



PHARMACOLOGICAL PROPERTIES AND PHYTOCHEMICAL OF ADHATODA VASICA NEES(VASAKA): A REVIEW

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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 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 diarrhoea 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; Vasaka, Phytochemistry, pharmacological activity, Ayurvedic.

1. INTRODUCTION

Adhatoda vasica belong to the family *Acanthaceae*. A shrub in plenty with dense foliage covering the ground around it. The leaves are dark green and minutely pubescent. The flowers are white bilabiate with lot of honey. It also known as *vasaka*, is herbs naturally know to be very effective in the management of respiratory problems like cough, asthma etc. it is also a potent anti-microbial agent and has many cooling properties as well. *Vasaka*, is used as medicine in the treatment of various diseases because it has ability of the formation of secondary metabolites like tannins, alkaloids, saponins, flavanoids, reducing sugars and anthraquinones substances which are in turn used to restore health and heal many diseases. We can use of leaves to treat cough, Asthma, Fever, tuberculosis, piles, jaundice, bleeding, gum, as an expectorant and as a bronchodilator. Extract of root, bark, leaves and flower is used for bronchial, asthmatic and pulmonary affections.

2. Habit (Swarupa)

A dense evergreen often gregarious shrub high 4-8ft. high. Stem with yellowish bark, terete, glabrous;

branches many ascending. Leaves 5-8 inch long, elliptic lanceolate, acuminate tapering to the base, minutely puberulous, dark green above when young, pale beneath, main lateral nerves 8-12 pairs, vein reticulate, petioles ½-1 inch long, arranged towards the ends of the branches; peduncles stout shorter than the leaves, bracts up to 7/8 inch long, elliptic, subacute, glabrous or nearly so, 5-7 nerved closely reticulate, bracteoles ¾ inch long, 1 nerved margins ciliate Calyx 1/3 - 1/2 inch long, often slightly pubescent; segments equal oblong, lanceolate, acute, 3-nerved. Corolla white with pink or purple stripes in the throat 1 1/4 "long hairy, outside tube 1/2" long upper half much inflated laterally; upper lip curved, ovate-oblong, notched; lower lip as long as the upper; lobes oblong, rounded Filaments hairy at the base; the lower anther-cells apiculate not Capsule ¾" or more in length, clavate, pubescent. Seeds sub orbicular, tubercular verrucose.^[1]

3. Vernacular names

Hindi: Adosa, adalsa, vasaka

Sanskrit: Amalaka, bashika, aatrusha, kaphaha, karkasha, Bengali: Basak

Tamil: Adatodai
 Marathi: Vasuka
 Telugu: Adasaram
 Malayalam: Ata-lotakam
 Gujrat: Aradusa

4. Classification of *Adhatoda vasica*

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

5. PROPERTIES AND ACTIONS ACCORDING TO AYURVEDA^[2]

Rasa (taste): Tikta (Bitter), Kashaya (Astringent)
Guana (quality): Laghu (light), Ruksha (Dry) **Virya (Potency):** Sheeta (cold) **Vipaka: (post digestive effect):** Katu / Laghu

6. Chemical composition

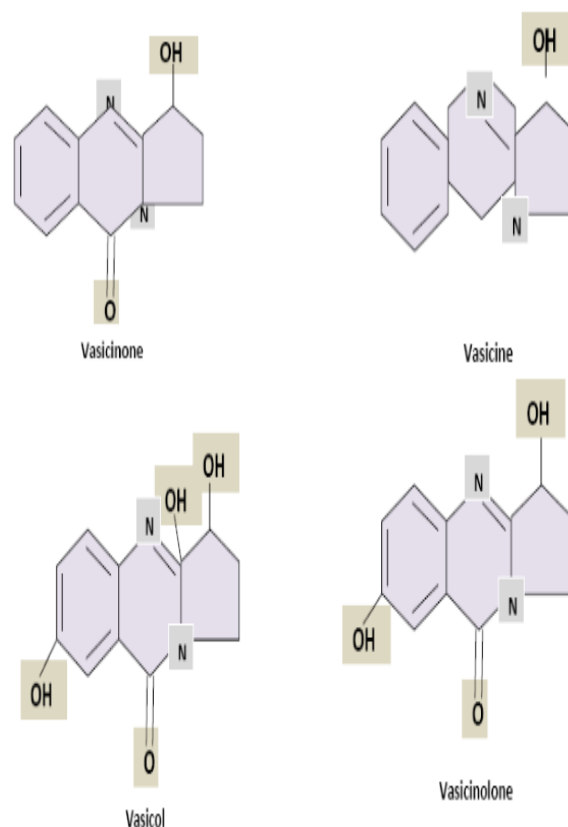
Plant contains an aromatic volatile oil, fat, resin, a bitter alkaloid vasicine, a carbonic acid named as adhatodic acid, sugar, gum, colouring matter and salts.

Leaves also yield a yellow dye which is a colouring agent. A principal chemical constituent vasicine is present in leaves bark in percentage of 0.2-0.4 and 0.35 respectively. The roots contains only traces and the alkaloidal content of the vasa plant different parts. Another active principal vasicinone is present in the leaves.

The pharmacological action and therapeutical properties of drug are attributed to alkaloidal contents in clouding essential oil.^[3]

7. Phytochemistry

The vast variety of pharmacological uses of *Adhatoda* is believed to be the result of its rich concentration of alkaloids.^[4, 5] The prominent alkaloid found in *Adhatoda* leaves is the quinazoline alkaloid known as vasicine.^[6] In addition to vasicine, the leaves and roots of *Adhatoda* contain the alkaloids l-vasicinone, eoxyvasicine, maiontone, vasicinolone and vasicinol.^[7] Research indicates that these chemicals are responsible for *Adhatoda*'s bronchodilatory effect.^[8, 9]



8. Pharmacological activity.

8.1 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. The presence of phenols, tannins, alkaloids, anthraquinones, saponins, flavanoids, amino acids and reducing sugars was indicated by the tests conducted. The effect of ethanol, petroleum ether and water extracts were tested on *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Bacillus subtilis*, *Enterococcus faecalis*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Proteus vulgaris*, *Klebsiella pneumoniae* and *Candida albicans*. The minimum inhibitory concentration of the crude extracts was determined for various organisms.^[10]

8.2 Antimicrobial Activity

Adhatoda vasica leaves for its phytochemical composition and antioxidant activity. Antioxidant activity of methanol extract of *A. Vasica* was estimated by total antioxidant activity, 2, 2 diphenyl-1-picrylhydrazyl radical scavenging activity, reducing power potential and iron chelating activity. Antimicrobial activity was performed by agar well diffusion method. Estimation of total phenolic content was measured by Folin- Ciocalteu reagent method and estimation of total flavonoid content was performed by aluminum chloride method. Leaves of *A. Vasica* were found to possess saponins, oils and fats, phytosterol, phenolic compounds, tannins, carbohydrate, alkaloids, flavanoids and proteins. Extract showed high antioxidant

activity in various antioxidant experiments. The extract of *A. Vasica* showed presence of high levels of polyphenolic compounds (phenolic compounds and flavonoids), which could be the possible reason behind the antioxidant activity of the plant. In addition extract demonstrated moderate antimicrobial and cytotoxic activity (Brine shrimp lethality).^[11]

8.3 Antioxidant activity

Adhatoda vasica Nees and *Sesbania Grandiflora* (L.) Pers are the two important medicinal plants native to India. The aqueous leaf extracts of these two plants have been analysed for their free radical-scavenging activity in different *in vitro* systems, e.g. DPPH radical scavenging activity, hydroxyl radical-scavenging activity in Fe³⁺/ascorbate/EDTA/H₂O₂ system, inhibition of lipid peroxidation induced by FeSO₄ in egg yolk, metal chelating activity. The free radical scavenging activities were compared with standard antioxidants like butylated hydroxy toluene (BHT), ascorbic acid and EDTA. Total antioxidant activity was measured, based on the reduction of Mo (VI) to Mo (V) by the extract and subsequent formation of green phosphate/Mo (V) complex at acid pH and reducing power by Fe³⁺ - Fe²⁺ transformation in the presence of extracts. The content of total phenolics (expressed as mg of gallic acid equivalents/gm) and total flavonoids (expressed as mg of quercetin equivalent/gm) and ascorbic acid were determined along with antioxidant enzymes. The results indicated that *A. vasica* and *S. Grandiflora* showed significant antioxidant activity *in vitro*. The enzymatic and non-enzymatic antioxidants in *A. Vasica* were found to be more than that of *S. grandiflora*, similarly the antioxidant and radical scavenging activities of *A.vasica* were found to be more significant than *S. Grandiflora*.^[12]

8.4 Anti-inflammatory

Adhatoda vasica(L.) Nees is a well-known plant drug in Ayurvedic and Unani medicine. It has been used for the treatment of various diseases, particularly for the treatment of inflammatory and cardiovascular diseases. However, the scientific rationale and mechanisms by which it functions in these diseases is not known. This study was designed to explore the inhibitory activity of *Adhatoda vasica* aqueous and butanolic fractions on arachidonic acid (AA) metabolism. For this purpose aqueous and butanolic fractions of *Adhatoda vasica* were screened for the presence of activities against arachidonic acid (AA) metabolites and their effectiveness was further evaluated by studying platelet aggregation induced by a AA, adenosine diphosphate (ADP), platelet activating factor (PAF), and collagen. AA metabolism was studied by thin layer chromatography system while platelet aggregation was measured by dual channel Lumiaggrego meter. Aqueous fraction of *Adhatoda vasica* but not of butanolic fraction inhibited the AA metabolites through COX pathway (TXB₂) and LOX pathway (LP1 and 12-HETE). However, in platelet aggregation studies butanolic extract of *Adhatoda vasica* showed strong inhibition

against AA, PAF and collagen induce aggregation but not against ADP.^[13]

8.5 Antitussive

The effect of the ethanol extracts of *Glycyrrhiza glabra* and *Adhatoda vasica* on SO₂ gas induced cough in experimental animals have very significant effects at the level of $P < 0.01$ in inhibiting the cough reflex at a dose of 800 mg/kg and 200 mg/kg body wt. p.o., in comparison with the control group. Mice showed an inhibition of 35.62%, in cough on treatment with *Glycyrrhiza glabra* and 43.02% inhibition on treatment with *Adhatoda asica* within 60 min of the experiment. The antitussive activity of the extract was comparable to that of codeine sulphate (10, 15, 20 mg/kg body wt.), a standard antitussive agent. Codeine sulphate, as a standard drug for suppression of cough, produced 24.80%, 32.98%, and 45.73% inhibition in cough at a dose of 10 mg/kg, 15 mg/kg and 20 mg/kg respectively, whereas, codeine sulphate (20 mg/kg) showed maximum 45.73% ($P < 0.001$) inhibition at 60 min of the experiment.^[14]

8.6 Hepatoprotective Activity

The hepatoprotective activity of Ethyl acetate extract of *Adhatoda vasica* was investigated against CCl₄ induced liver damage in Swiss albino rats. At the dose of 1ml/kg, CCl₄ induced liver damage in rats as manifested by statistically significant increase in serum Alanine aminotransferase, (ALT), Aspartate aminotransferase (AST), Alkaline Phosphatase (ALP) and also in serum Bilirubin. Pre-treatment of rats with the ethyl acetate Extract of *Adhatoda vasica* (100mg/kg and 200mg/kg) prior to the CCl₄ dose at 1ml/kg statistically lowered the three serum level enzymes and also Bilirubin. Histopathological observations also coincided with the above results, however 200mg/kg dose was found to be more active. Current results suggest that Ethyl acetate extract of *Adhatoda vasica* has potent hepatoprotective effect against CCl₄ - induced liver damage.^[15]

8.7 Antiviral activity

The influenza viruses are major etiologic agents of human respiratory infections, and inflict sizable health and economic burden. The present study reports the *in vitro* antiviral effect of *Justicia adhatoda* crude extracts against influenza virus by Hemagglutination (HA) reduction in two different layouts of simultaneous and post treatment assay. The aqueous and methanolic extracts were used for antiviral activity in the noncytotoxic range. Methanolic extract showed 100% reduction in HA in the simultaneous and post treatment assays at the concentration of 10mg/ml. The aqueous extracts at concentrations of 10mg/ml and 5mg/ml reduced the HA to 33% and 16.67%, respectively, in the simultaneous assay. These results suggest that extracts have strong anti-influenza virus activity that can inhibit viral attachment and/or viral replication, and may be used as viral prophylaxis.^[16]

8.8 Thrombolytic Activity

As a part of discovery of cardio-protective drugs from natural sources the extractives of *Adhatoda vasica* were assessed for thrombolytic activity. Addition of 100 μ l SK, a positive control (30,000 I.U.), to the clots and subsequent incubation for 90 minutes at 37°C, showed 80.65% lysis of clot. At the same time, distilled water was treated as negative control which exhibited negligible lysis of clot (4.08%). In this study, the methanolic fraction (MF) exhibited highest thrombolytic activity (53.23%).^[17]

8.9 Antifungal Activity

Plants have been proven as promising sources of new and biologically active natural products exhibiting higher activity in medicinal applications. The usage of natural products and active plant extracts has been increased recently and new drugs are discovered using new technological advancements. The present elucidates the phytochemical constituents of *Adhatoda vasica* and their effective agent's human pathogenic fungus. The minimum inhibition activity of the phytochemical extract is identified. Further study is carried out with the extract for the partial characterization by TLC and antifungal determined by agar disc diffusion and germ tube formation inhibition activity. The aim of the current study on the effect of *A. Vasica* on *Aspergillus ruber* and *Trichophyton rubrum* pathogenic fungus was to conclude the antifungal activity of the *A. Vasica*.^[18]

8.10 Anthelmintic activity

The main objective of this study was to evaluate the anthelmintic activity of *Adhatoda vasica* (Acanthaceae) *in vitro* against the gastrointestinal nematodes of sheep. The aqueous and ethanolic extracts of *Adhatoda vasica* aerial parts were evaluated by egg hatching and larval development assays. The aqueous and ethanolic extracts at 25-50 mg/ml concentrations exhibited ovicidal and larvicidal ($P < 0.05$) activity against gastrointestinal nematodes. The plant extracts showed dose-dependent inhibition ($P < 0.05$). The ethanolic extract at the concentration of 50.0 mg/ml was more effective in inhibiting egg hatching and larval development of gastrointestinal nematodes. The effective dose (ED₅₀) of aqueous and ethanolic extracts were determined graphically from linear regression equation with probit scale, $y = 5$. The results of this study suggested that *Adhatoda vasica* extracts may be useful in the control of gastrointestinal nematodes of sheep.^[19]

8.11 Antidiabetes activity

'Diabetic encephalopathy' refers to diabetes associated cognitive decline (DACD), which involves oxidativenitrosative stress, inflammation and cholinergic dysfunction. Current study was designed to investigate the effect of *Adhatoda vasica*, a known anti-inflammatory, antioxidant, anti-cholinesterase and anti-hyperglycemic plant, on diabetic encephalopathy. Streptozotocin (STZ)-induced diabetic Wistar rats were treated with *Adhatoda vasica* leaves ethanolic extract

(AVEE) for 6 weeks at 100, 200 and 400 mg/kg/day dose. During fifth week of treatment, learning and memory was investigated in single Y-maze and passive avoidance test. At the end of the study biochemical parameters like acetylcholinesterase (AChE) activity, nitrite levels, tumor necrosis factor-alpha (TNF- α) and oxidative stress was measured from cerebral cortex and hippocampus regions of brain. AChE activity was found increased by 70% in the cerebral cortex of diabetic rat brain. Lipid peroxidation (LPO) levels were increased by 100% and 94% in cerebral cortex and hippocampus of diabetic rats, respectively. Nonprotein thiol levels, enzymatic activities of superoxide dismutase and catalase were found decreased in cerebral cortex and hippocampal regions of diabetic rat brain. Nitrite levels in both regions of diabetic brain were increased by 170% and 137% respectively. TNF- α , a pro-inflammatory.

Cytokine was found significantly increased in diabetic rats. Conversely, animal groups treated with AVEE significantly attenuated these behavioral and biochemical abnormalities. The results suggest a protective role of *Adhatoda vasica* Nees against diabetic encephalopathy, which may be sum of its anti-oxidant, anti-cholinesterase, anti-inflammatory and glucose lowering action.^[20]

8.12 Anti-tuberculosis Activity

The extraction and determination of alkaloids was performed and confirmed by phytochemical analysis. Six different quinazoline alkaloids (vasicoline, vasicolinone, vasicinone, vasicine, triterpenes and anisotine) were found in the leaf of *Justicia adhatoda* (*J. adhatoda*). The presence of the peaks obtained through HPLC indicated the diverse nature of alkaloid present in the leaf. The enzyme β -ketoacyl-acyl carrier protein synthase III that catalyses the initial step of fatty acid biosynthesis (FabH) via a type II fatty acid synthase has unique structural features and universal occurrence in *Mycobacterium tuberculosis* (M. tuberculosis). Thus, it was considered as a target for designing of anti-tuberculosis compounds. Docking simulations were conducted on the above alkaloids derived from *J. adhatoda*. The combination of docking/scoring provided interesting insights into the binding of different inhibitors and their activity. These results will be useful for designing inhibitors for M. tuberculosis and also will be a good starting point for natural plant-based pharmaceutical chemistry.^[21]

8.13 Anticestodal activity

The result indicated 800 mg/kg double dose of extract has profound efficacy against mature worms, where the EPG count was reduced by 79.57% and percentage worm recovery rate by 16.60%. These effects were better than treatment with 5 mg/kg single dose of praziquantel, the standard drug. In case of efficacy against immature worms, the extract showed a significant reduction in worm recovery rate (from 100% in control to 20.00% at 800 mg/kg dose of extract).^[22]

8.14 Electrophoresis

A new method of capillary electrophoresis was developed for the quantitative determination of vasicine and vasicinone from *Adhatoda vasica* (L.) Nees. The electrophoretic separation was performed using a 47cm_50 mm ID (38.5 cm effective length) fused silica capillary. The samples were injected by pressure for 3 s at 50 mbar and the running voltage was 19 kV at the injector end of the capillary. The capillary temperature was maintained at 40 °C. The separation of the two alkaloids has been achieved within 11 min with good repeatability. The method was validated in terms of reproducibility, linearity, accuracy and applied for the quantitative determination of vasicine and vasicinone in *A. vasica* plant samples/extracts. Parameters affecting the resolution such as pH, temperature, organic modifier, buffer Concentration and capillary dimensions were reported.^[23]

8.15 Hepato suppression

Liver disorder is one of the common thrust area declared by the Indian Council of Medical Research, New Delhi in the reviewed research on traditional medicine. *Adhatoda vasica* have been reported to exhibit varying degrees of hepatoprotection against the CCl₄induced liver dysfunction in rats. The present work was carried out to investigate the hepatoprotective action of *Adhatoda vasica* whole plant powder against CCl₄ induced liver damaged Wister rat model. Blood and tissue biochemical parameters of liver have been examined for evaluating the hepatoprotection action. These biochemical markers are GOT, GPT, Alkaline phosphate, glucose, bilirubin, Triglycerides, γGT, cholesterol, DNA, RNA, total protein, The effect of *Adhatoda vasica* whole plant powder is compared with Silymarin by standard protocol and is found to have better hepatoprotective action, thus *Adhatoda vasica* indicating protection in liver may prove promising effect against liver disorders. Thus it may act even in humans as a potent liver tonic.^[24]

8.16 Radio modulatory

The radiomodulatory influence of ethanolic extract of *Adhatoda vasica* Nees leaf extract against radiation-induced hematological alterations in peripheral blood of Swiss albino mice was studied at various post-irradiation intervals between 6 h to 30 days. Conversely, animals pre-treated with *A. vasica* leaf extract showed 81.25% survival till 30 days after exposure and a gradual recovery was noted in the hematological values. However, these hematological values remained significantly below the normal even till day 30. A significant decrease in blood reduced glutathione (GSH) content and increase in lipid peroxidation (LPO) level was observed in control animals (Radiation alone). However, *A. vasica* leaf extract pretreated irradiated animals exhibited a significant increase in GSH content and decrease in LPO level. A significant increase in the serum alkaline phosphatase activity and decrease in acid phosphatase activity was observed in *A. vasica* leaf

extract pretreated irradiated animals during the entire period of study.^[25]

8.17 Immunomodulatory activity

Methanolic, chloroform and diethyl ether extracts of leaves of Indian medicinal plant *Adhatoda vasica* Linn. Were pharmacologically validated for its immunomodulatory properties in experimental animals. Oral administration of extracts at a dose of 400 mg/kg in adult male Wister rats significantly increased the percentage neutrophil adhesion to nylon fibers ($P < 0.001$). It extracts were also found to induce Delayed Type Hypersensitivity reaction by sheep erythrocytes ($P < 0.001$). The observed results at different doses were significant when compared to control groups. These findings suggested that the extracts of this plant, *A. vasica* Linn positively modulates the immunity of the host.^[26]

8.18 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.^[27] 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.^[28] Recent investigations using vasicine showed bronchodilatory activity both *in vitro* and *in vivo*.^[29]

8.19 Wound healing activity

For the purposes of the study, wounds were created along the ~ 90 ~ International Journal of Herbal Medicine vertebral columns of buffalo calves, and alcoholic and chloroform extracts of *Adhatoda* in a powdered form were applied. As compared to control animals, the calves treated with *Adhatoda vasica* showed significantly improved healing. Vasicine improved breaking strength, tensile strength, absorption and extensibility in the wound repair tissue. In addition, the levels of elastin, collagen, hydroxyproline, hexosamine and zinc were greatly increased in the animals treated with *Adhatoda*. The alcoholic extract of the herb was found to be the most effective.^[30]

8.20 Anti-ulcer activity

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.^[31] 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.^[32]

8.21 Cholagogue activity

In laboratory experiments on cats and dogs, *Adhatoda vasica* was found to increase bile activity when the animals were given an intravenous dose of 5 mg/kg. In dogs, the amount of excreted bile increased by 40-100%. The animals also showed an increase in bilirubin excretion.^[33]

8.22 Anti-allergy activity

The extract containing the alkaloid vasicinol and 20% vasicine inhibited ovalbumin-induced allergic reactions by about 37% at a concentration of 5 mg.^[34] Vasicinone has been shown to be a potent anti-allergen in tests on mice, rats and guinea pigs.^[35]

8.23 Anti-tubercular activity

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.^[36, 37]

8.24 Abortifacient and uterotonic activity

Adhatoda vasica has abortifacient and uterotonic properties, making it useful for inducing abortion and for stimulating uterine contractions in order to speed childbirth.^[38] Studies on human subjects have shown that the alkaloid vasicine has significant uterotonic activity. This action appears to be influenced by the presence or absence of certain estrogens. In research on the activity of vasicine in stimulating uterine contractions, human myometrial strips taken from the uterus of both pregnant and non-pregnant women were treated with *Adhatoda*. The herb was found to induce uterine contractions, with effectiveness similar to the drug oxytocin.^[39] During the research period, the anti-reproductive properties of *Adhatoda vasica* were anecdotally confirmed by local women.^[40] Animal studies have also demonstrated *vasica*'s abortifacient properties. Aqueous or 90% ethanol plant extracts were given orally to test rats and guinea pigs for 10 days after insemination. Leaf extracts of *Adhatoda vasica* were 100% abortive at doses equivalent to 175 mg/kg.^[41] *Adhatoda vasica* was also shown to have an abortifacient effect on guinea pigs, with effectiveness varying depending on the stage of pregnancy. The effects were more marked when estrogens were used as a priming influence, indicating that the actions of vasicine was probably mediated via the release of prostaglandins.^[42]

8.25 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.^[43] 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.^[44]

9. INDICATION DESCRIBED IN AYURVEDIC MEDICINE:

Raktapitta (Purpura /Haemorrhagical disorder), *Kasa* (Cough), *Jwara* (Fever), *Kshaya* (Pthisis), *Kasa* (Cough), *Shvasa* (Asthma), *Raktapitta* (Purpura/ Haemorrhagical disorder), *Rajayakshma* (Tuberculosis), *Parshvashula* (pain in flanks), *Hritshula* (Angina pectoris), *Shotha* (oedema)^[45-49] *Atisara*, (Diarrhoea) *Pravahika*, *Mutrakrcchra* *Mutradaha*-*paittika*-*Prameha*, *Carmavikara*-*kustha*.

10. USES DESCRIBED IN FOLK MEDICINE

The leaves are used fever, rheumatism, bronchitis, asthma, cough, cold, menorrhagia, leprosy, jaundice, stomachic, wound healing, malaria, mumps, heart trouble and delivery complaint.

CONCLUSION

Adhatoda vasica possesses numerous biological activities proved by many experimental studies. It represents a class of herbal drug with very strong conceptual or traditional base as well as a strong experimental base for its use. Thus, this plant has great potential to be developed as drug pharmaceutical industries, but before recommending it for clinical use in these conditions, there is a need to conduct clinical use in these conditions, there is a need to conduct clinical trials and prove its clinical utility.

REFERENCES

1. Dravyaguna vijñana Prof.D.Shanth Kumar Lucas Vol 2nd Varanasi Chaukhamba visvabharati 326.
2. Priyavrat sharma vol 2nd Reprint edition 2012 Chaukhambha Orientalia, Varanasi, India 424.
3. Dravyaguna vijñana Dr.Gyanendra Pandey Vol.3rd Varanasi Chaukhamba Krishadas Academy 799.
4. Shrivastava N, Shrivastava A, Banerjee A, Nivsakar M, Anti-ulcer activity of *Adhatoda vasica* Nees. J Herb Pharmacother, 2006; 6(2): 43-9.
5. Maikhuri RK, Gangwar AK. Ethnobiological notes on the Khasi and Garo tribes of Meghalaya, Northeast India. Economic Botany, 1965; 47: 345.
6. Dhar KL, Jain MP, Koul SK, Atal CK. Vasicol, a new alkaloid from *Adhatoda vasica*. Phytochemistry, 1981; 20(2): 319.
7. Jain MP, Sharma VK. Phytochemical investigation of roots of *Adhatoda vasica*. Planta Medica, 1982; 46: 250.
8. Bhalla HL, Nimbkar AY. Preformulation studies III. Vasicinone, a bronchodilatory alkaloid from

- Adhatoda vasica* Nees (absorption, potency and toxicity studies). Drug Dev Indian Pharm, 1982; 8(6): 833.
9. Amin AH, Mehta DR. A bronchodilator alkaloid (vasicinone) from *Adhatoda vasica* Nees. Nature, 1959; 184: 1317.
 10. Karthikeyan A, Shanthi V, Nagasathaya A. Preliminary phytochemical and antibacterial screening of crude extract of the leaf of *Adhatoda vasica* L. International Journal of Green Pharmacy. 2014; IP: 49.202.103.78.
 11. Vankata KR, Munjal M, Patnayak A, Karthik L, Kumar G. Phytochemical Composition, Antioxidant, Antimicrobial and Cytotoxic Potential of Methanolic Extracts of *Adhatoda vasica* (Acanthaceae). Research J. Pharm. and Tech., 2013; 6(9): 997-1002.
 12. Padmaja M, Sravanthi M, Hemalatha KPJ. Evaluation of Antioxidant Activity of Two Indian Medicinal Plants. Journal of Phytology., 2011; 3(3): 86-91.
 13. Ahmed S, Gul S, Gul H, Bangash MH. Dual Inhibitory Activities of *Adhatoda vasica* against Cyclooxygenase and Lipoxygenase. International journal of endorsing health science research., 2013; 1: 14-17.
 14. Jahan Y, Siddiqui HH. Study of Antitussive Potential of Glycyrrhiza Glabra and *Adhatoda vasica* using a cough model induced by Sulphur Dioxide gas in mice. IJPSR, 2012; 3(6): 1668-1674.
 15. Ahmad R, Raja V, Sharma M. Hepatoprotective Activity of Ethyl Acetate Extract of *Adhatoda vasica* in Swiss Albino Rats. Int J Cur Res Rev., 2013; 5: 16-21.
 16. Chavan R, Chowdhary A. *In vitro* Inhibitory Activity of *Justicia adhatoda* Extracts against Influenza Virus Infection and Hemagglutination. Int. J. Pharm. Sci. Rev. Res., 2014; 25(2): 231-236.
 17. Shahriar M. Phytochemical screenings and thrombolytic activity of the Leaf extracts of *Adhatoda vasica*. International Journal of Sciences and Technology. The Experimen. 2013; 7(4): 438-441.
 18. Ramachandran J, Sankaranarayanan S. Antifungal Activity and the mode of Action of Alkaloid Extract from the Leaves of *Adhatoda vasica*. International Journal of Ethnomedicine and Pharmacological Research. 2013; 1(1): 80-87.
 19. Al-Shaibani RM, Phulan MS, Arioand A, Qureshi TA. Ovicidal and Larvicidal Properties of *Adhatoda vasica* (L.) Extracts Against Gastrointestinal Nematodes of Sheep *In vitro* Pakistan Vet. J, 2008; 28(2): 79-83.
 20. Mohan Y, Patil R, Vadivelan SP, Dhanabal MN, Kumar S. Anti-oxidant, anti-inflammatory and anticholinergic action of *Adhatoda vasica* Nees contributes to amelioration of diabetic encephalopathy in rats: Behavioral and biochemical evidences. International Journal of Diabetes in Developing Countries., 2014; 34(1): 24-31.
 21. Kumar D, Panda JL, Lavanya P, Ramaiah S, Anbarasu A. Detection and Confirmation of Alkaloids in Leaves of *Justicia adhatoda* and Bioinformatics Approach to Elicit Its Anti-tuberculosis Activity. Appl Biochem Biotechnol, 2012. DOI 10.1007/s12010-012-9834-1.
 22. Arun K Yadav, Tangpu V. Anticestodal activity of *Adhatoda vasica* extract against *Hymenolepis diminuta* infections in rats. Journal of Ethnopharmacology., 2008; 119: 322-324.
 23. Avula B, Begum S, Ahmed S, Choudhary MI, Khan IK. Quantitative determination of vasicine and vasicinone in *Adhatoda vasica* by high performance capillary electrophoresis. Pharmazie., 2008; 63: 20-2.
 24. Shirish S Pingale. Hepatosuppression by *Adhatoda vasica* against CCl4 Induced Liver Toxicity in Rat. Pharmacologyonline, 2009; 3: 633-639.
 25. Wasserman H, Kuo Gh. The chemistry of vicinal tricarbonyls, an efficient synthesis of vasicine Tetrahedron Lett., 1991; 32: 7131-7132.
 26. Apooshan PG, Sundar K. Anti-Ulcer activity of *Adhatoda vasica* Leaves against Gastric Ulcer in Rats Anti-Ulcer activity. journal of Global Pharma Technology., 2011; 3(2): 7-13.
 27. Dorsch W, Wagner H. New antiasthmatic drugs from traditional medicine. Int Arch Allergy Appl Immunol, 1991; 94(1-4): 262-5.
 28. Dhuley JN. Antitussive effect of *Adhatoda vasica* extract on mechanical or chemical stimulation-induced coughing in animals. J Ethnopharmacol 1999; 30 67(3): 361-5.
 29. Lahiri PK, Pradhan SN. Pharmacological investigation of vasicinol, an alkaloid from *Adhatoda vasica* Nees. Indian Journal of Experimental Biology 1964; 2: 219.
 30. Bhargava MK, Singh H, Kumar A. Evaluation of *Adhatoda vasica* as a wound healing agent in buffaloes. Clinical, mechanical and biochemical studies. Indian Veterinary Journal, 1988; 65(1): 33.
 31. Shrivastava N, Srivastava A, Banerjee A, Nivasarkar M. Anti-ulcer activity of *Adhatoda vasica* Nees. J Herb Pharmacother, 2006; 6(2): 43-9.
 32. Chaturvedi GN, Rai NP, Dhani R, Tiwari SK. Clinical trial of *Adhatoda vasica* syrup (vasa) in the patients of non-ulcer dyspepsia (Amlapitta). Ancient Science of Life, 1983; 3(1): 19.
 33. Rabinovich MI, Leskov AI, Gladkikh AS. Cholegic Properties of peganine. Vrachei, 1966; 181.
 34. Paliwa JK, Dwivedi AD, Sihgh S, Gupta RC. Pharmacokinetics and in-situ absorption studies of a new anti-allergic compound 73/602 in rats. Int J Pharm, 2000; 197(1-2): 213-20.
 35. Wagner H. Search for new plant constituents with potential antiphlogistic and antiallergic activity. Planta Med, 1989; 55(3): 235-41.
 36. Narimaian M, Badalyan M, Panosyan V, Gabrielyan E, Panossian A, Wikman G. Randomized trial of a fixed combination (KanJang) of herbal extracts

- containing *Adhatoda vasica*, *Echinacea purpurea* and *Eleutherococcus senticosus* in patients with upper respiratory tract infections. *Phytomedicine*, 2005; 12(8): 539-47.
37. Grange JM, Snell NJC. Activity of bromhexine and ambroxol, semi-synthetic derivatives of vasicine from the Indian shrub *Adhatoda vasica*, against *Mycobacterium tuberculosis* in vitro. *Journal of Ethnopharmacology* 1996; 50(1): 49.
 38. Claeson UP, Malmfors T, Wikman G, Bruhn JG. *Adhatoda vasica*: a critical review of ethnopharmacological and toxicological data. *Journal of Ethnopharmacology*, 2000; 72: 1.
 39. Pahwa GS, Zutshi U, Atal CK. Chronic toxicity studies with vasicine from *Adhatoda vasica* Nees. in rats and monkeys. *Indian J Exp Biol*, 1987; 25(7): 467-70.
 40. Gupta OP, Anand KK, Ghatak BJ, Ray, Atal CK. Vasicine, alkaloid of *Adhatoda vasica*, a promising uterotonic abortifacient. *Indian Journal of Experimental Biology*, 1978; 16(10): 1075.
 41. Atal CK. The chemistry and pharmacology of vasicine, a new oxytocic and abortifacient. Regional Research Laboratory, CSIR, Jammu-Tawi, 1980.
 42. Nath D, Sethi N, Singh RK, Jain AK. Commonly used Indian abortifacient plants with special reference to their teratologic effects in rats. *J Ethnopharmacol.*, 1992; 36(2): 147-54.
 43. Srivastava AS, Saxena HP, Singh DR. *Adhatoda vasica*, a promising insecticide against pests of storage. *Lab Dev* 1965; 3(2): 138.
 44. Saxena BP, Tikku K, Atal CK. Insect antifertility and antifeedant alleochemicals in *Adhatoda vasica*. *Insect Sci Appl*, 1986; 7(4): 489.
 45. Anonymous: The Ayurvedic Pharmacopeia of India, part I, vol I, Dept. of Ayush, Ministry of health & family welfare, New Delhi, 2004: 173-74.
 46. Sharnagadhar: Sarngadhar Samhita, Madhyamkhanda, 1/34, Shailaja S. editor, Chaukhambha Orientalia, Varanasi, 2011; 133.
 47. Anonymous: The Ayurvedic Pharmacopeia of India, part II Vol- I, Dept. of Ayush, Ministry of health & family welfare, New Delhi, 2004; (11): 46-48.
 48. Anonymous: The Ayurvedic formulary of India, Part 1, Dept. of Ayush, Ministry of health & family welfare, New Delhi, 2003: 92.
 49. Anonymous: Review on Indian medicinal plants, Indian council of medical research, New Delhi, 2004; 1: 259.
 50. Jaya kachchhwaha, Meenakshi Kumawat, Ayush Kumar Garg, Chandan Singh, Dilip Gehlot, Manoj Kumar Adhlakha, Role of Medicinal Herbs in the Management of Gridhrasi (Sciatica): An Ayurvedic Approach *WJPR*, 2018; 17(4): 420-432.
 51. Meenakshi Kumawat, Jyoti Damor, Jaya Kachchhwaha, Ayush Kumar Garg, Chandan Singh. Pharmacological Properties and Therapeutic potential of *Syzygium Cumini* (Jamun): A Review. *World Journal of Pharmaceutical Research.*, 2018; 7(3): 312-322.
 52. Meenakshi Kumawat, Jyoti Damor, Jaya Kachchhwaha, Mayukh Sharma, Harish Vishnoi, Chandan Singh. Role of Medicinal Herbs in the Management of Amawata (Rheumatic Arthritis): An Ayurvedic Approach. *International Journal of Ayurveda and Pharma Research.*, 2018; 6(1): 62-68.