

# Use of malabar nut (*Justicia adhatoda* L.) from traditional medicine to current pharmacopeia – A review study

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## Abstract

Malabar nut (*Justicia adhatoda* L.) is a smaller sub-herbaceous and an evergreen plant belonging to family Acanthaceae. Due to unique phytochemistry, this plant is considered to be a well-known drug in Ayurvedic and Unani system of medicines. It is worldwide in distribution but most commonly found in tropical areas of Burma, Malaysia, Srilanka, India and south East Asia. This plant shows optimum growth in the waste places having dry and stony soil conditions with relatively lower moisture contents. *Justicia adhatoda* contains vasicine and vasicinone as the chief active chemical components besides an essential oil. The chemical composition of *Justicia adhatoda* shows that it contains alkaloids, polyphenolics, glycosides and phytosterols while its major constituents are quinazoline alkaloids having vasicine as its principal alkaloid. The phytochemical analysis of essential oil obtained from leaves of *Justicia adhatoda* showed the presence of numerous chemical constituents such as phytosterols, anthraquinones, alkaloids, polyphenols, flavonoids, saponins and triterpenoids containing N-oxides of vasicine, vasicine, maiontone and deoxyvasicine. Due to these chemical compounds, this plant shows several biological activities such as anti-diabetic, anti-bacterial, anti-inflammatory, anti-malarial, anti-oxidant, anti-mutagenic, respiratory stimulant and bronchodilatory activities along with cardio-protective, anti-ulcer, insecticidal, allopathic, hepatoprotective and anti-cholinesterase potentials thus used in several commercial products.

**Keywords:** *Justicia adhatoda* L., medicinal plant, alkaloids, polyphenolics, glycosides, phytosterols, vasicine, vasicinone

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## 1. Botany

### 1.1 Introduction

Malabar nut (*Justicia adhatoda* L.) is a small, sub-herbaceous, evergreen plant that belongs to the Acanthaceae family. It is a well-known plant drug which is used in Unani and Ayurvedic medicine [1]. It is widely distributed throughout the tropical regions of south East Asia, in India, Srilanka, Malaysia and Burma. It is found upto 1300m above sea level in lower Himalayas. There are about 420 known species of this plant among which, few species have been studied, with thirteen species in Asia, fifteen species found in America and eight species in Africa. Among the studied species, 23 species were investigated chemically, 31 species have pharmacological information and 18 species were biologically and chemically studied, mainly in the last decade. Normally, the plant ranges from 50cm to 90cm in height. Leaves of *Justicia adhatoda* L. are lanceolate and broad having 10cm to 16cm length and 5cm thick. Flowers are generally white and inflorescence showing dense, large and axillary spikes. Fruits are young having club-shaped capsules. Propagation is done by seeds broad cast in areas of need or in waste areas.

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The honey bees attracts towards the flower and result in honey formation as the flower contains pollen and nectar in small amount and thus it build up colony for the coming winter [2]. It is one of the highly apparent plant species, utilized in indigenous system of medicines in India for over 2000 years [3]. In Ayurvedic medicine system, it has been used for the treatment of various respiratory diseases including cold, cough, bronchitis, asthma. *Justicia adhatoda* L. leaves have been used in the treatment of skin diseases, tuberculosis, dysentery, diarrhoea, vomiting and leprosy etc. The plant was botanically first described by Linnaeus as *Justicia adhatoda* L. in 1753 and in 1831, Nees redefined it as *Adhatoda vasica*. The plant genus name is derived from a south Indian language (Tamil), which means plant not touched by goat as in Tamil, Aadu means goat and toda means not touched. It is also known by different names depending on where you are in the world. It is called "Basak" (Bengali), "Bansa", "Basuti", "Arusha", "Baansa", "Adulsa" (Hindi), "Atalotakam" (Malayalam) in India, "Alduso" (Gujrathi), "Adadodai" (Tamil), "Nongmangkha-agouba" (Manipuri), "Shwetavasa", "Vasa" and "Vasaka" (Sanskri) and "Ya-Zui-Hua" (China) [4]. "Malabar nut",

"Casaka", "Lion's muzzle" and "Stallion's tooth" is mostly used in English and "Bhekhar" in Pakistan.

### 1.2 History/Origin

*Justicia adhatoda* L. is a dense, common, green house plant and persistent shrub which is a native of the island of Ceylon in the East-Indies growing in desecrate places and spread throughout India mainly in lower Himalayan range upto a height of 1000 m and in Maharashtra especially, in kokan region [5]. Besides India, it is found in Srilanka, Myanmar, Laos, southern China, Indonesian Archipelago and Malaya. It is common to tropical India from Punjab to southern India, Burma, Srilanka, Pothohar region of Pakistan (Karachi, Wazir, Khyber, Sind, Kurram, Dir); China, Hong Kong and Yunnan [6]. *Justicia adhatoda* L. is an official drug which is mentioned in Pharmacopoeia of India. It has been reported that all the parts of the plant have been used because of their therapeutic applications from ancient times. In India and Srilanka, the fresh bruised leaves of *Justicia adhatoda* L. are used for the treatment of snake-bites. The paste of roots which is mixed with sugar is used for the treating acute nightfall in Uttar Pradesh, Sitapur District, India [7]. It has also been used as an expectorant, anti-spasmodic and febrifuge by European herbal practitioners. In Nepal, leaf juice is recommended in malarial fever. In Bangladesh, the juice from leaves and bark are used for nausea and as an anthelmintic [8].

### 1.3 Demography/Location

It is a small, evergreen shrub widely spread throughout the tropical region of South-east Asia and found along road sides, on dry and waste places and in stony soil [9] as in dry soil and low moisture areas it grows well. As the plant is often abundant, ordinary and gregarious in the regions of adaptation, it is cultivated mainly in the areas of habitation, as wind-breaks, hedges and for reclaiming soil. Any forest edge is a likely place to seed, so that the leaves or branches will be handy for use on other cultivated plants drained and has sufficient rainfall. Propagation is done by seeds broad cast in areas of need, or in waste areas. *Justicia adhatoda* L. is abundant in many areas of India and China, growing in full sun, at edges of forests, in mountainous regions often as the co-dominant shrub with *capparis sepiaria* L. It also grows in full sun on flood plains and in meadows. The plant requires a subtropical to tropical climate with temperate precipitation [6]. Though killed to the ground by brief forests, it recovers quickly. In Curacao, it grows well on weathered diabase, in South Florida on oolitic limestone. Whereas, in Sub-Himalayan region it ascends to 1,300m altitude, more frequent at altitudes about 200 to 300m. The optimum conditions are found in countries having warm climate. For propagation, light, warmth and moisture are the most important ecological factors. No particular care is taken, as the plants flourish on any tropical soil.

### 1.4 Morphology, Ecology and Botany

*Justicia adhatoda* L. is a gregarious, densely branched, evergreen shrub 1.5m to 3m tall; smooth bark; coloured ash; branches hairy and soft; leaves opposite, elliptic ovate or elliptic lanceolate, entire, minutely-pubescent, acuminate with length 12.5cm to 20cm and width of 8cm having both ends pointed. When dried, the colour changes to dull brownish green and taste bitter having smell similar to strong tea [4]. When the leaf is washed with chloral hydrate, microscopic examination depicts the presence of oval stomata which are surrounded by two crescent shaped cells at right angles to the ostiole. The epidermis consists of simple one to three celled warty hairs and small glandular hairs. Beneath the epidermis, cystoliths are present. Flowers are white with pink, red or white spots or streaks, indense axillary, stalked, bracteates spikes 2.5cm to 7.5cm long; calyx is pubescent and deeply divided into 5 lobes. Corolla is 2-lipped, pubescent outside; upper lip notched and curved, lower lip 3-lobed; capsule is 2.5cm or more long and 0.8cm broad, young clavate and 4-seeded; seeds are suborbicular and rugose [6]. It has soft stem that makes a good charcoal.

### 2. Chemistry

*Justicia adhatoda* L. contains vasicine and vasicinone as the chief active chemical components besides an essential oil. In addition to insecticidal properties, vasicine which is an active compound of Malabar nut produces a slight fall of blood pressure, followed by the increase to the original level, and a slowing of the rhythm with an increase in the amplitude of heart beats. It has a slight but constant bronchodilator effect. Besides being used as expectorant in India, vasicine has recently modified to form bromhexine derivative, a mucolytic inhalant agent, which dilutes the mucus, increases respiratory fluid volume and reduces its viscosity. Fluid extract of leaves relieve cough, liquefies sputum and also relieve *tubercular bacillus*. Vasicine, vasicinine, betaine, vasakin, adhatodine, anisotinine, vasicinol, vasicoline, vasicolinone and vasicoline are reported. Deoxy vasicine is a highly effective anti-feedant followed by vasicinol and vasicine.

#### 2.1 Chemical Composition

The chemical composition of *Justicia adhatoda* L. shows that it contains the major group of compounds, such as alkaloids, polyphenolics, glycosides and phytosterols. Its major constituents are quinazoline alkaloids having vasicine as its principal alkaloid. The yield of alkaloid ranged from 0.541 to 1.105 from different samples in India and the yield of vasicine is measured as 0.541 to 1.1% by dry weight. The leaves contain two major alkaloids i.e., vasicinone and vasicine. In addition, adhatodine and anisotine has also been reported to present in leaves. From the inflorescence, vasicol and vasicinone have been isolated [8]. Alkaloids have also been reported to show temperate hypotensive activity and uterine stimulant activity. The leaves yield an essential oil

and are rich in carotene and vitamin C. It has also been reported that essential oil (at specific concentration) inhibit *Mycobacterium tuberculosis* [5]. The chemical compounds present in the roots and leaves of this plant contains essential oils, sugar, gum, resins, proteins, vitamin C and amino acids etc. [10]. Its leaves also have a very small quantity of crystalline acid and essential oil [1]. Elemental analysis showed that *Justicia adhatoda* L. contains Ca, Na, Mg and K as chief elements and Ni, Co, Cd, Cr, Mn, Fe, Zn, Pb and Cu are present as trace elements. It was found that the roots of *Justicia adhatoda* L. contain fats (2.5%), protein (8.5%), vitamin C (5.2%), and vasicine (7.5%). Whereas, leaves contain low level of such compounds except for sugar (16.4%), vasicinone (3.5%), S (1.3%), fiber (5.2%), Zn (0.6%) and Fe (1.2%) [11].

## 2.2. Phytochemistry

The phytochemical analysis of the leave's extract of Malabar nut (*Justicia adhatoda* L.) showed the presence of various components such as triterpenoids, saponins, flavonoids, poly-phenols, alkaloids, anthraquinones and phytosterols. It also contains N-oxides of vasicine, vasicine, maiontone, deoxyvasicine and essential oils. An analysis published in India has been reported the presence of 25.8% of deep yellow oil composed of lignoceric 10.7%, cerotic 5%, behenic 11.2%, arachidic 3.1%, oleic 49.9%,  $\beta$ -sitosterol 2.6% and linoleic acids 12.3% [4]. A typical compound termed as organic adhatodic acid which is an aromatic substance has been reported to be present in the whole plant of Malabar nut. *Justicia adhatoda* L. roots contain vasicol, peganine, vasicinolone and glycosyloxychalcone and hydroxyl oxychalcone compounds. The flower of *Justicia adhatoda* L. has been reported to contain Kaempferol, glycosides of kaempferol,  $\beta$ -sitosterol-D-glucoside and queretin etc. The important chemical constituent of leaf includes vasicol, vasicine, pyrroloquinazoline, alkaloids, vasicinone, adhatonine, 2'-hydroxy-4-glucosyl-oxychalcone and peganine. It is reported that Kaempferol,  $\beta$ -sitosterol-D-glucoside, its glycosides and quercetin are present in flower of Malabar nut [5]. The major component of *Justicia adhatoda* L. is vasicine which shows several biological activities viz., anti-oxidant, anti-malarial, anti-inflammatory, anti-bacterial and anti-diabetic etc. The honey bees are attracted towards the flower of *Justicia adhatoda* L. and result in honey formation as the flower contains pollen and nectar in small amount and thus it build up colony for the coming winter [2].

Table 1 Percentage of chemical components analysed in *Justicia adhatoda* L. (Malabar nut)

Constituents	Percentage in Leaves	Percentage in Roots
Moisture	15.3	24.6
Dry Matter	50.4	66.4
Fat	1.6	2.5
Protein	6.5	8.5

Fiber	6.4	5.2
Iron	1.2	0.7
Sugar	16.4	2.6
Sulphur	1.3	1.2
Sodium	1.4	2.4
Calcium	1.5	3.1
Zinc	0.6	0.5
Vitamin C	1.5	5.2
Berberine	-	0.3
Vasicine	4.5	7.5
Vasicinone	3.5	-

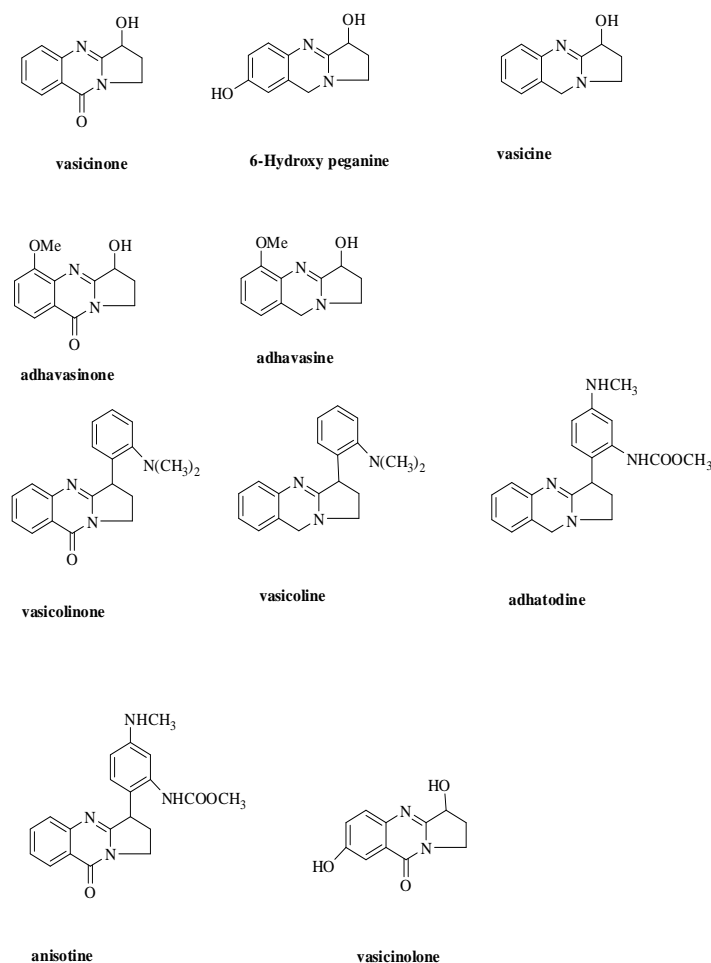


Fig 1 Molecular structures of different components present in *Justicia adhatoda* L.

Similarly, the structures of some bioactive compounds are shown below:

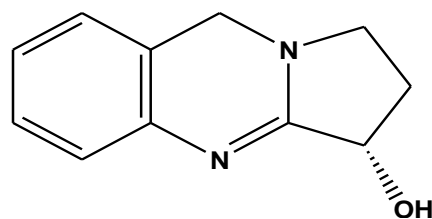


Fig 2 Structure of Vasicine

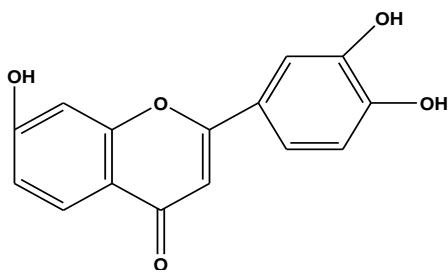


Fig 3 Structure of Luteolin

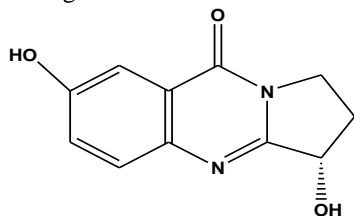


Fig 4 Structure of Vasicinolone

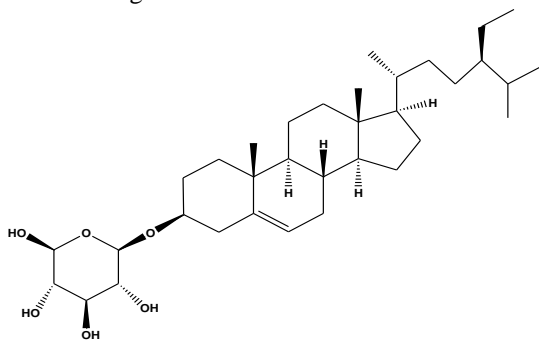


Fig 5 Structure of Daucosterol

### 3. Postharvest Technology

Harvesting of *Justicia adhatoda* L. is done at the end of second or third year of growth. By digging the seedbeds, roots are collected. Cutting of stem is done 15cm above the roots. Stems and roots are generally dried and stored.

#### 3.1 Processing

*Justicia adhatoda* L. prefers soil which is loamy with high organic content and good drainage. It is cultivated either as a pure crop or mixed with plantation crops. Repeatedly the land is ploughed for having good tilth and the surface of the soil is broken upto 15cm depth and mixed with fertilizers. For preparing beds, 1m breadth and 3-4m length is required. Flowering period is from May to September. During April-May, cuttings are planted into the beds at a spacing of 30×30cm. In the first year, FYM is given at 5-10t/ha. Regular weeding and irrigation are needed.

#### 3.2 Value Addition

It is a source of vasak which is a well-known drug in the indigenous system of medicine for its advantageous effects especially in asthma, bronchitis, tuberculosis and fever. It has been reported that the plant has high medicinal value [12]. The leaves of the plant contain white crystalline quinazoline alkaloid vasicine, a crystalline acid and small amount of essential oil among which vasicine and essential oil is responsible for the therapeutic properties of plant. Moreover a famous product Glycodin which is used for the

treatment of bronchitis is extracted from the leaves of *Justicia adhatoda* L. The leaves of *Justicia adhatoda* L. have nutritive value 106.00 cal/100g.

### 4. Uses of Malabar Nut

The medicinal importance of *Justicia adhatoda* L. is due the presence of active compounds which produce physiological actions in animals and human body. It has been reported that various parts of this plant contains bioactive components like essential oil, quinazoline alkaloids [5] and vasicine which shows numerous pharmacological activities like anti-malarial, anti-oxidant, anti-bacterial, anti-inflammatory and anti-diabetic potentials.

#### 4.1 General Uses

In Ayurvedic medicine system, it has been used for the treating different respiratory disorders which include cold, cough, bronchitis and asthma. The plant leaves have been used in the treatment of skin diseases, tuberculosis, dysentery, diarrhea, vomiting and leprosy etc. It is one of the highly apparent plant species utilized in indigenous system of medicines in India for over 2000 years [13]. In Srilanka, *Justicia adhatoda* L. is used for curing menorrhagia and extreme phelgum. It has also been used for the treatment of impotence, bleeding piles and sexual disorders [14]. The rural population used the extracts of *Justicia adhatoda* L. roots for treatment of cough, liver disorders and diabetes. In South east Asia, the powder, paste and decoction of root have been used for treating diphtheria, malarial fever, leucorrhoea, tuberculosis and diseases of eye [7]. There is only one single report on the food value of *Justicia adhatoda* L. The leaves and flowers of the plant are cooked as vegetable in India and Nepal by the Khasi tribe. Moreover, it is presently used as an ingredient in many dietary supplements in order to support weight loss, immune system health and respiratory relief [15]. It relieves cramps or convulsions and muscular spasms, stimulates contraction of the uterine muscle and used to lower the blood pressure. The juice from the leaves and roots are helpful in bronchitis, asthma, chronic coughs and breathlessness.

It is also used for local bleeding due to piles, peptic ulcer and menorrhagia [13]. The juice obtained from the leaves and bark of *Justicia adhatoda* L. is used for treating vomiting and also used as an anthelmintic. Furthermore, the leaf juice of plant is given in malarial fever [16]. The plant fruit is used for the treatment of bronchitis, as anti-spasmodic and cold [4]. A mixture of the leaves is an excellent agent to kill flies, mosquitoes and white ants [17]. The flowers and leaves of the plant possess anti-asthmatic and expectorant properties [18]. The roots, leaves and the flowers are widely used in indigenous medicine as a treatment for asthma, cough and cold. Its bark, leaves, the root-bark, the flowers and fruit have been used in removing the parasites of intestine. The decoction of its bark as well as root in doses of 30g twice or thrice a day can be given for

this use. The juice extracted from the leaves has been used in doses of 2-4g in treating dysentery and diarrhea. A poultice of leaves has been applied to fresh wounds, inflammatory swellings and rheumatic joints. A warm decoction of the leaves are useful in skin diseases and scabies [5]. Traditionally, the leaf extract of *Justicia adhatoda* L. is used for curing bronchitis. It has been used in the treatment of cough and respiratory disorder like breathlessness. It is also famous in Unani and Siddha medicinal system. Locally, the leaf extract is used when the gums are bleeding and also used for treating pyorrhoea.

#### 4.2 Pharmacological Uses

The aqueous and alcoholic extract of *Justicia adhatoda* L. shows significant pharmacological effect due to the presence of active components, vasicine and vasicinone. The extract of plant is reported to have anti-asthmatic, abortifacient, anti-tussive, anti-spasmodic expectorant and bronchodilator activity. Mucolytic, uterotonic, oxytocic and febrifuge activity has also been shown by the plant.

##### 4.2.1 Anti-mutagenic and Anti-oxidant Effect

Anti-oxidant and anti-mutagenic effect has also been reported by *Justicia adhatoda* L. It exerts anti-oxidant effect against xanthine oxidase induced oxidation and lipid peroxide [19]. *Justicia adhatoda* L. and its pure component vasicine shows a very strong anti-oxidant activity [20].

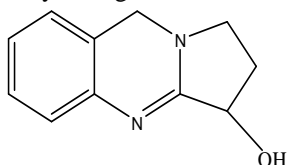


Fig 6 Structure of Vasicine

##### 4.2.2 Respiratory Stimulant and Bronchodilatory Activity

In Ayurveda, leaves are mainly used in curing respiratory disorders. The respiratory stimulant activity has been shown by vasicine, alkaloids and vasicinone present in the leaves of plant [5]. Whereas, low concentrations of vasicine induced relaxation and bronchodilation of the tracheal muscle but high concentration of vasicine offers major protection against histamine-induced bronchospasm in guinea pigs. Vasicinone, the auto-oxidation product of vasicine has been used to show bronchodilatory effects both in vivo and vitro. Anti-histaminic and bronchodilatory activity has been shown by active alkaloid vasicine and vasicinone which is its auto-oxidation product.

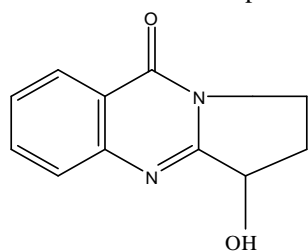


Fig 7 Structure of Vasicinone

##### 4.2.3 Cardioprotective Activity

A significant reduction in cardiac depressant effect was observed in combination of vasicine and vasicinone. It was revealed that no effect has been shown by vasicinone (dl-form), however l-form was weakly effective in stimulating cardiac muscles [3].

##### 4.2.4 Anti-ulcer Activity

*Justicia adhatoda* L. was studied for its anti-ulcerogenic activity to treat ulcer which are induced by pylorus, ethanol and aspirin. In rats, anti-ulcer activity was shown by the leaf powder of plant in ethanol induced ulceration model [19]. The results have shown that in addition to its vast pharmacological activities, *Justicia adhatoda* L. has a great ability to act as an anti-ulcer agent.

##### 4.2.5 Insecticidal Activity

In India, *Justicia adhatoda* L. has been used as an insecticide for centuries. Its leaves are used to control insects, pests in oil seeds, both in laboratory and warehouse. It has been revealed that the plant's alkaloid and vasicinone have an anti-fertility effect against several insect species by causing blockage of oviduct. It has also been used as an insect repellent.

##### 4.2.6 Hepatoprotective Effect

Significant hepatoprotective effect on the liver rats damage in induced by d-galactosamine at a dose of 50-100 mg/kg was shown by the leaves [21].

##### 4.2.7 Anti-bacterial Activity

Alcoholic extract of roots and leaves of *Justicia adhatoda* L. showed anti-bacterial activity against *Escherichia coli* and *Staphylococcus aureus*. However, the water extract of plant showed anti-bacterial activity only against *Staphylococcus aureus* [22].

##### 4.2.8 Allopathic Activity

Allopathic activity was studied by Mitra and Prasad [23]. The aqueous flower and leaf extracts show inhibitory effect on seed germination and seed survival of turnip.

##### 4.2.9 Anti-cholinesterase Potential

Vasicinone obtained from the plant roots produced transient hypotension in cats, depression of isolated heart in guinea pigs and contraction of isolated intestine thus showing good anti-cholinesterase activity [24].

#### 5. Summary

*Justicia adhatoda* L. belongs to Acanthaceae family. Flowers are white streaked with purple or pink. Fruit is a legume which is 30-60cm long and 1.5-2.5cm broad. The leaves extract has been shown to contain proteins, polysaccharides, tannins, uronic acid, saponins, alkaloids flavonoids, triterpenes and essential oil having anti-microbial and anti-tussive activity. Furthermore, leaves contain major constituents as alkaloids vasicinol, vasicinone, adhatodine, anisotine, adhava sinone and peganine. It has been used in India in the indigenous medicine system for about 2000 years. Moreover, it is also used in Unani and Ayurvedic medicine and has been used for the treatment of various respiratory diseases including

cold, cough, bronchitis and asthma. The major component of *Justicia adhatoda* L. is vasicine which shows several biological activities viz., anti-oxidant, anti-malarial, anti-inflammatory, anti-bacterial and anti-diabetic etc.

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