief alkaloid. The leaves are rich in Vitamin C and carotene and yield an essential oil. Chemical compounds found in leaves and roots of this plant includes essential oils, fats, resins, sugar, gum, amino acids, proteins and vitamin C etc (Dymock, 1972). The leaves also contain a very small amount of an essential oil and a crystalline acid. An analysis published in India in 1956 showed the seeds as containing 25.8% of deep yellow oil composed of glycerides of arachidic 3.1%, behenic 11.2%, lignoceric 10.7%, cerotic 5%, oleic 49.9% and linoleic acids 12.3% and β -sitosterol (2:6%) (Dweck, 1995). Elemental analysis using atomic absorption spectrophotometry revealed the presence of major (K, Na, Ca and Mg) and trace (Zn, Cu, Cr, Ni, Co, Cd, Pb, Mn and Fe) elements in *Adhatoda vasica* (Jabeen *et al.*, 2010). The chemical analysis of various bioactive compounds isolated from leaves and roots of *Adhatoda vasica* was carried out by Gulfraz *et al.* (Gulfraz *et al.*, 2005). From the data, concentration level of protein (8.5 %), vasicine (7.5%), vitamin C (5.2%), and fats (2.5%) were found in roots samples of *Adhatoda vasica*. Whereas, level of such compounds was low in leaves except sugar (16.4%), fiber (5.2%), vasicinone (3.5%), Zn (0.6%), S (1.3%) and Fe (1.2%).

4. Ethnomedicinal uses

All the parts of *Adhatoda vasica* has been used for their curative effects from ancient times (Atal, 1980). It has been used in Ayurvedic system of medicine for the treatment of various ailments of respiratory tract in both children and adults. Various parts of the plant are used in Indian traditional medicine for the treatment of asthma, joint pain, lumber pain, sprains, cold, cough, eczema, malaria, rheumatism, swelling and venereal diseases (Jain, 1991). *Adhatoda vasica* has also been used by the European medical practitioners. The fluid extract and tincture were used in England as an Antispasmodic, Expectorant and febrifuge. It was said to be beneficial in intermittent, typhus fever and Diphtheria (Wren, 1932). In Germany, the leaves are used as an expectorant and spasmolytic agent (Madaus, 1938). In Sweden *Adhatoda vasica* is classified as a natural remedy and some preparations against cough containing an extract of Vasaka are accessible (Farnlof, 1998). The ethnomedicinal uses of various parts of *Adhatoda vasica* are along these lines.

4.1. Whole plant

The whole plant is used as an ingredient of numerous popular formulations including cough syrup used in combination with Ginger (*Zingiber officinale*) and Tulsi (*Ocimum sanctum*) where it exerts its action as an expectorant and antispasmodic (Atal, 1980). The plant is used for treatment of excessive phlegm and menorrhagia in Sri Lanka (Kirtikar and Basu, 1975). It is also used for the treatment of bleeding piles (Ahmad *et al.*, 2009), impotence and sexual disorders (Pushpangadan *et al.*, 1995).

4.2. Leaves

A yogic practice is to chew the leaf buds alone or with a little ginger root, to clear the respiratory passages in preparation for the vigorous breathing exercises. The various preparation of leaves are used for curing bleeding, haemorrhage, skin diseases, wounds, headache and leprosy in Southeast Asia (Adnan *et al.*, 2010). The bruised fresh leaves are used for snake-bites in India and Sri Lanka (Roberts, 1931). Usually, yellow leaves are exploited for cough (Lal and Yadav, 1983) and smoke from leaves is used for asthma (Shah and Joshi, 1971). The plant leaves are used for checking postpartum haemorrhage and urinary trouble (Pushpangadan *et al.*, 1995). It is found that 70% of the pregnant women in the Gora village of Lucknow (Uttar Pradesh, India) use the leaves of *Adhatoda vasica* to induce abortion (Nath *et al.*, 1997). Moreover, it is observed that the Neterhat

people in Bihar (India) used a decoction of the leaves to stimulate and heal before and after delivery (Jain *et al.*, 1994). The leaf powder boiled in sesame oil is used to stop bleeding, earaches as well as pus from ears (Reddy *et al.*, 1989) and jaundice (Reddy *et al.*, 1988). Decoction and ash of leaves are used for bronchial complaints such as asthma, tuberculosis (Jain and Puri, 1984), antipyretic (Jain, 1965) and relieve acidity. The leaves are toxic to 'all forms of lower life' and have insecticidal effects (Agrawal *et al.*, 1986). It was also used for stomach catarrh with constipation, gout, urinary stone (Madaus, 1938) and warmed leaves used externally for rheumatic pains and dislocation of joint (Rao and Jamir, 1982). Moreover, the preparation of leaves in spirit is used for curing the wealthy persons suffering from certain humours in Myanmar (Kirtikar and Basu, 1975).

4.3. Root

The extract of roots of *Adhatoda vasica* is commonly used by rural population against diabetes, cough and certain liver disorders (Bhat *et al.*, 1978). The paste, powder and decoction of root is used for curing tuberculosis, diphtheria, malarial fever, leucorrhoea and eye diseases in Southeast Asia (Dymock *et al.*, 1890). The paste of roots mixed with sugar and used for treatment of acute nightfall in Sitapur District, Uttar Pradesh, India (Siddiqui and Hussain, 1993). Moreover, the macerated roots of *Adhatoda vasica* are applied on the pubic region and vagina to help parturition (Pathak, 1970) and it facilitates the expulsion of foetus (Iyengar *et al.*, 1994). The root decoction is also used for gonorrhoea (Siddiqui and Hussain, 1993).

4.4. Flower

The fresh flowers are used for ophthalmia and various preparations of flowers are used for treatment of cold, phthisis, asthma, bronchitis, cough, antispasmodic, fever and gonorrhoea in South-East Asia (Dymock *et al.*, 1890). The flowers are also used as antiseptic to improve blood circulation and hectic heat of blood (Kirtikar and Basu, 1975).

4.5. Fruit

The fruit of *Adhatoda vasica* are used for curing cold, antispasmodic, bronchitis, Jaundice, Diarrhea, Dysentery, Fever and as laxative (Roberts, 1931).

5. Pharmacological activity

Extracts of *Adhatoda vasica* are widely used in pharmaceuticals and traditional systems of medicines for a number of ailments (Claeson *et al.*, 2000). The plant as a whole possesses remarkable biological activities.

5.1. Antibacterial activity

The leave extract of *Adhatoda vasica* exhibits moderate antibacterial activity (Sarker *et al.*, 2009). The antibacterial activity against the microorganism strains of *Bacillus subtilis* (11mm) and *Vibrio cholera* (15mm) in petroleum ether extract, and also *Bacillus subtilis* (11mm) and *Vibrio cholera* (13mm) in ethanol extract were determined by the disc diffusion technique. Where, the plates were incubated at 37 °C for 24h to allow maximum growth of the organism, the activity of the test agents were measured by the zone of inhibition of the plates.

5.2. Anti-asthmatic and bronchodilator activity

Adhatoda has been used in traditional medicine to treat respiratory disorders. Both vasicine and vasicinone the primary alkaloid constituents of *Adhatoda* are well established as therapeutical respiratory agents (Dorsch and Wagner, 1991). Extracts of *Adhatoda*'s leaves and roots are useful in treating bronchitis, and other lung and bronchiole disorders, as well as common coughs and colds. A decoction of the leaves of *Adhatoda* has a soothing effect on irritation in the throat, and acts as an expectorant to loosen phlegm in the respiratory passages. To evaluate the antitussive activities of *Adhatoda* extract in anesthetized guinea pigs and rabbits and in unanesthetized guinea pigs showed the plant to have a good antitussive activity (Dhuley, 1999). Recent investigations using vasicine showed bronchodilatory activity both *in vitro* and *in vivo* (Lahiri and Pradhan, 1964).

5.3. Anti-ulcer activity

The Leaves of *Adhatoda vasica* possessed anti-ulcer activity. *Adhatoda* leaf powder showed a considerable degree of anti-ulcer activity in rats with the highest degree of activity (80%) observed in the ethanol-induced ulceration model in comparison to pylorus, and aspirin (Shrivastava *et al.*, 2006).

Adhatoda vasica was studied for its anti-ulcerogenic activity against ulcers induced by ethanol, pylorus, and aspirin. *Adhatoda* leaf powder showed a considerable degree of anti-ulcer activity in experimental rats when compared with controls. The highest degree of activity was observed in the ethanol-induced ulceration model. These results suggest that in addition to its classically established pharmacological activities, *Adhatoda vasica* has immense potential as an anti-ulcer agent. Further research showed that a syrup of *Adhatoda* improved symptoms of dyspepsia (Chaturvedi *et al.*, 1983).

5.4. Anti-inflammatory activity

Vasicine, the main alkaloid of *Adhatoda vasica* showed anti-inflammatory activity (Srmivasarao *et al.*, 2006). The anti-inflammatory activity of the methanol extract, the non-alkaloid fraction, the saponins and the alkaloids were evaluated by the modified hen's egg chorioallantoic membrane test. The alkaloid fraction showed potent activity at a dose of 50 µ/pellet equivalent to that of hydrocortisone while the MeOH extract and the other fractions showed less activity (Chakraborty and Bratner, 2001).

5.5. Abortifacient activity

Vasicine was found to have uterotonic activity in different species including human beings. It was shown that the effect was influenced by the priming degree of the uterus by estrogens. Vasicine initiated rhythmic contractions of human myometrial strips from both non-pregnant and pregnant uteri with the effect which was comparable with that of oxytocin and mathergin (Atal, 1980). In a study conducted on rats, rabbits, hamsters and guinea pigs; it was found that vasicine has uterotonic and abortifacient effects possibly by enhancing the synthesis and release of prostaglandins. In this study dose dependent effect was observed with effective doses ranging between 2.5 to 10 mg/kg. However, administration of estradiol dipropionate potentiated the abortifacient effect in guinea pigs whereas treatment with aspirin inhibited the abortifacient activity due to inhibition of release of prostaglandins (Chandhoke, 1982).

5.6. Cardioprotective activity

In combination of vasicine and vasicinone significant reduction in cardiac depressant effects was observed. No effect was shown by vasicinone (DI-form), however Lform was found to be weakly effective stimulating cardiac muscles (Atal, 1980).

5.7. Radioprotective effects

Swiss albino mice (Kumar *et al.*, 2007) when exposed to ⁶⁰Co radiation showed radiation-induced sickness including marked changes in histology of testis and chromosomal aberrations in bone marrow cells with 100% mortality within 22 days. The ethanolic extract of *A. vasica* leaf when given orally at a dose of 800 mg kg⁻¹ body weight per mouse for 15 consecutive days and then exposed to radiation, death of *Adhatoda* pretreated irradiated mice was reduced to 70% in 30 days. *Adhatoda* pretreatment significantly prevented radiation induced chromosomal damage in bone marrow cells, which suggests that *Adhatoda* plant extract has significant radioprotective effects on testis.

5.8. Antimutagenic activity

Researchers studied the antioxidant and anticlastogenic efficacy of *Adhatoda vasica* against cadmium chloride (CdCl₂)–induced renal oxidative stress and genotoxicity in Swiss albino mice. A single intraperitoneal dose of CdCl₂ (5 mg/kg b.wt.) resulted in significant ($p < 0.001$) increase in chromosomal aberration and micronuclei formation. Oral administration of *A. vasica* at two doses (50 and 100 mg/kg BW) for seven consecutive days showed significant ($p < 0.001$) suppression of mutagenic effects of CdCl₂ in plant-pretreated groups. Cadmium intoxication altered the antioxidant levels and enhanced MDA formation significantly ($p < 0.001$). *Adhatoda vasica* showed significant ($p < 0.001$) recovery in antioxidant status, viz., GSH content, its dependent enzymes, and catalase activity. Prophylactic pretreatment of *Adhatoda vasica* extract in cadmium-intoxicated mice showed marked ($p < 0.001$) inhibition of lipid peroxidation (LPO) and xanthine oxidase (XO) activity (Jahangir *et al.*, 2006).

5.9. Insecticidal activity

Adhatoda vasica has been used for centuries in India as an insecticide. Its leaves have been shown to control insect pests in oil seeds, in both laboratory and warehouse conditions (Srivastava *et al.*, 1965). Research has shown *Adhatoda*'s alkaloid, vasicinol, to have an antifertility effect against several insect species by causing

blockage of the oviduct. Research has also proven *Adhatoda*'s effectiveness as an insect repellent (Saxena *et al.*, 1986).

5.10. Anti-tubercular activity

The anti-tubercular activity of *Adhatoda vasica* was studied by Barry (Barry *et al.*, 1955). Bromohexine and ambroxol- two widely-used mucolytics, semi-synthetic derivatives of vasicine from *Adhatoda vasica* have growth inhibitory effect on *Mycobacterium tuberculosis* (Grange *et al.*, 1996).

A chemical constituent of *Adhatoda* alkaloids, vasicine, produces bromhexine and ambroxol two widely-used mucolytics. Both of these chemicals have a pH-dependent growth inhibitory effect on *Mycobacterium tuberculosis*. Indirect effects of *Adhatoda* on tuberculosis include increased lysozyme and rifampicin levels in bronchial secretions, lung tissue and sputum, suggesting that it may play an important adjunctive role in the treatment of tuberculosis (Narimaian *et al.*, 2005).

5.11. Anticholinesterase activity

Vasicinone obtained from the roots, produced transient hypotension in cats, contraction of isolated intestine and depression of isolated heart in guinea pigs, thus showing good anticholinesterase activity (Lahiri and Prahdan, 1964).

5.12. Sucrase inhibitory activity

The methanolic extract from the leaves of *Adhatoda vasica* Nees (Acanthaceae) showed excellent sucrase inhibitory activity with sucrose as a substrate (Hong *et al.*, 2008). The alkaloids, vasicine and vasicinol inhibited sucrase activity, with an IC₅₀ value of 125 μ M and 250 μ M respectively. Though, the alkaloids did not show inhibitory effects (IC₅₀ > 1 mM) on intestinal maltase, isomaltase and α -amylase. Thus, *Adhatoda vasica* can be explored as a natural antidiabetic agent.

6. Conclusions

The therapeutic uses of *Adhatoda vasica* in treating various ailments have been well documented in this brief review and a wide range of biological activities are well reported. In view of its multiple uses, more activity screening and structure activity relationship studies are required to explore further. The present review would be helpful in promoting research aiming at the search and development of new agents for therapeutic application and agro-industries based on natural products derived from plants.

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Conflict of interest

None to declare.

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