



Review

A comprehensive Review on Phyto-Pharmacological Potential of *Justicia adhatoda*

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Abstract

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Herbs have always been a source of new medicine since ancient times. Consequently, the use of alternative medicines such as herbal products has been increasing over the last decades gaining popularity among the public and health care professionals. The *Justicia adhatoda L.* is a species of the Acanthaceae family, an iconic native plant of the Indian subcontinent. It is mentioned for its traditional use in the WHO basic health care guidelines. Primarily it is used to treat a variety of ailments in the alternative system of medicine. The plant possesses a substantial number of phytochemicals such as alkaloids, triterpenoids, flavonoids, proteins, carotene, amino acids, and vitamin C, found in roots and leaves like vasicine, vasicoline, vasicinone, adhatodine, vasicolinone, and anisotine exhibiting diverse pharmacological effects. A few of the chronic medical conditions that are treated by *Justicia adhatoda* include bronchodilator, anti-microbial, hepatoprotective, anti-asthmatic, antibacterial, anti-arthritis, anti-inflammatory, cardioprotective, anti-cancer, and anti-allergic actions. The chief phytochemicals of the plant are vasicine and vasicinone, which have the major therapeutic effect of treating respiratory disorders. Hence this medicinal plant could be the source of new therapeutic drugs in the future.

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Introduction: *Justicia adhatoda* commonly known as Malabar nut, Vasaka, and Adulsa (the greater "neem")¹. The World Health Organization (WHO) estimates that 65–80% of developing nations rely mostly on ethnomedicine due to its accessibility and affordability for treating their basic health issues^{2,3}. The World Health Organization (WHO) manual mentions *Adhatoda vasica* (*A. vasica*) for its conventional application in primary healthcare⁴. *Adhatoda vasica* (L.), Nees is a shrub with opposing ascending branches of the acanthaceae family. This plant has been used in the Indian traditional system of medicine for 2500 years. The plant is widely used in Ayurvedic and Unani medicine as a medication. It has a long history of acute and chronic illnesses treatment. Studies have shown that it is particularly effective for bacterial infections, cough, bronchial infection, reproductive abnormalities, heart diseases, and many other ailments. *Adhatoda vasica* yielded several phytochemicals including alkaloids, flavonoids, tannins, etc. (*A. vasica*). Extract from *A. vasica* may be dangerous to people, especially pregnant women. Literature search elaborates that significant information on traditional usage and toxicological studies were carried out to assess its efficacy, relevance, and significance⁵.

It is an evergreen plant with a height range of 1 to 2.5 metres having bitter flavor and odour⁶. It has been used as medication for many years to cure multiple disorders in several medical systems such as Ayurveda, Siddha, Homeopathy, and Unani⁷. It has been concluded that more research should be done on the medicinal uses of this plant. The importance of *Adhatoda vasica* is highlighted by traditional and ethnomedical usage, this review tends to make use of the search and formulate herbal remedies without adverse effects⁴. Plant chemical analysis is of great importance for the treatment of diseases and to identify and isolate the active ingredients. Finding new active compounds can be aided by screening phytochemicals⁸.

Different parts of *Justicia adhatoda* used as medicine:

Root: Mature green leaves are used to heal fever, cough, asthma, and dysentery. Inflorescence and mature leaves are also used as food. The respiratory system is stimulated by the fresh leaves of *Justicia adhatoda* L¹⁰.

Flowers: In Ayurveda, a preparation named gulkand is made from *Justicia adhatoda* L. flowers and is used in the treatment of tuberculosis. Flowers, fruits, leaves, and bark are also known for the removal of intestinal parasites¹¹.

Bark or root: Its root and bark decoction have been administered for long-lasting comfort, particularly in the acute phases of bronchitis. To treat this issue, doses of 30 grams of the root and bark decoction are given twice or three times over the course of three days. Additionally, 2 to 4 grams of leaf juice are administered for the treatment of diarrhoea and dysentery¹².

Phytochemical Constituent: High concentrations of bio-nutrients and phytochemicals are found in medicinal plants, which also exhibit amazing bioactivities. Numerous human illnesses, including chronic conditions like coronary heart disease, diabetes, and cancer, have been linked to phytochemicals, which have been found to have great potential for treating them¹³. It is generally known that these phytochemicals are produced in response to a

need for self-protection given the extensive research done on the role of these compounds in plants. Additionally, phytochemicals protect plants from harm and illness while also influencing plant flavor, aroma, and color¹⁴. The leaves, flowers, fruit, stems, and roots of plants all contain biologically active components. These components function as a protective mechanism to deal with stress¹⁵. Phytochemicals are now understood to be the basic component of traditional herbal treatment leading to research studies for the treatment of disease conditions¹⁶. The presence of effective bioactive complexes, such as alkaloids, vitamins, organic acids, minerals, etc., is attributed to the variety of biological activities displayed by plants, such as hepatoprotective, anti-cancerous, cardioprotective, anti-malarial, anti-inflammatory, etc¹⁷. Multiple bioactive chemicals are present in *Justicia adhatoda* L., and its phytochemical composition can be utilized to create a variety of organic pharmaceuticals¹⁸. The various alkaloids present in *Justicia adhatoda* L. are its major chemical constituent. Important quinazoline alkaloids found in *Justicia adhatoda* L. include vasicine, vasicoline, vasicinone, adhatodine, vasicolinone, and anisotine. These complexes are responsible for a variety of pharmacological effects, including anti-inflammatory, antioxidant, antibacterial, antidiabetic, anti-depressant, and anti-cancerous². *Justicia adhatoda* L. has high levels of soluble proteins, phenols, and flavonoids in both its leaves and flowers, making it a species that is rich in phytochemicals¹⁹. Due to the presence of active chemicals that generate physiological activities in both the human and animal body, *Justicia adhatoda* L. is significant in medicine. It has been claimed that numerous plant parts contain bioactive elements like essential oil and quinazoline alkaloids¹².

The phytochemical examination of the Malabar nut (*Justicia adhatoda* L.) leaf extract revealed the presence of several different substances, including triterpenoids, saponins, flavonoids, polyphenols, alkaloids, anthraquinones, and phytosterols. N-oxides of vasicine, vasicine, maiontone, deoxyvasicine, and essential oils⁴. Additionally, it has also been reported that leaves contain anisotine and adhatodine. Vasicol and vasicinone have been isolated from the inflorescence²⁰. Essential oils, sugar, gum, resins, proteins, vitamin C, amino acids, and other chemicals are found in roots and leaves²¹. This plant is a possible source of essential oils because the leaves are abundant in carotene and vitamin C. It also comprises proteins and amino acids. Flowers contain large amounts of flavonoids and terpenes. Flavonoids include apigenin, astragalín, kaempferol, quercetin, and vitexin⁵. As a result, biological characteristics are often attributed to active chemicals produced by metabolic activities. *Justicia adhatoda*. root and fruit research reveals the presence of numerous additional significant elements as well, such as B-sitosterol²². The elements sodium (Na), potassium(K), copper(Cu), calcium(Ca), nickel(Ni), cobalt(Co), zinc(Zn), chromium(Cr), manganese(Mn), magnesium(Mg), palladium(Pd), iron(Fe), and cadmium(Cd) are particularly abundant in the different parts of *Justicia adhatoda*²³.

Vasicine and vasicinone are the key components of *Justicia adhatoda*, exhibiting biological properties, such as

anti-inflammatory, anti-allergic, antidiabetic, immunomodulatory, hypotensive, antioxidant, bronchodilator, antimalarial, and antibacterial²⁴.

Pharmacological Properties: *Justicia adhatoda* has numerous pharmacological properties which are described in figure 1. and the details are as follows.

Antimicrobial: *Justicia adhatoda* L. exhibits a broad spectrum of antibacterial activity and is a potential source of antibiotics that are useful in chemotherapy and the management of infectious disorders. According to the research study, plant extract can suppress the growth of bacteria, its plant-based antimicrobials are more potent and have fewer adverse effects³⁵. The plant extracts were produced using various solvents and evaluated the profound antibacterial activity and antimicrobial activity of *Justicia adhatoda* L. against several clinical pathogens including gram-positive and negative bacteria³⁶. When the antibacterial potential of fresh *Justicia adhatoda* leaves was tested, essential oil showed significant antimicrobial activity against both methicillin-sensitive and resistant *Staphylococcus aureus* as well as its clinical isolates³⁷.

Anti-asthmatic: The leaf and root extracts are used to treat cough and respiratory infections including bronchitis. The plant having expectorant property removes phlegm from the respiratory system relieving chest congestion³⁸. The plant had been used for the treatment of asthma as a bronchodilator. The vasicine and vasicinone are known for their respiratory system-healing properties^{39,40}.

Antidiabetic: Research studies claim that *A. vasica* also exhibits strong anti-diabetic properties⁴¹. One such research study proved that the methanolic leaf extract has strong anti-diabetic activity⁴². Along with lowering blood glucose levels, it also produces a positive response to depressive symptoms caused by diabetes⁴³. Another study showed that leaf extract yields a significant decrease in blood glucose levels as compared to root extract in mice with alloxan-induced diabetes. Additionally, significant changes were observed in the experimental animal's glucose tolerance, serum lipid profiles, glycosylated hemoglobin, and body weight indicating that *Justicia adhatoda* L. exerts protective effects against associated symptoms of the disease⁴⁴.

Anticancer: The Vaska plant is used by the people of Chhattisgarh (India) to prevent cancer because of its antioxidant properties⁴⁵. Research studies showed that *Justicia adhatoda* L. methanol extract significantly suppresses cancer cells⁴⁴ by significantly reducing the growth of cancer cells. The MTT assay was used to evaluate the cytotoxic potential of the methanolic and ethanolic extracts of *Justicia adhatoda* L.⁴⁶.

Insecticidal: A pesticide frequently used in India and throughout the world is *A. vasica*¹⁰. Various studies have addressed the use of this plant as a pesticide⁴⁷. Due to the presence of terpenoids, the leaf extract containing acetone exhibits strong insecticidal action against *Callosobruchus maculatus* in beetles⁴⁸. Along with its numerous therapeutic uses, it can also be used as a natural larvicidal agent. Four stored-grain insects were evaluated for resistance to the essential oils: *Stegobium panicum*, *Sitophilus oryzae*, *Rhizopertha dominica*, and *Bruchus chinensis*⁴⁹.

Thrombolytic and cardioprotective:

The thrombolytic natural substance may also exhibit cardioprotective effects. Alkaloids and terpenoids from the plant are known to have thrombolytic effects⁵⁰. The methanolic fraction of *Adhatoda vasica* leaf extract showed powerful thrombolytic activity⁵¹. Alkaloids, flavonoids, sterols, and glycosides are abundant in the plant reflecting diverse medicinal benefits, Cardioprotective being the most significant⁵². Vasicine and vasicinone were found to produce bradycardia.

Antituberculosis: Due to *Mycobacterium tuberculosis* multidrug resistance, anti-tubercular drugs result in complications⁵⁴. In Ayurveda, several herbal preparations are used to eradicate tubercular bacteria, one of which is made from Vaska (gulkand) flowers¹¹. The presence of vasicine causes this effect by indirectly raising the levels of lysozyme and rifampicin in the bronchioles¹¹. Triterpenes, anisotine, vasicine, vasicolinone, vasicolinone, vasicine, and vasicine are the anti-tubercular alkaloid components of the plant⁵⁵.

Analgesic and anti-inflammatory: Significant analgesic and anti-inflammatory actions were shown by *A. vasica*. as a polyherbal ayurvedic treatment for arthritis. This research reveals that the mixture has potent anti-inflammatory and analgesic properties depending on the dosage⁵⁶.

Uterine tonic: Abortion occurs when hydro alcoholic extract of *Justicia adhatoda* leaf (175 mg/kg) is taken orally for about 8-10 days¹⁰. Due to vasicine, it has considerable uterine tonic and abortifacient effects. The combined impact increases uterine contractions, which facilitates parturition. It was evaluated that it functions similarly to the hormone oxytocin and ergometrine³⁰. It has been demonstrated that vasicine stimulates the uterus and myometrium layer⁵⁷. The stage of pregnancy is affected by the activity and dose. Vasicine effects were increased when estrogens were used as priming agents, indicating that it releases prostaglandins⁵⁸. Vasicinol, an alkaloid from *A. vasica*, has been shown to block the oviduct and decrease fertility in insects⁴⁷.

Hepatoprotective: The plant exhibits a strong resistance against liver damage. At doses of 100 and 200 mg/kg, the ethyl acetate extract exhibits a highly substantial protective effect. It increases the liver marker enzymes that were decreased because of the liver injury⁵⁹. Another study using whole plant powder medicine likewise produced the same results, which were recorded for their hepatoprotective effects and numerous liver illnesses⁶⁰. In 2012, Saroj and Mishra chose a polyherbal formulation that contained vasicine and reported its liver-protective effects against paracetamol-induced hepatotoxicity⁶¹.

Antioxidant: Antioxidants are by-products of the several chain reaction pathways that produce free radicals⁶². Natural antioxidants can be found in large quantities in the leaves⁶³. The high concentration of polyphenols, which are mostly flavonoids and phenolic acids, reflects antioxidant properties⁷.

Immunomodulatory: For their immunomodulatory effects in the rat model, three different leaf extracts (methanolic, chloroform, and diethyl ether) from *A. vasica* (400 mg/kg) were validated: due to the high alkaloid

content, it is also used for its immunomodulatory properties. By taking leaf extracts orally, a neutrophil percentage that adheres to fibers increased significantly³⁰. **Antiulcer:** The pylorus ligation, ethanol, and aspirin-induced stomach ulcers are effectively treated by an ethanol extract of *A. vasica* leaves. However, the ethanol-induced stomach ulcer model in rats showed the best results. Another study illustrated that it has strong anti-ulcer properties and can also be used to treat dyspepsia by the formulation of syrup made from the extract of this plant⁶⁴.

Anti-allergic: The plant active ingredients vascinol and vasicine have anti-allergic properties because they prevent ovalbumin-induced allergic reactions in guinea pigs, rats, and mice models⁶⁵.

Antidiabetic: The effects of *Justicia adhatoda L.* leaf extract was investigated in rats with co-occurring depression and diabetes produced by alloxan. Increased levels of neuronal oxidative stress, which are a result of diabetes, may result in neuropsychological consequences like depression. Depression is the most common neurological complication in diabetic individuals⁴³.

Conclusion: In conclusion, the *Justicia adhatoda*, commonly known as the Malabar nut, has been used in traditional medicine for centuries to treat respiratory ailments such as coughs, colds, and asthma. The major biochemical present in *Justicia adhatoda L.* builds up its strong pharmacological profile viz., hepatoprotective, anti-fungal, anti-depressant, anti-bacterial, anti-diabetic, anti-allergic, antidiarrheal, anti-pathogenic, etc., which makes it a potent drug source and helpful to the mankind. Modern scientific research has confirmed many of the plant's traditional uses and has identified additional potential health benefits. However, it is important to note that more research is needed to fully understand the plant's mechanisms of action, potential side effects, and optimal dosages.

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Table 1. Phytochemicals in different parts of *Justicia adhatoda*

S.no	Parts of plant	Phytochemicals	References
1.	Leaves Roots	Vasicinone	25
2	Leaves Roots Flowers	Vasicine	25,26
3	Leaves Roots	Vasicinolone	27
4	Leaves	Vasicol	27
5	Leaves	Vasicoline	27
6	Leaves Roots	Adhatodine	25,5
7	Leaves	Adhava sinone	27
8	Whole plant	Carotene	27, 5
9	Leaves	Anisotine	28
10	Leaves	Vasicinol	29
11	Leaves	Vitamin C	12
12	Roots	B-sitosterol	30
13	Flower	Quercetin	5
14	Flowers	Kaempferol	30
15	Flowers	2'-4- dihydroxy chalcone - 4-glucoside	26
16	Seeds	Linoleic acid	4
17	Seeds	Oleic acid	4
18	Seeds	Be- humic acid	4

Table 2. Different parts of *Justicia adhatoda* used in different diseases

Parts of the plant	Disease/ pharmacological activity	References
Leaves, Roots, and Flowers	Antibacterial, Anti-inflammatory, Uterine stimulant, Thrombopoietic, Antioxidant, Hypotensive inhibitors of the HIV protease Inflammation-healing and liver protection, Respiratory stimulant	2,66,26
Roots and Leaves	Antitussive, Anti-cancer, Bronchodilator, Cardioprotective, Hepatoprotective, Uterine activity and wound healing	66,10
Roots	Antibacterial, Anti-Inflammatory, Anti-Cancer, Antifertility, Angiogenic, Antioxidant, Hepatoprotective, Immunomodulatory	26,67
Flowers	Antitumor, Antioxidant, Antiulcer, Antibacterial, Antiallergic, Antiviral, Anticancer, Antimalarial, Anti-inflammatory, Hepatoprotective, Cardioprotective, Neuroprotective	30,10,67
Seeds	Anticancer, Antiosteoporosis, Anti-inflammatory, Analgesic, gastro-protective activity, Neuroprotective, muscle relaxant, Hepatoprotective, Insecticidal	4
Leaves	Anthelmintics, Antitubercular, Cardioprotective, Hepatoprotective, Antiallergic, Respiratory diseases, Expectorant, Antiseptic, Diarrhea, Dysentery	30,25
Whole plant	Antioxidant and Cardioprotective activity	68

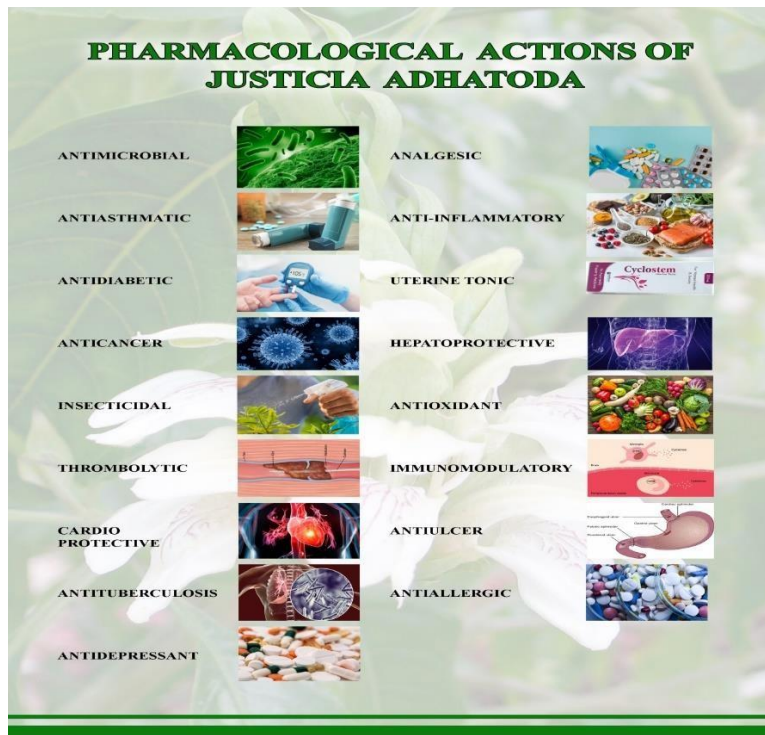


Figure 1. Pharmacological Properties of *Justicia adhatoda*.