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Exploring The Therapeutic Spectrum Of Vasaka (*Adhatoda Vasica* Nees): A Review

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Abstract: *Adhatoda vasica Nees. (Justicia adhatoda L.) is a member of the Acanthaceae family, include adhatoda, adulsa/adosa, and Malabar nut. This review updates information on 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 more. Several phytochemical analyses have been carried out on different parts of A. vasica, including leaf, root, bark, wood, flower, fruit, and even on the whole section. The two major alkaloids present in these leaves of the plant are Vasicine (0.85%) and vasicinone (0.027%). The literature survey revealed that Adhatodavasica has been widely studies for its phytochemical and pharmacological activities. It presents in class of herbal drug with very strong conceptual or traditional base. Adhatodavasica is an important source of vasicine, vasicinone, vasicolone and some other Alkaloids. This review aims to draw the conclusion that the herbal plant represents different crucial pharmacological activities with their active constituents which needs to be studied for further investigation and also its unknown effect should be recognised.*

INTRODUCTION:

Since herbal medicine is more ethnically acceptable, more compatible with the human body, and has fewer side effects, it continues to be the primary source of healthcare for 75–80% of the world's population, mostly in developing nations."Traditional medicine" (including herbal drugs) is defined by the World Health Organization (WHO) as "therapeutic practices that have been in existence, often for hundreds of years, before the development and spread of modern medicine and are still in use today" (1).Vasa is regarded as the ruler of herbs because of its great medicinal ethics, though there are many other herbal plants in the world. Hindu mythology has a long history of medicinal uses. Vasa from various geographical origins had a variety of chemical constituents, according to the literature, and the researchers discovered a wide range of uses in the conventional healthcare system.

Adhatoda vasica Nees. (*Justicia adhatoda* L.) is a member of the Acanthaceae family, include adhatoda, adulsa/adosa, and Malabar nut. Native to Asia, this essential plant is found throughout the Indian subcontinent, including Punjab, Bengal, Nepal, Assam, and Sri Lanka. At an elevation of 1300 meters above sea level, it also encompasses the Himalayan ranges and the Indian plains (2).In the Indian system of medicine, it is well known by its name “vasaka”. And widely used for the treatment of various respiratory diseases especially asthma and bronchitis (3). *Adhatodavasica* (*A. vasica*) is included in the manual of the World Health Organization (WHO) for its traditional use in primary health care (4).

A. vasica is a common small evergreen, sub-herbaceous bush that is widely used in indigenous medicine. With leaves that are roughly 10 to 15 cm long and 5.0 cm wide, white or purple flowers, and four-seeded fruits, it can reach a height of 1.5 to 2.0 meters. The leaves have a pale yellow underside and a dark green top. The typical white flowers are arranged in pedunculated spikes. For more than 2,000 years, Ayurvedic medicine has made extensive use of adhatoda leaves, mainly for treatment of respiratory conditions. Tender stem cuttings are used to propagate it. For planting, stem cuttings with three to four nodes and a length of 15 to 20 cm are ideal. Although seeds are the most common method of propagation, hardwood cuttings can also be propagated from spring or early summer [5].

This review updates information on 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 more. (6)

Vernacular names for *Adhatodavasica*(7):

Hindi	Adosa, adalsa, vasaka
Bengali	Shwetavasa, vasa, vasaka, Vaidyamatasinghee
Tamil	Adatodai
Marathi	Vasuka
English	Malabur nut
Punjabi	Bansa, basuti, bhekkar
Malayalam	Ata- lotakam
Gujarati	Aradusi, adusa
Telugu	Adasaram
Kannada	Adusoge
Manipuri	Nongmangkha-agouba
Mizo	Kawl-dai
Assamese	Boga
Oriya	Basango
Nepali	Asuro
Konkani	Adulasha

Botanical Classification of *Adhatodavasica*(7):

Taxonomical Rank	**Taxon**
Kingdom	Plantae
Division	Angiosperms
Class	Eudicots
Order	Lamiales
Family	*Acanthaceae*
Genus	*Justicia*
Species	*J. adhatoda*

Botanical description of *Adhatodavasica* (8):

Adhatoda is a tall shrub, up to 2.5 m hight; younger parts tomentose. Leaves are opposite, elliptic or elliptic-lanceolate, acuminate, obtuse or acute at base, entire, up to 18 cm long; petiole 1.5 – 2.5 cm long; secondary veins 10 – 13 pairs; tomentose when young, glabrous afterwards.

Inflorescence a dense terminal spike up to 7.5 cm. long on a peduncle up to 8 cm. long, or a fascicle at the axil of upper leaves, bracteate; bracts broadly elliptic, 5 - 7 — nerved from the base, longer than calyx, bracteoles oblong — lanceolate, 1-nerved, ciliate at the margin. Flowers sub sessile, bisexual, zygomorphic, hypogynous. Calyx shortly campanulate with 5 lanceolate acute lobes, up to 1.2 cm long.

Corolla bilabiate, white with pinkish violet tinge at the throat up to 3 cm. long, minutely pubescent outside; tube up to 1.2 cm. long, narrow at base, much inflated above; upper lip ovate-oblong, notched at the middle, lower lip 3-lobed, recurred, oblong with rounded tip, the middle one broader; lips of corolla imbricate.

Stamens 2, inserted at the throat of corolla; filaments hairy at base; anthers 2-celled; cells oblong, minutely apiculate, one cell little higher up than the other. A cup-like disc usually present.

Ovary bicarpellary syncarpous, 2-celled, superior, tomentose; ovules 2 in each cell; style filiform, subclavate above; stigma entire. Fruit a clavate capsule up to 2 cm. long, contracted below into a solid stipe. Seeds 1 or 2, 5-6 mm. sub orbicular, compressed, glabrous and rugose.

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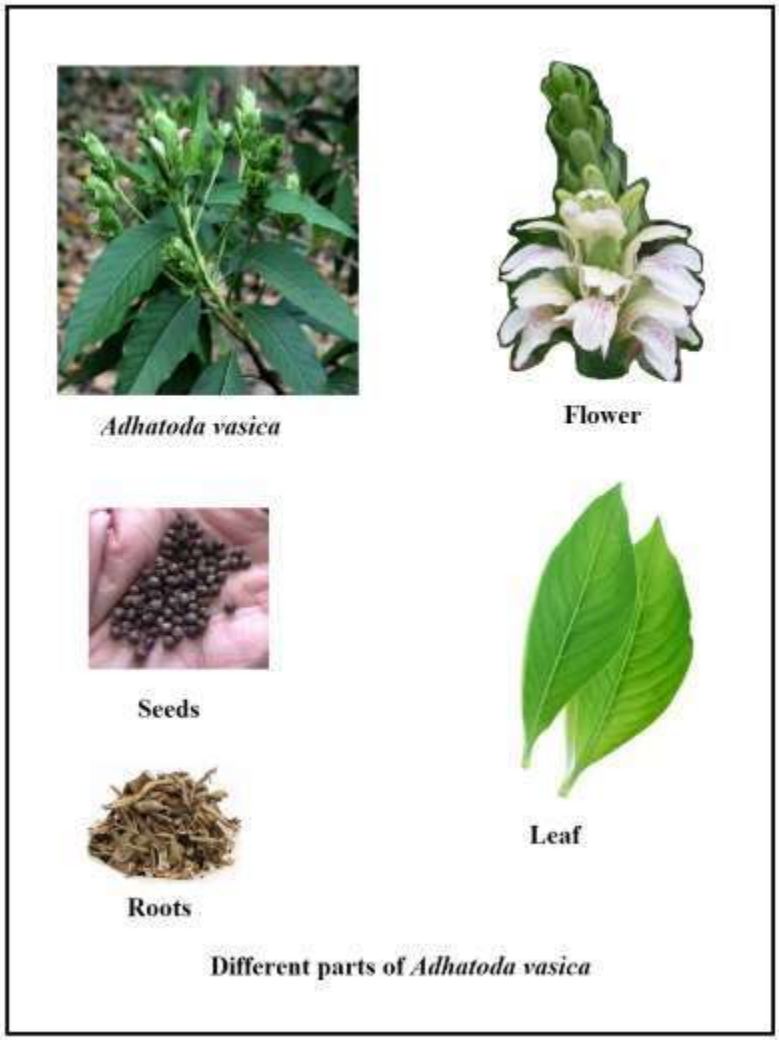
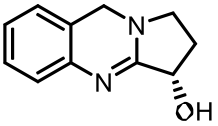
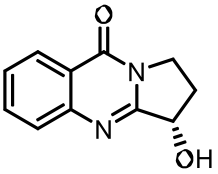
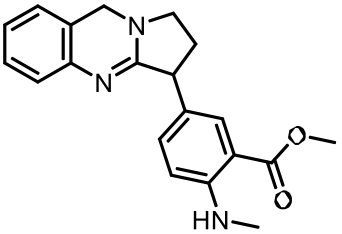
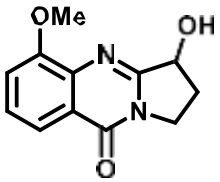
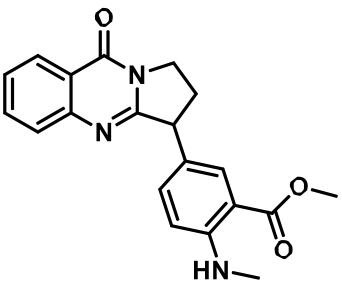
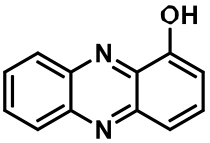
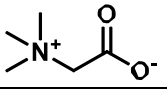
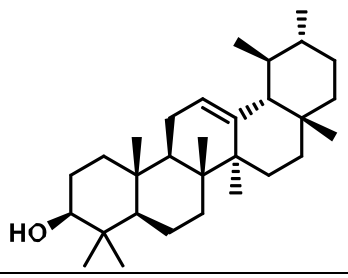


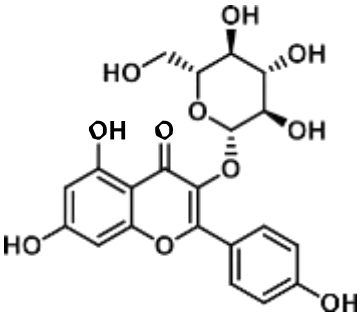
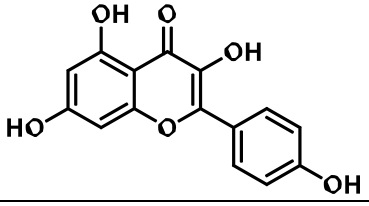
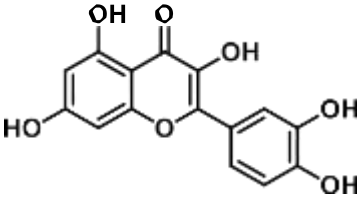
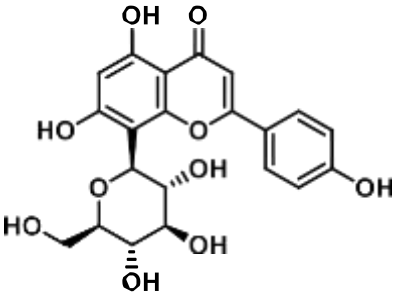
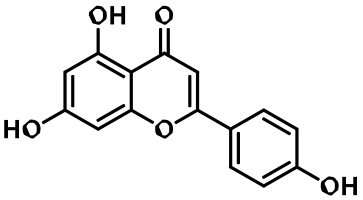
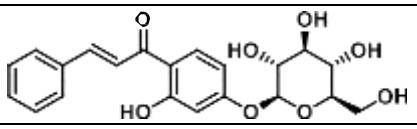
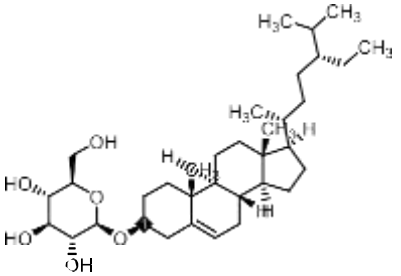
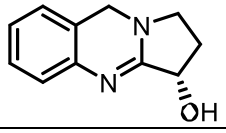
Fig 1 : Pictures of different parts of the plant

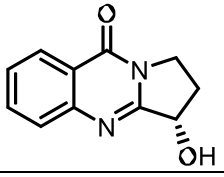
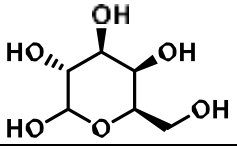
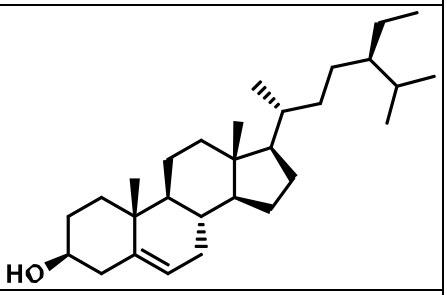
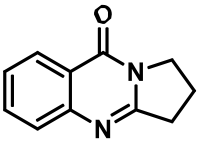
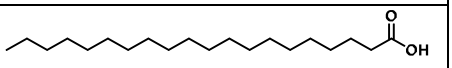
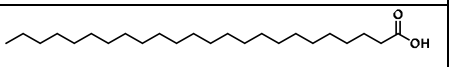
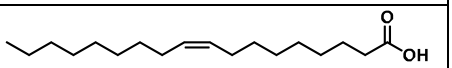
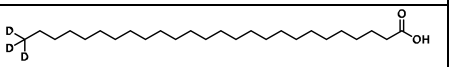
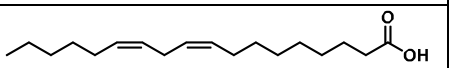
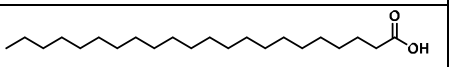
Phytochemical constituents:

Several phytochemical analyses have been carried out on different parts of A. vasica, including leaf, root, bark, wood, flower, fruit, and even on the whole section. The two major alkaloids present in this leaves of the plant are Vasicine (0.85%) and vasicinone (0.027%). Leaves of the plant also contain other alkaloid constituents such as Vascinone, Vascinol, Adhatodine, Adhatonine, Adhavasinone, Anisotine and Hydroxypeganine. Besides this, it also contains a small amount of essential oil and crystalline acid, betaine, steroids and alkanes. (7, 8). The flower contains triterpenes (alpha-amyrin), flavonoids (Astragalin, Kaempferol, Quercetin, Vitexin, Apigenin), 4-dihydrochalcone-4 -glucoside and alkanes (9). The root part contains Vitamin C (5.2%), fats (2.5%), daucosterol which is a steroid, carbohydrates, alkanes and alkaloids such as vascine (7.5%), vasicinal, vasicinolone, vasicinone 3.5%), fiber (5.2%) and adhatonine. D-galactose, β-sitosterol and deoxyvasicinone extracts are also found in the root part of the plant (10). Seeds of the plant contain 25.8% of deep yellow oil consists of glycerides of arachidic acid 3.1%, lignoceric acid 10.7%, oleic acid 49.9%, cerotic 5%, linoleic acids 12.3% behenic 11.2% and β-sitosterol 2.6% (11). Different chemical constituents involved in different parts of A. vasica, their molecular formula, molecular weight and chemical structure as represented in **Table 1**.

Table 1: Different chemical constituents involved in different parts of A. vasica, their molecular formula, molecular weight and chemical structure.

PARTS OF THE PLANT	NAME OF THE CHEMICAL CONSTITUENTS	MOLECULAR FORMULA	MOLECULAR WEIGHT(g/mol)	CHEMICAL STRUCTURE
Leaves	Vasicine	$C_{11}H_{12}N_{2O}$	188.23	
	Vasicinone	$C_{11}H_{10}N_2O_2$	202.21	
	Adhatodine	$C_{20}H_{21}N_3O_2$	5355.41	
	Adhavasinone	$C_{12}H_{12}N_2O_3$	232.24	
	Anisotine	$C_{20}H_{19}N_3O_3$	349.39	
	Hydroxypeganine	$C_{12}H_8N_2O$	196.21	
	Betaine	$C_5H_{11}NO_2$	117.15	
FLOWER	Alpha-amyrin	$C_{30}H_{50}O$	426.73	

	Astragalin	$C_{21}H_{20}O_{11}$	448.38	
	Kaempferol	$C_{15}H_{10}O_6$	286.24	
	Quercetin	$C_{15}H_{10}O_7$	302.24	
	Vitexin	$C_{20}H_{21}O_{10}$	432.38	
	Apigenin	$C_{15}H_{10}O_5$	270.24	
	4-dihydrochalcone-4 -glucoside	$C_{21}H_{22}O_8$	402.40	
ROOT	Daucosterol	$C_{34}H_{59}O_6$	563.84	
	Vascine	$C_{11}H_{12}N_2O$	188.23	

	Vasicinone	$C_{11}H_{10}N_2O_2$	202.21	
	D-galactose	$C_6H_{12}O_6$	180.16	
	β-Sitosterol	$C_{29}H_{50}O$	414.72	
	Deoxyvasicinone	$C_{11}H_{10}N_2O$	186.21	
SEEDS	Arachidic acid	$C_{20}H_{40}O_2$	312.54	
	Lignoceric acid	$C_{24}H_{48}O_2$	368.65	
	Oleic acid	$C_{18}H_{34}O_2$	282.47	
	Cerotic acid	$C_{26}H_{49}D_2O_2$	399.72	
	Linoleic acids	$C_{18}H_{32}O_2$	280.45	
	Behenic acids	$C_{22}H_{44}O_2$	340.59	

Important formulations (12)

Important formulations containing Asgandh of unani, Ayurveda formulations are as follows,
Syrup Basakarista
Basadi kwath
Sarbat Ejaz
Sarbat Tulsi
Sarbat Sadar
Sarbat Vasac
Basaboleho

Pharmacological and therapeutic uses:

Anti-asthmatic and bronchodilator Activity:

The alkaloid components, particularly vasicine and vasicinone, have therapeutic benefits for respiratory conditions. Leaf and root extracts were found to have calming effects on the throat, treat lung disorders, bronchitis, and bronchioles, and act as an expectorant. Anaesthetic guinea pigs, rabbits, and un anaesthetics guinea pigs exhibiting antitussive properties were used in the experiment . According to published research, Vasicine exhibited bronchodilator effects in both *in vitro* and *in vivo* experiments (13).

Uterine activity:

The uterotonic action of vasicine was investigated in detail both by *in vitro* and *in vivo* techniques using the uteri under various hormonal influences and of various animal species. The uterotonic action appeared to be comparable to that of oxytocin and methyl ergometrine. The abortifacient action of vasicine similar to its uterotonic action was more pronounced under the priming effect of oestrogens [14, 15]. Induced abortion in vasicine was investigated in rats, hamsters and guinea pigs, and rabbits. Research demonstrated that vasicine acted via release of PGs Synthesized vasicine and vasicinone derivatives in *in vitro* studies were oxytocic at the dose greater than 1 mg/ml [15].

Antidiabetes activity:

'Diabetic encephalopathy' is the term used to describe diabetes-associated cognitive impairment (DACI), which is characterized by oxidative nitrosative stress, inflammation and cholinergic dysfunction. Present research was aimed to assess the impact of *Adhatoda vasica*, a well-known anti-inflammatory, antioxidant, anti-cholinesterase and anti-hyperglycaemic herb, on diabetic encephalopathy. Diabetic Wistar rats induced by streptozotocin (STZ) were administered with *Adhatoda vasica* leaves ethanolic extract (AVEE) for 6 weeks at 100, 300 and 400 mg/kg/day dose. At fifth week of treatment, learning and memory was examined in single Y-maze and passive avoidance test. At the end of experiment biochemical parameters such as acetylcholinesterase (AchE) activity, nitrite levels, tumour necrosis factor-alpha (TNF-α) and oxidative stress was determined from cerebral cortex and hippocampus areas of brain. AchE activity was increased by 70% in cerebral cortex of diabetic rat brain. Lipid peroxidation (LPO) was elevated by 100% and 94% in cerebral cortex and hippocampus of diabetic rats, respectively. Levels of nonprotein thiol, enzymatic activity of superoxide dismutase and catalase were found to be lowered in cerebral cortex and hippocampal areas of diabetic rat brain. Nitrite level in both areas of diabetic brain was raised by 170% and 137% respectively. TNF-α, a pro-inflammatory cytokine, was also found substantially higher in diabetic rats. In contrast, the animal groups administered with AVEE substantially reduced such behavioural and biochemical abnormalities. The findings indicate a neuroprotective effect of *Adhatoda vasica* Nees against diabetic encephalopathy, which can be the sum of its antioxidant, anti-cholinesterase, anti-inflammatory and glucose lowering activity [16].

Anti-ulcer activity

Adhatoda vasica was examined for its anti-ulcerogenic activity against pyloric, ethanol, and aspirininduced ulcers. Adhatoda leaf powder exhibited a significant level of anti-ulcer activity in experimental rats compared to controls. Ethanol
induced ulceration model was the most active [15]. The findings indicate that apart from its classically proven pharmacological effects, *Adhatoda vasica* possesses vast potential as an anti-ulcer drug. Later studies revealed thatasyrupof Adhatoda relieved dyspepsia symptoms [17].

Cholagogue activity:

In experimental studies on dogs and cats, *Adhatoda vasica* was seen to enhance bile activity when intravenous administration of 5 mg/kg was administered to the animals. In dogs, excretion of bile was enhanced by40-100%. The animals also exhibit an enhancement in the excreation of bilirubin. [18].

Antitussives

Intravenous administration of the extract exhibited1/20–1/40 as active as codeine on mechanicallyand electrically induced cough in rabbits and guinea pigs. Oral administration of plant extract toguinea pigs showed antitussive activity against irritant induced aerosols comparable to codeine.Petroleum ether extract of *A. vasica* caused stimulation of respiratory tract fluidmore than ammonium chloride and eucalyptol in atropinised rats. Respiratory secretions werereduced by 78.5%, 47% and 36%, respectively.

(19)antitussive activity of *A. vasica* extract was studied on unanaesthetized and anaesthetized guinea pigs and rabbits. Action was found similar to codeine. It was suggested that it may be attributed to specific site of action of vasicinone and vasicine, which act on neuronal system and thus suppress coughing. (20)

Wound healing activity

The methanolic extract of *A. vasica* was shown to be beneficial in the healing of wounds in the rat model.This was followed with a study when the wound is induced alongside the vertebral columns of calves and then they are treated with the alcoholic and chloroform extract of the *A. vasica*. The outcome of this research indicates that alcoholic extract has a considerable improvement in the wound healing process compared to other extracts.Another research group is involved with the various extracts of vasaka prepared from leaves extract against wound healing property in mice model caused by excision. The outcome was astounding that the ointment (1%) formulated by using methanolic extract possesses strong wound healing activity (21).

Anti-tuberculosis Activity

Extraction and identification of alkaloids were carried out and verified by phytochemical test. Six quinazoline alkaloids (vasicoline, vasicolinone, vasicinone, vasicine, triterpenes and anisotine) were present in the leaf of *Justicia adhatoda* (*J. adhatoda*). The occurrence of the peaks derived using HPLC confirmed the varied nature of alkaloid in the leaf. The enzyme ů″-ketoacyl-acylcarrier protein synthase III catalyzing the first step of fatty acid biosynthesis (FabH) through a type II fatty acid synthase possesses special structural characteristics and common occurrence in Mycobacterium tuberculosis (*M. tuberculosis*). Therefore, it was targeted for the design of anti-tuberculosis agents. Docking simulation experiments were performed on the said alkaloids isolated from *J. adhatoda*. The docking/scoring combination gave valuable insights into how various inhibitors bind and are active. These findings can be helpful in inhibitor design against *M. tuberculosis* and also would be a good initial point for natural plant-based pharmaceutical chemistry (22).

Anti-inflammatory Activity

The chief alkaloid constituent Vasicine of *J. adhatoda* plant is anti-inflammatory in nature.Altered hen's egg chorioallantoic membrane test was carried out for testing the antiinflammatory action of Methanolic extract (non-alkaloid fraction saponins and alkaloid) constituent of J. adhatoda plant. The result revealed that alkaloid content revealed highly active at 50 mg/kg dose level comparable to hydrocortisone whereas Methanolic extracts are less active (23).

Anti-bacterial activity

A leaf extract was investigated for antibacterial activity using the paper disc and dilution methods. In-vitro screening showed a strong activity of Adhatoda's alkaloids against the bacteria *Pseudomonas aeruginosa*. Significant antibacterial activity against the Gram-positive bacteria strains *Streptococcus faecalis*, *Staphylococcus aureus*, *Staph epidermidis* and the gram-negative *E. coli* were also noted (24)

Anthelmintic activity

Adhatoda vasica as an *in vitro* anthelmintic activity against gastrointestinal nematodes in sheep. Egg hatch and larval growth tests were conducted to analyze the aqueous and ethanolic extracts of the plant. The ethanolic extract was more effective compared to the other. Anthelmintic or anticestodal effect of the plant extract occurs at 800 mg/kg. For the young worms, the extract shows a significant decline in recovery percentage. The anthelmintic activity of *Adhatoda vesica* was assessed in vitro and in vivo against the standard drug levamisole. *In vitro*, aqueous and methanolic extracts possess high inhibitory activity, yet root powder presents greatest effects. Both models possess anthelmintic activity towards nematodes (24, 25).

Antiviral activity

The aqueous and methanolic extract of the plant shows significant antiviral activity against the influenza virus by inhibiting attachment of virus at host surface and/or replication cycle of the virus. Thus, we can say that it can be used as prophylaxis for the treatment of viral infection (26)

Antioxidant activity

The leaf samples of *Adhatoda vasica* was subjected to phytochemical analysis. The plant contained antioxidant phytochemicals such as alkaloids, tannin, saponins, phenolics and flavonoids. The methanolic extracts of the plants were also analyzed for antioxidant and reducing power potentiality. The plant showed strong antioxidant and reducing power ability. The strong antioxidant and reducing power ability of the plant underlines their use as antioxidant supplement against diseases such as typhoid during which antioxidant system fails; cardiovascular diseases which are caused due to accumulation of Reactive oxygen species; ageing related diseases, Alzheimer disease, Parkinson's disease, and other diseases. (27) Oral administration of *A. vasica* leaves extract at 800 mg/kg controlled hematological parameters to normal like GSH and LPO level in post irradiated animals. Pretreatment with *A. vasica* Nees at 100 and 200 mg/kg also significantly improved SOD, catalase and GSH levels in CCl4-induced hepatotoxicity. (28)

Effect on reproductive organs

The potential abortifacient activity of an extract of *Adhatoda vasica* leaf spissum was investigated in rats. Vasicine (0.85 ± 0.03%) was the major alkaloid found in the extract. The extract (325 mg/kg/day) was given via a gastric cannula to 5 pregnant females on days 1-9 of gestation. In another trial 9 pregnant women were given in water 0.25 and 2.5% of *Adhatoda vasica* from day 1 to day 9 of pregnancy. It was found that *Adhatoda vasica* administration did not cause abortion in any of the tested groups (29)

Anti-Alzheimer Activity

The chemical ingredient of *A. vasica* (alcoholic extract) inhibited the acetylcholine esterase enzyme reversibly. Among the active ingredients are vasicine,vasicinone, vasicole, anisotine. Because of its competitive inhibitory action on AChE, the study concluded that vasicine could be used to treat Alzheimer's disease. Most isolated alkaloids had no or modest inhibitory effects on cholinesterase. The results from the docking show that vasicine having same action as that of tacrine and galantamine in the catalytic site due to its binding similarity (30)

Anticholinesterase activity

Vasicinone is an alkaloid obtained from the roots of *A. vasica* that produces hypotension in cat model and also a contraction of isolated intestine along with that it causes depression in isolated frog heart in a guinea pig model (31).

Immunomodulatory activity

Methanolic, chloroform and diethyl ether leaf extracts of the Indian medicinal plant *Adhatoda vasica* Linn. Were pharmacologically tested for its immunomodulatory activity in experimental animals. Significant increase of the percentage neutrophil adhesion to nylon fibers ($P< 0.001$) was produced by oral administration of extracts at a dose level of 400 mg/kg in adult male Wister rats. The results read at various doses were significant compared to control groups. These observations implied that this plant's extracts, *A. vasica* Linn, in a positive manner, modulate the host immunity (32).

Pyorrhea

The test was carried out in 25 patients with pyorrhea. The leaf extract of the plant was massaged against inflamed gums for three weeks (twice a day). It was found that there were more relief and reduction in inflammation and bleeding condition of gums (33).

Hepatoprotective Activity

The plant demonstrates very protective activity against liver toxicity. Ethyl acetate extract of the plant at the dose of 100 and 200 mg/kg; demonstrates highly significant protective activity against the liver toxicity produced by carbon tetrachloride in albino rats. It increases liver marker enzymes which were lowered due to injury in the liver (33). Similar findings were also mimicked by another study with the use of whole plant powder drug, these accounts for its hepatoprotective activity and different liver disorders (34). The leaf aqueous extract has significant hepatoprotective activity against d-galactosamine-induced

hepatotoxicity in rats at a dose below 100 mg/kg per oral (35). Another scientist experiments on the same at a dose of 250 mg/kg body weight using the carbon tetrachloride induce model. (36) The ethanolic extract of vasaka plant, restore the highly increased biochemical levels to that of a normal range which was altered due to the liver toxicity caused by perchloroethylene.(37)It was stated that the pretreatment of vasicinone with silymarin at a dose of 25 mg/kg/day exhibits a strong hepatoprotective activity by reducing the level of hepatic enzymes.(38) The ethanolic extract of vasaka leaves (100 – 200 mg/kg p.o.) exhibits significant protective action on hepatic cells in a carbon tetrachloride (CCl_4) induced model The plant extracts were prepared using different solvent (alcohol, chloroform and ether) shows its strong hepatoprotective action against the CCl_4 causing liver damage in the rat model(39).

Safety Profile of *A.vasica*

When we concern about the safety profile of *A. vasaka* we could not find any such record about its severe adverse effects or death. There are some minor effects like vomiting and diarrhea but they occur when they are consumed in higher doses than recommended. Besides the active and toxic action, theleaves of the plant exhibit a strong action on the uterus which causes increased contraction of the uterus and can be a probable cause of abortion (40).Different pharmacological activities and their actions on the basis of dose, parts used and test system used are represented in Table 2.

Table 2: Different pharmacological activities and their actions on the basis of dose, parts used and test system used.

Sl.N0	Pharmacological activities	Parts/extracts/ possible chemical constituents	Effective dose range	Test system for activity	Result	References
1.	Antiallergic and anti-asthmatic activity	In vivo: Ethanolic extract of plant	250, 500, 750 mg/kg	Acetylcholine and histamine induced brancho-spasm in guinea pigs	Spasmolytic effect of ethanolic extract of A. vasica found similar to ketotifen (1 mg/kg).	41
2.		Plant: Aqueous extract	130 mg/kg	Ova-allergen mouse model	Extract attenuated the increased airway resistance and inflammation in acute allergic asthmatic mice.	42
3.	Anti-tubercular activity	Volatile extract from leaves	340 mg/kg	Parkes albino mice infected intravenously with the Ravenel Rv strain of M. tuberculosis	Volatile principle showed no anti-tubercular properties in mice on oral administration.	43
4.	Anti-ulcer activity	Leaves powder	500 mg/kg in 0.2 % agar	Ethanol induced and Pylorus ligation plus aspirin-induced rats	The ethanol-induced ulceration model had the highest level of activity (80 %)	44

5.	Hepatoprotective activity	Leaves: aqueous extract	50–100 mg/kg	D-galactosamine liver damage induced in rats	Results supported the use of the plant as hepatoprotective element in traditional medicine.	45
6.	Anti-Alzheimer activity	Whole plant	294 µg/mL	in vitro: acetylcholinesterase (AChE) and cycloxygenase-1 (COX-1) enzymes	Adhatoda vasica showed inhibitory effect on AChE at IC50 294 µg/mL.	46
7.	Anti-typhoid activity as an antityphoid agent.	Leaves	2.50 mg/mL	methanolic extract	Salmonella typhi Methanolic extract proved effective against Salmonella typhi	47

CONCLUSION

The literature survey revealed that *Adhatodavasica* has been widely studies for its phytochemical and pharmacological activities. It presents in class of herbal drug with very strong conceptual or traditional base. *Adhatodavasica* is an important source of vasicine, vasicinone, vasicolone and some other Alkaloids. Other phytoconstituents such as phenolics,flavonoids, terpenoids, tannins, steroids and glycosides extracted from different parts of thisplant have many traditional uses and pharmacological activities in animal models.In this reviews some pharmacological studies has been concluded like antibacterial, antifungal, hepatoprotective, antitussive, radiomodulation, anti-inflammatory and antiulcer, abortifacient, antiviral, thrombolytic, antimutagenic, cardiovascular protection, hypoglycaemic, antitubercular, antioxidant and some more studies are done. Furthermore, studies are summarized in mentioned review papers.The medical application of *Adhatoda vasica* needs to be further evaluated for the benefit of mankind to investigate its unknown effect.

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