Review Article

www.ijrap.net (ISSN:2229–3566)

ADHATODA VASICA (VASAPATRA): A REVIEW BASED UPON ITS MEDICINAL PROPERTIES

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Received on: 03/05/21 Accepted on: 19/06/21

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DOI: 10.7897/2277-4343.120379

ABSTRACT

Adhatoda vasica (L.) Nees is also known as *Justicia adhatoda* L. belongs to the family Acanthaceae and is considered the most significant plant in the world. It is commonly known as Vasaka, Vasica, Adosa, Malbur nut and is distributed in various regions of India and throughout the world. It is a well-known plant in Ayurveda and Unani medicinal system. This plant has been used in the indigenous medicinal system of India for more than 2000 years. The plant has great medicinal importance and is used to treat various diseases and disorders mainly respiratory tract diseases like cough, symptoms of common cold, asthma, tuberculosis and chronic bronchitis. All the parts of the plant are used in medicines. Vasicine is the main chemical constituent present in this plant which possesses various medicinal properties and is used in different Ayurveda formulations. Also, it contains various reported pharmacological properties like antispasmodic, sedative, expectorant, antitussive, oxytocic, antibacterial, anti-diabetic, wound healing, abortifacient, antiasthma and anti-pyorrhea.

Keywords: Vasapatra, Ayurveda, Rasapanchak, Pharmacological properties

INTRODUCTION

Herbal plants play a significant role in human life as we all are dependent on plants for our livelihood. Herbal medicine is an old practice of healing and originated from ancient Greek in 1600 BC. According to WHO (World health organization), there are about 6000 higher plant species found in India out of which 40% of the species are used in the traditional healthcare system. Most of the plants possess medicinal properties and are used to cure various ailments[1]. There are about 258,650 species of higher plants reported worldwide out of which 10% of the plants are used by different cultures and communities to treat a variety of diseases[2]. The medicines derived from these herbal plants have been used by the different medicinal systems such as Ayurveda, homeopathy, Naturopathy, Siddha, Unani to cure different types of diseases[3].

Adhatoda vasica Nees (Figure 1) also known as "vasaka, adosa, Malabur nut tree" belongs to the family Acanthaceae. It is also known as *Justicia adhatoda* synonymously. It is considered the most significant drug in Ayurveda and Unani medicinal systems[4,5]. The plant is small evergreen mainly found in the plains regions of India, Sri Lanka and Burma[6]. This plant has been used for 2000 years to treat respiratory problems and it was also said by ancient Indians," No man suffering from phthisis needs despair as long as the Vasaka plant exists". The leaves of this plant give a stimulant effect on the respiratory system[7]. In Ayurveda medicinal system it is considered a prime herb to cure diseases like cough, symptoms of cold, asthma, bronchitis[8]. This plant is treated like a mother to doctors in the traditional medicinal system of India therefore known as Vaidyamata singhee in Sanskrit[9]. The major constituent reportedly present in the *A. vasica* plant is Vasicine that is a quinazoline-type alkaloid that is of great medicinal importance[10]. The plant is known to have a rich source of Vitamin C, carotene and essential oil, Phenolics, flavonoids, sterols[11,12]. In Ayurveda medicinal system, it is used to cure various diseases like Shwasa (dyspnea), ksaya (phthisis), Kasa (cough), Raktapitta (hemorrhagic disease) Kamala (jaundice) and Kushtha (skin disease)[13]. The source of the therapeutic drug 'Vasaka' is considered for its indigenous system of medicine. It contains various therapeutical properties including cardiovascular protection, ant tubercular, antiulcer, anti-asthmatic, hepatoprotective, antibacterial, antitussive, ant mutagenic, antibacterial, abortifacient[14]. This plant is known by different names in different states of India and other countries as shown in Table 1.

Table 1: Vernacular names for *Adhatoda vasica*

Hindi	Adosa, adalsa, vasaka
Sanskrit	Shwetavasa, vasa, vasaka, Vaidyamata singhee
Bengali	Basak
Tamil	Adatodai
Marathi	Vasuka
Telugu	Adasaram
Malayalam	Ata- lotakam
Gujarati	Aradusi, adusa
Punjabi	Bansa, basuti, bhekkar
English	Malabur nut
China	Ya-Zui-Hua
Manipuri	Nongmangkha-agouba
Kannada	Adusoge
Arabic	Adusha[15-18]

Table 2: Botanical Classification of *Adhatoda vasica*

Taxonomical Rank	Taxon
Kingdom	Plantae
Division	Angiosperms
Class	Eudicots
Order	Lamiales
Family	*Acanthaceae*
Genus	*Justicia*
Species	*J. adhatoda*
Common name	Adulsa (Vasaka)[19,20]

Distribution

Botanical description of *Adhatoda vasica*

Adhatoda vasica is a small, dense, perennial, thickly branched, evergreen shrub that belongs to the family Acanthaceae. The height of this plant reaches up to 1-3 to 6 meters[21]. It contains long opposite branches. The stem is woody from the abaxial side and herbaceous from the adaxial side. Flowers are large, dense, terminal spikes with large bracts, bisexual, zygomorphic, small, irregular, hypogynous, white, pink or purple in appearance with length 1.9-2.2 cm and breadth 2.2 cm - 0.8 cm[22,23]. The taste and smell of the plant are unpleasant and bitter[24]. Leaves of the plant are simple, dark green, tapering base; reticulate, opposite, short peduncle, elliptic-lanceolate or ovate-lanceolate, hairy with breadth 4-7 cm and 7-19 cm long[25]. The fruit of this plant is small, clavate and longitudinally capsulated having four globular seeds with length 5-6 mm[26].

Figure 1: *Adhatoda vasica* (*J. adhatoda*)

Geographical distribution of *Adhatoda vasica*

Adhatoda vasica is an evergreen shrub that is native to the Indo-Malayan region. This plant is distributed in countries like Sri Lanka, Nepal, Germany, Pakistan, Burma, Malaysia, India, Southern China, Myanmar, Laos, Malay-Peninsula and the Indonesian Archipelago[27,28]. In India, it is mainly grown in tropical and subtropical regions especially in the lower Himalayas at an altitude of 1350 m. It is mainly found in states like Punjab, Bengal, Manipur, Kerala[29-31].

Phytochemical constituents of *Adhatoda vasica*

There are different chemical compounds found in the plant of *Adhatoda vasica*. The leaves, roots, seeds, fruit, flower stem contain several chemical constituents which include essential oils, fats, sugar, gum, resins, amino acids, proteins and Vitamin C[32]. The analysis results showed that the leaves of *J. adhatoda* contain phenols, flavonoids, alkaloids, anthraquinone, saponins and reducing sugar[33]. Pharmacologically, the most studied phytochemical constituent is bitter quinazoline alkaloid, Vasicine (1, 2, 3, 9-tetrahydropyrrole [2, 1-b] quinazoline-3-ol, $C_{11}H_{12}N_2O$) found in flowers, roots and leaves[34]. The synthesis of Vasicine is done by adding 2- amino benzylamine to vicinyl vasicinone tricarbonyl reagent[35]. The other triterpenoid 3-hydroxyl- D- friedoolean-5-ene with two other compounds named epitaraxerol and peganidine are also found in aerial parts of *Adhatoda vasica* Nees. Major trace elements such as K, Na, Ca, Mg and minor trace elements like Zn, Cu, Cr, Ni, Co, Cd, Pb, Mn and Fe are also found during elemental analysis using atomic absorption spectrometry[36]. The structures of some major phytochemicals are shown in Figure 2.

Leaves

The two major alkaloids present in this plant are Vasicine (0.85%) and vasicinone (0.027%) that are present in leaves and roots[37]. 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[38-40].

Flower

It contains triterpenes (alpha- amyrin), flavonoids (Astragalin, Kaempferol, Quercetin, Vitexin, Apigenin), 4-dihydrochalcone-4 - glucoside and alkanes[41-43].

Root

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. β- glucoside-galactose, sitosterol and deoxyvascine extracts are also found in the root part of the plant[44].

Seeds

Seeds 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%[45].

Traditional and Modern view

Folk Uses

Adhatoda vasica commonly known as vasica or *J. adhatoda* is the most important Ayurvedic herb which is mainly used in respiratory diseases including chronic bronchitis, whooping cough and asthma for both children and adults[46]. Glycodin, which is a significant product isolated from the leaves of *Adhatoda vasica* is used to cure bronchitis. Reported studies revealed that the leaves of the *A. vasica* plant are used to induce abortion by 70% of the pregnant women in Gora village of Lucknow (Uttar Pradesh, India)[47]. In Sri Lanka, it is used as a sedative expectorant to treat excessive phlegm (mucus with bacteria, the debris a sloughed-off inflammatory cells) and menorrhagia (a disorder of endometrial lining of the uterus). It acts as an antispasmodic and anthelmintic drug and is also used to treat diseases like bleeding piles, impotence and sexual disorders[48]. As the plant is a rich source of Vitamin C it possesses various therapeutic properties like anti-inflammatory, anti-bleeding, anti-jaundice, anti-diabetic, disinfectant[49]. Also, the plant has been used to treat cold, cough, pneumonia, fever, jaundice, whooping cough, catarrh, asthma and whooping cough[50]. Traditionally, various parts of the plant are used to treat diseases like asthma, joint pain, sprains, lumbar pain, malaria, cold, cough, eczema, rheumatism, swelling and venereal disease[51]. In England, the fluid extracted from its leaves used as an antispasmodic, expectorant and febrifuge. It is also advantageous against typhus fever, Diphtheria and intermittent[52]. The leaves of this plant are used as a spasmolytic agent and as an expectorant in Germany[53]. In Sweden, the extract of the *Adhatoda vasica* plant is used to prepare medicine against cough[54]. Various parts of the plant play a significant role to cure different diseases.

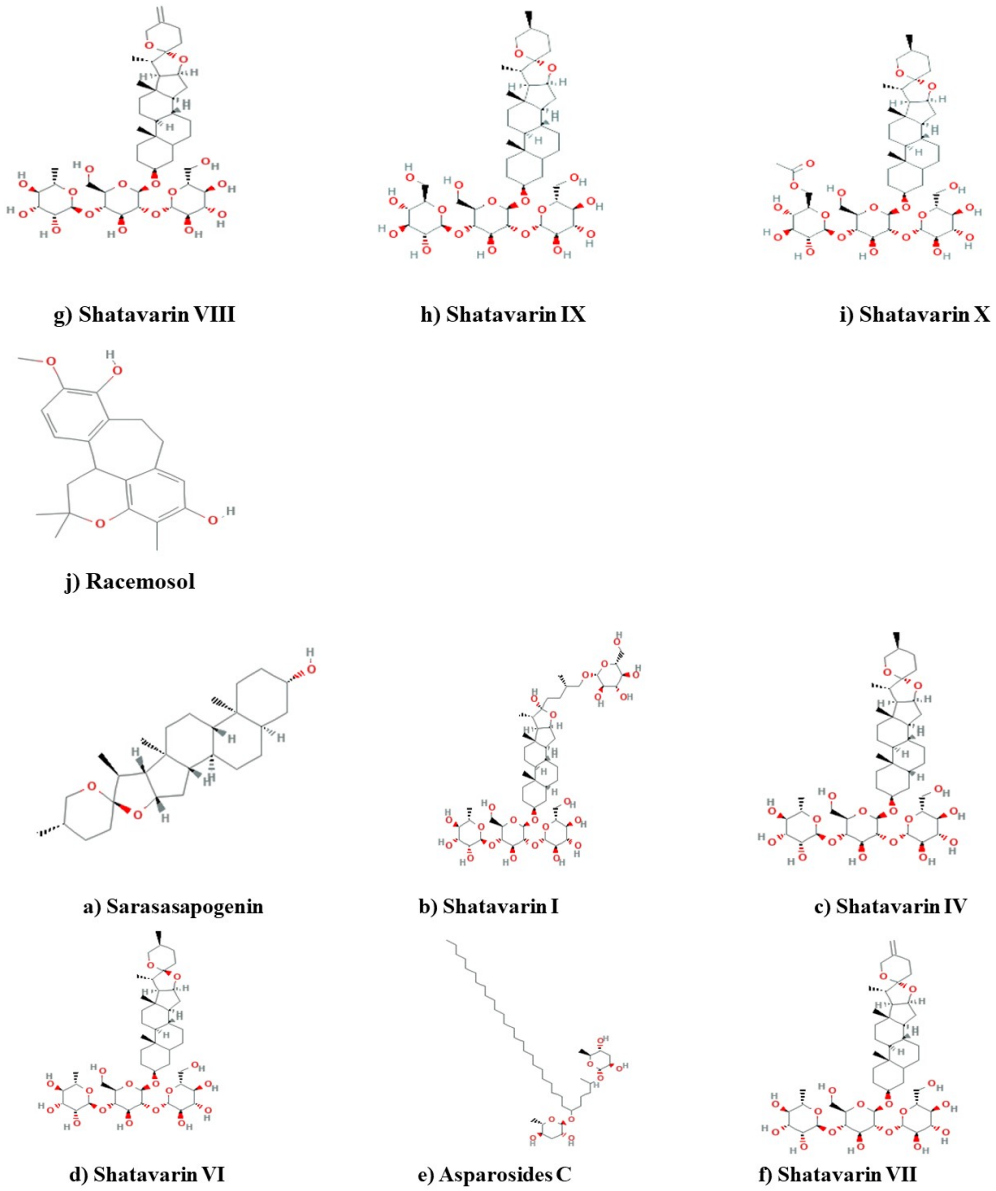

Figure 2: Chemical structures of some major phytochemical constituents of *Adhatoda vasica*

Whole plant

The plant extract is utilized as an ingredient like in cough syrup when mixed with Ginger and Tulsi where it acts as an expectorant and antispasmodic agent. It also acts as a curative agent against various diseases like bleeding piles, phlegm, menorrhagia, impotence and sexual disorders[55].

Leaves

Chewing of leaf buds alone or with the root of ginger helps clears the respiratory passage. In southeast Asia, leaf extracts are used to treat various diseases like hemorrhage, skin diseases, wounds, headache and leprosy[56,57]. In India and Sri Lanka, the fresh leaves of the plant are used against snake bites[58]. The smoke of the leaves is used to detect the urinary problem and postpartum hemorrhage. The powder form of the leaves when boiled with sesame oil is used against earaches, jaundice and pus from ears and to stop bleeding[59]. Leaf ash and leaf extracts are utilized against asthma, tuberculosis, bronchitis, antipyretic and acidity[60]. Also, it was used against stomach catarrh with constipation, urinary stone and gout[61].

Fruit

It is used to treat diseases like jaundice, diarrhea, dysentery, fever, laxatives, bronchitis, cold and acts as an antispasmodic agent[56].

Flower

In South-East Asia, various formulations of the flower are used to cure a cold, phthisis, bronchitis, cough, fever, gonorrhea. The fresh leaves of the plant are used to treat ophthalmia. Also, the flower act as an antiseptic used to boost blood circulation[56].

Root

Root extracts are used by rural people to cure cough, cold, diabetes and liver diseases[62]. In South-East Asia the powder, paste and root extracts are used to treat diphtheria, malarial fever, leucorrhoea and tuberculosis and eye diseases. In the Sitapur district of Uttar Pradesh (India), root paste in combination with sugar is used to cure acute nightfall problems[63]. Besides, the liquefied roots are applied over the vagina and pubic region which help in parturition[64].

Adhatoda vasica (Vasaka) in Ayurveda

Adhatoda vasica is considered as the prime herb in Ayurveda medicinal system and is used to cure various diseases[65]. In Ayurveda, this plant is mainly used to cure respiratory disorders which include bronchitis, asthma, cough and symptoms of a common cold. In the Indigenous system of medicine, it is known by the name Vasaka or Vasa which is used to cure bronchitis[66]. As the plant contain various therapeutic properties, *J. adhatoda* plant is prescribed by various Ayurvedic practitioners to cure diseases like malarial fever caused by pitta and Kapha, intrinsic hemorrhage, cough, asthma, chronic fever, leprosy, skin diseases and piles[67].

Ayurvedic Formulations

The leaf juice of the Vasaka plant (Vasa Swarasa) is assimilated in the production of more than 20 products which include Vasarishta, Mahatikataghrita, Triphala ghrita, Vasavaleha, Vasakasava, Mahatriphalaghrita, Panchatikta ghritaguggulu and Panchatikta ghrita[68]. Other formulations of the Vasa plant are Vasa Avaleha (sugar formulation of *A. vasica* leaves), Vasa ghrita (clarified butter of *A. Vasica* leaves), Vasa Asava/Arista (alcoholic preparation pf A. vasica leaves)[69].

Table 3: Rasapanchak (properties) of *Adhatoda vasica* in Ayurveda

Sanskrit / English	Sanskrit / English
Virya/Potency	Sheeta/ cold
Vipaka (Metabolic property)	Katu/astringent, laghu/light
Guna (Physical property)	Laghu/light
Rasa (taste)	Tikta/bitter, Kashaya/ astringent

Karma (Action)

Hridya: It act against heart diseases
Kaphapittahara; It act against digestion problem, heartburn, arthritis
Raktasangrahika: It helps in blood circulation.
Kasaghna: It is used against cough and cold.

Properties of Vasaka plant

Raktapitta: It is used to cure hemorrhagic disorder/purpura.
Kasa: It is used against cough and cold.
Jwara: It is used to cure fever.
Kshaya: It is used in the treatment of Phthisis.
Rajayakshma: It is used to cure tuberculosis
Parshvashula: It is used to cure pain in flanks.
Hritshula: It is used to treat cardiovascular diseases like angina pectoris.
Shotha: It is used to cure oedema.

Modern view

The consumption of herbal medicines has increased world widely. Reported studies have revealed an increased growth in the sale of herbal products from the year 2000 to 2008 ranges from 3% to 12% per year[70]. Due to the increased demand for herbal products, the risk with the herbal medicines also rises as the quality of the end product compromises because of the contaminated raw material with toxic metals, microbes and other residues, adulteration (addition of fake or inferior plant material, orthodox drugs, foreign material) which results in the poor quality of raw material and end product[71]. Internal issues like non-uniformity (rises due to environmental factor and geographical distribution, use of pesticides, fertilizers) and complexity in the ingredients of herbal medicines also rises which is affecting the quality of herbal medicines[72]. Lack of standardization techniques is also responsible for the poor quality of drugs as it fails to detect the original drug which exploits its usage in the conventional system of medicines[73]. The development of new dosage formulations without affecting the principal component is the present-day need. There are various formulations produced from the plant *J. adhatoda.* One of the formulations of this plant is Vasa candy which is a more stable, palatable dosage prepared from this plant Other formulations include Adusa cough syrup, Adusa tablet, Avaleha that are significant drugs prepared from this plant without disturbing the basic principle structure[74].

Pharmacological and therapeutic uses

Anti-asthmatic and bronchodilator Activity

The alkaloid constituents mainly Vasicine and vasicinone possess medicinal properties against respiratory disorder. The extracts of leaves and roots showed soothing effects against the throat, to cure bronchitis, bronchiole and lung disorder and act as an expectorant[75]. The experiment was conducted in anesthetic guinea pigs and rabbits and unaesthetic guinea pigs that showed the antitussive property[76]. Reported studies revealed the bronchodilator activity of Vasicine when experimented with both *in vitro* and *in vivo*[77].

Anti-allergic Activity

Reported studies revealed that the vasicinone constituent of *J. adhatoda* plant possesses ant allergic property when tested in mice, rats and guinea pig[78]. The Methanolic extract of the plant when tested against guinea pig possess anti-allergic and anti-asthmatic activity when inhaled or administered at 6 mg dosage per animal or 2.5 gm/kg respectively[79].

Abortifacient and uterotonic Activity

The *in vivo* and *in vitro* studies were carried out to detect the uterotonic activity of *J. adhatoda* plant which is similar to the oxytocin and methylergometrine. It was also reported that the Vasicine component possesses abortifacient activity[80]. The study was carried out in rats, guinea pigs, hamsters and rabbits. It was found that Vasicine possesses abortifacient property and acts through the release of prostaglandin hormones[81].

In vitro studies were carried out in synthesized derivatives of Vasicine and Vasicinone demonstrated to have oxytocic activity at a dosage above 1 µg/ml[82]. When studied in the albino rat model, it was found that the aqueous extract of leaves revealed 100% abortifacient activity when given in 175 mg/kg dosage[83].

Expectorant Activity

From the reported studies it was found that the petroleum ether extract of the leaves possesses expectorant activity when given at a dose of 50 mg/kg[84].

Anti-tubercular Activity

From the reported study it was found that the *Adhatoda vasica* plant possesses anti-tubercular activity. The *in-vitro* study was carried out against *Mycobacterium tuberculosis* revealed that the Bromohexine and ambroxol the two derivatives of Vasicine showed a growth inhibitory effect on *M. tuberculosis*[85,86].

Anti-inflammatory Activity

The main alkaloid component Vasicine of *J. adhatoda* plant possesses anti-inflammatory properties[87]. The modified hen's egg chorioallantoic membrane test was conducted to evaluate the anti-inflammatory activity of Methanolic extract (non-alkaloid fraction saponins and alkaloid) constituent of *J. adhatoda* plant. Results showed the alkaloid content showed potent activity at 50 mg/kg dosage equivalent to hydrocortisone while Methanolic extracts possess less activity[88].

Hepatoprotective Activity
The ethyl acetate extract of *Adhatoda vasica* possesses hepatoprotective activity when tested against CCL_4 induced liver damage in Swiss albino rats at 50-100 mg/kg dosage[89].

Radio modulatory Activity

The leaf extract of the plant possesses radio modulation activity against radiation-induced hematological alteration when studied in peripheral blood of Swiss albino mice. Results showed a significant increase in serum alkaline phosphatase but decreased activity of acid phosphatase was observed in leaf extract pretreated irradiated animals during the entire study[90].

Anti-microbial Activity
Reported studies have revealed the anti-microbial activity of the alcoholic and water extracts of leaves and roots of *J. adhatoda* plant when tested against *Staphylococcus aureus* and *E. coli*[91].

Anti-bacterial Activity
The *in vitro* studies against *Pseudomonas aeruginosa* showed the strong anti-bacterial activity of the alkaloid content extracted from leaf extract of *J. adhatoda* plant using a paper disc and dilution method. Various reported studies also revealed the antibacterial activity of the plant against gram-positive bacteria strains *Streptococcus faecalis*, *Staphylococcus aureus*, *Staph epidermidis* and gram-negative *E. coli*[92].

Immunomodulatory Activity
Various experimental studies demonstrated that diethyl ether, chloroform and Methanolic extract isolated from leaves of *Adhatoda vasica* possesses the immunomodulatory property. To find out the immunomodulatory activity, the study was carried out in male Wistar rats administered with an oral dosage of 400 mg/kg resulted in an increasing percentage of neutrophil adhesion to nylon fibers and boost the immunity of the host[93].

Antiulcer Activity
Previous studies revealed that the ethanolic extract of leaf powder showed antiulcer activity when tested in an ethanol-induced rat model[94].

Wound healing Activity
From various reported studies it was found that the alcoholic and chloroform extracts isolated from leaves of *J. adhatoda* plant showed healing effect and act as an ointment. It was also reported that the healing rate is higher in buffaloes as compare to pancreatic tissue extracts[95].

Hypoglycemic/ Anti-diabetic Activity
The experimental studies revealed that the ethanolic extract of the plant possesses anti-diabetic properties when tested in rats[96]. Other reported studies also demonstrated that the leaves of the plant when administered orally in suspension form lower down the blood sugar level of rabbits for short time at 25 mg/kg dosage[97].

Anticholinesterase Activity
The experimental studies showed that the Vasicine constituent extracted from the roots possesses anticholinesterase activity and produced transient hypotension in cats, depression of isolated heart and contraction of the isolated intestine in guinea pigs[98].

Clinical studies

Oxytocic effect
The safe study was conducted on 24 human volunteers with Vasicine hydrochloride at 16 mg dosage. Vasicine hydrochloride was given on the 2nd to 8th day of normal puerperium. It was found that after Vasicine treatment, the uterus became firm and contracted which showed its oxytocic effect[99].

Dyspepsia/ Gastric acidity
The experimental study was conducted in 20 patients of Amlapitta (Dyspepsia) where 60 ml dosage of *A. vasica* syrup (30 g of the crude drug) was given daily for six weeks in four divided doses. It was observed that gastric acidity was reduced in 85% of the patients[100].

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[101].

Asthma and bronchitis
The comparative study was conducted to assess the efficacy of Vasa-arishta and Vasaka asava on 24 patients of Shwasa. The effective results were found more in Vasa arishta group whole improvement was observed in Vasaka asava treated group[102].

The other study was conducted in 32 patients of Shwasa which were divided into 3 groups consisting of Vasa avleha, Vasa arishta and Vasa ghrita. It was found that Vasa avleha showed more effective results than the other two. From other clinical studies, it was found that Vasa avleha (prepared from Swarasa) gives effective clinical results as compare to Vasa avleha prepared from Kwatha[102].

Toxicity of Vasapatra
Usually, there are no side effects of *J. adhatoda* plant when experimented for study purposes. There is no mentioned data of this drug that showed its adverse effects. The only data found is that when it is taken in high dosages, it leads to diarrhea and vomiting.

CONCLUSION

From various reported studies it is clear that *Adhatoda vasica* plays a significant role in the herbal medicinal system. This plant is used in Ayurveda and Unani medicinal systems from ancient times. The traditional and Ayurvedic view of this plant is briefly discussed in the current study. It is widely studied for its chemical constituents and therapeutical properties. This plant is a rich source of Vitamin C, Vasicine, Vasicinone and other alkaloids components. Various scientific studies revealed that the Vasaka plant possesses different pharmacological properties proved by many experimental studies like antifungal, antitussive, antiulcer, abortifacient, hypoglycemic, anti-tubercular, anti-inflammatory, radio modulatory, antiviral, hepatoprotective. Scientific studies revealed that the formulations made from this plant are beneficial to human use especially in respiratory diseases.

Table 4: Some experimental and clinical studies of *Adhatoda vasica* plant

Extract	*in vivo* / *in vitro* model	Pharmacological activity	Reference
Leaf and root extract	Guinea pig, Rabbit	Anti-asthmatic and bronchodilator	75,76,77
Methanolic extract	Mice, rat, guinea pig	Anti-allergic and anti-asthmatic	78,79
Aqueous extract	Albino rat, guinea pig, hamster and rabbit	Abortifacient and uterotonic	80,81,82,83
Petroleum ether	mice	expectorant	84
Bromohexine and ambroxol derivative of Vasicine	*Mycobacterium tuberculosis*	Anti-tubercular	85,86
Methanolic and alkaloid content	Hen's egg chorioallantoic membrane test	Anti-inflammatory	87,88
Ethyl acetate	Swiss albino rat	hepatoprotective	89
Leaf extract	Swiss albino mice	radio modulatory	90
Alcoholic and water extract	*Staphylococcus aureus and E. coli*	Anti-microbial	91
Leaf extract	*Pseudomonas aeroginora, Staphylococcus aureus, Streptococcus faecalis, Staph epidermidis* and *gram negative E. coli.*	Anti-bacterial	92
Methanolic, diethyl ether, chloroform	Male Wistar rat	Immunomodulatory	93
ethanolic	Rat model	Anti-ulcer and anti-diabetic	94,96,97
Alcoholic and chloroform	buffaloes	Wound healing	95
Root extract	Cat, guinea pig	Anticholinesterase	98
Vasicine hydrochloride	24 human volunteer (clinical study)	Oxytocic effect	99
Crude drug (A. vasica syrup)	20 human volunteer (clinical study)	Ant gastric / ant dyspepsia	100
Leaf extract	25 human volunteer (clinical study)	Anti- pyorrhea	101
Vasa arishta, Vasaka asava	24 human volunteer	Ant asthmatic	102

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Cite this article as:

Shailja Choudhary *et al*. *Adhatoda vasica* (Vasapatra): A Review based upon its Medicinal properties. Int. J. Res. Ayurveda Pharm. 2021;12(3):79-87 http://dx.doi.org/10.7897/2277-4343.120379

Source of support: Nil, Conflict of interest: None Declared