Review Article

Bauhinia acuminate Linn: A brief review of its phytochemistry and pharmacology

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Abstract

Bauhinia acuminata L. selected for this study belongs to the family *Fabaceae*. It is an important medicinal plant of the Indian subcontinent. But still require exploring its pharmacological activities. It is research oriented plant and may provide new aspect to treat the various disorders. *B. acuminata* has been found to possess some pharmacological activities such as the antimicrobial, anti-inflammatory, antinociceptive, anthelmintic, antioxidant, antidiarrheal, cytotoxic, hemolytic activity, **ameliorative effect in chronic arsenicosis / stem bark.** The demand is due to the increased acceptance of Ayurveda and traditional herbal medicines, because of having their safe therapeutic effect and no side effects, as such modern peoples relies more on drug resources of plant origin. Therefore, based on the above-mentioned deliberation, this article reviews the most updated information of the phytochemical properties and pharmacological effects of *B. acuminata*.

***Keywords*:** *Bauhinia acuminata,* phytochemistry, antimicrobial, antioxidant

Introduction

Plant extracts are known as chemical libraries of structurally diverse compounds. Many researchers have extremely focused on diverse procedures to evaluate active chemical compounds from plant resources. Many of the current drugs either mimic naturally occurring molecules or their structures that are fully or in part derived from natural motifs (Joseph and Raj, 2010). Population rise, inadequate supply of drugs, prohibitive cost of treatments, side effects of several synthetic drugs and development of resistance to currently used drugs for infectious diseases have led to increased emphasis on the use of plant materials as a source of

Medicine (Pathare and Wagh, 2012).

Bauhinia is a large and diverse tropical and subtropical genus comprising approximately 300 species, belonging to the family Leguminosae (The Plant List). It consists of shrubs or trees, very rarely climbers, distributed throughout the tropical regions of the world. The genus *Bauhinia* includes 773 scientific plants; of these 352 are accepted species names according to the Integrated Taxonomic Information System (ITIS) (Wunderlin and Eilers, 2006).About 15 species of this genus occur in India (Kirtikar and Basu, 1999). Plants in genus Bauhinia have characteristic butterfly shaped leaves. Most Bauhinia spp. have applications in traditional medicines. *Bauhinia* is further divided into four subgenera: Piliostigma, Kurz, Barklya and Phanera. This is perfect little tree for places where you don't want anything wild to take over.it will grow no more than two or three meters, and won't take up much space or get in anyone way .it really is quite in offensive .The white beautiful flowers look like snowflakes hanging on the branches with a sweet clean fragrance. *Bauhinia* flower appears on the Hong Kong flag and Hong Kong Airlines uses *'Bauhinia'* as its radio call sign in air traffic communication.

Bauhinia acuminata (*Fabaceae*), an evergreen large shrub, grows in disturbed areas of Southeast Asia such as Indonesia, Malaysia or the Philippines. *Bauhinia acuminata,* belonging to the family of Fabaceae. The term *Bauhinia* is from the new Latin word Bauhin". The equivalent word of *Bauhinia* is dwarf white orchid tree. Bark, leaves, stem, blooms, and roots have been utilized in conventional drugs. The plant is well known for its preventive action in tuberculosis .This review summarizes the profile of the plant in terms of its activities and phytochemical constituents.

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Figure 1. Whole plant of *Bauhinia acuminate* L.

Indian Species of bauhinia

B. acuminate, B blakeana, B. galpinii, B. grandidieri, B. monandra, B. phoenicea, B. purpurea, B. racemosa, B. rufescens, B. tomentosa, B. variegate,

Plant profile

Classification:

Kingdom	:	Plantae-plants
Subkingdom	:	Tracheobionta -Vascular plants
Super Division	:	Spermatophyta – Seed plants
Division	:	Magnoliophyta-flowering plants
Class	:	Magnoliopsida-dicotyledons
Subclass	:	Rosidea
Order	:	Fabales
Family	:	Fabaceae –pea family
Genus	:	Bauhinia *L*
Species	:	*Bauhinia acuminata*

Habitat

The plant is chiefly distributed in the mountains of southern and western India and has long been cultivated both as an ornamental and medicinal plant. Full sun to partial shade, average water needs, soil pH 5.6-6.5 (mildly acidic to acidic).

Propagation

Bauhinia acuminata are chiefly propagated from seeds; vegetative propagation except inarching has not shown much success .Seed is spread short distances when capsules rupture by water. They thrive in alkaline soils and keep on to not tolerate salty conditions. Full sun exposure is preferred but they can survive grown under partial sun (Teixeira da Silva., 2013).

Botanical description

Morphology: It is medium sized deciduous, fast-growing, sun-loving, flowering tree with a short, dark trunk and hairy branches (thin and ascending). It is usually growing on a rocky soil on hill slopes to sandy loam and loamy soil in the valley, basically, an acidic soil as it doesn't tolerate salty conditions .*B. acuminata* grows two to three meters tall in a mildly acidic soil (pH 5.6-6.5).

Stems: stems are strong, smooth, upright with many slender branches; young twigs are pubescent

Bark: Bark of the plant is grayish brown, rough externally (due to the presence of fissures transverse cracks, exfoliations) and smooth surface, creamish color internally

Leaves: Leaves are alternate, linear-lanceolate, running parallel venation, green color, entire margin, smooth and glabrous surface, broad, rounded and bilobed apex., shaped like an ox hoof with an apical cleft up to 15 cm long, as broad as or broader than long, 9-15 nerved, cleft 1 green color which changes to brown on drying petioles 1.5-4 cm long; blades ovate, broadly ovate or suborbicular, 5.4-11.3 (20) x 3.7-11.3 cm, divided about 1/3 their length, membranous, glabrous adaxially, densely puberulent abaxially, base cordate to rounded, apex of lobes acute. Leaves and leaflets often show sleep movements.

Flowers are bisexual, fragrant, showy, magenta and rosy purple-colored with five petals (4-6 cm long) with pedicel 6-12 mm long; hypanthium 5-9 mm long; calyx limb spathaceous, 28-37 mm long, with few scattered hairs abaxially, apex of 5 spidery lobes 1.7-4.1 mm long; petals not clawed, elliptic to oblanceolate, 39-49 (60) x 20-25 (30) mm, glabrous, white; fertile stamens 10, filaments strigose at base; ovary stipitate, strigose on sutures, stigma peltate, bilobed. The white flowers look like snowflakes hanging on the branches. Sometimes it is called Snowy Orchid Tree.

Legumes :Legumes are elongated linear, 7.5-15 x 1.7-1.8 cm, pod-like shape, 6-12 inches, dry/hard covering and glabrous, brown; seeds suborbicular, ca. 10 mm in diameter" (Howard, 1988).

Inflorescences axillary racemes, 2.5-5.8 cm long; peduncles negligible; bracts and bracteoles lance-linear, 3-9 mm long, puberulent, especially on margins, caduceus.

Quantitative Microscopy of Leaf: Microscopical studies of a lamina showed that Laminar T.S. revealed polygonal epidermal cells palisade cells in the mesophyll unicellular trichomes. The transverse section of leaves of selected Bauhinia species showed various distinct features. The lower cortex region of *B. acuminata* L. is wide (6-7 layered). B. acuminata have large number of simple trichomes and the size is long in *B. acuminata* L. in quantitative microscopy *B. acuminata* L. have paracytic stomata a. Vein islet number and palisade ratio was found to be highest in *B. acuminata* L. leaf (Gupta., 2018).

Quantitative microscopy of leaf

Stomatal index : 50.56-52.65
Vein islet no : 25-27.
Stomatal no. : 100-110
Palisade ratio : 6-7

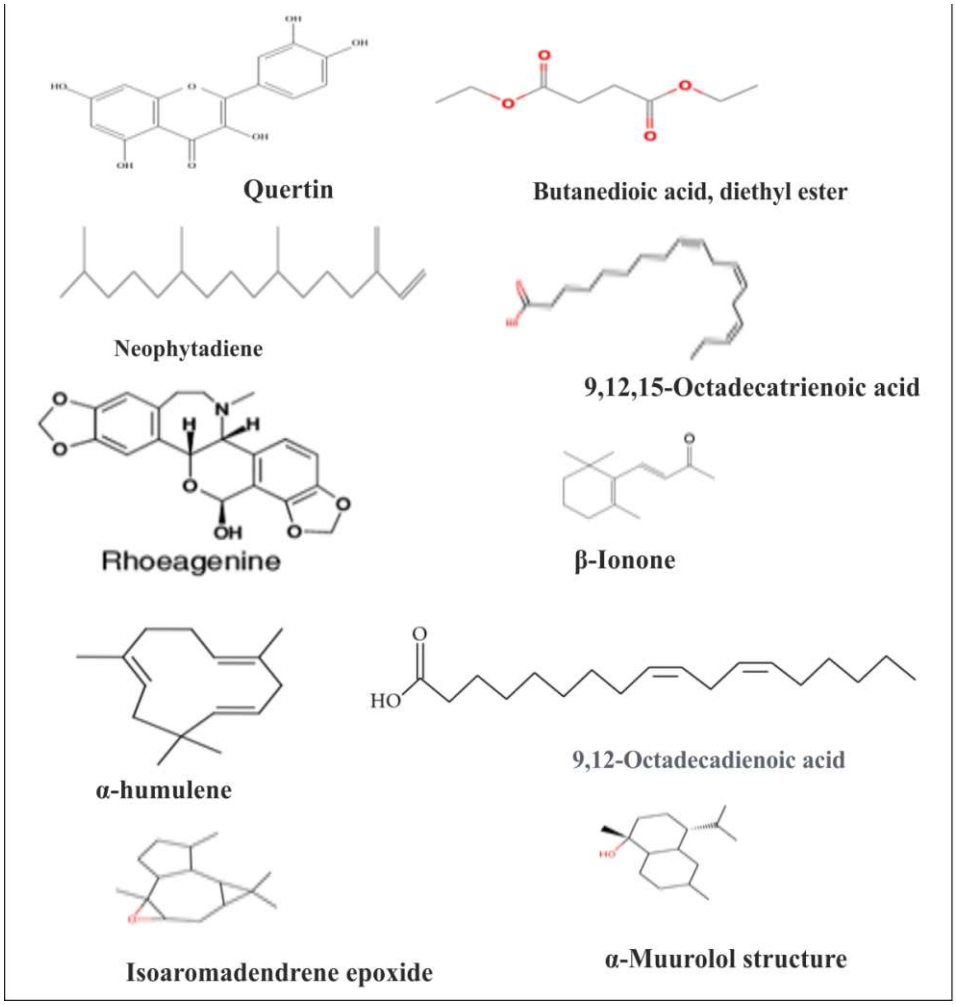

Figure 2. Structures of chemical constituents of *Bauhinia acuminata*

Chemical constituents present in *Bauhinia acuminata*

Bauhinia acuminata leaves contain chemical compounds such as, palmitic acid, three phallic acid esters, gallic acid and ursolic acid (Nag et al., 2013). The leaves and stems of *B. acuminata* showed the presence of carbohydrate, phenolic compounds, saponins, flavonoids, oils, and fats, alkaloids, anthocyanoside, steroids, anthraquinone, terpenoids, resins, amino acid, sugars and cardiac glycosides in phytochemical screening. GC-MS analysis of *B. acuminata* detected hexamethyl cyclotrisiloxane and 1-methyl 3-nonyl indane in leaf and stem extracts (Krishna et al., 2015). *B. acuminata* leaf oil identified 19 compounds through GC-MS analysis are β-Caryophyllene,α-Humulene,Isomethyl-α-ionone,α-Farnesene,β-Ionone, Caryophylleneoxide 1,6,10-Dodecatrien-3-ol,3-hexen-1-ol, Humulene epoxide Caryophyllene oxide, caryophyl, Humulene epoxide, Caryophylla-4(12),8(13)-dien-5α-ol, α-Muurolol,α-Cadinol and Isoaromadendrene (Vasudevan et al.,2013) Phytochemical screening of plant extracts showed the presence of saponin, alkaloid, cardiac glycosides, flavonoids, and tannin and steroid compounds (Dongray et al., 2016).

Pharmacological activities of *B. acuminata*

Although *Bauhinia acuminata* has been widely used in various symptoms and diseases, only a few pharmacological studies have been reported

Antioxidant activity

Experiment carried out by Khan (2014) screened the crude methanol extract of leaves of *B. acuminata* and its Kupchan fractions for antioxidant,cytotoxic and membrane stabilizing activities. Among all partitionates, the aqueous soluble fraction of *B. acuminata* showed the highest antioxidant activity with IC50 value of 7.22±0.200 µg/ml. At concentration of 1.0 mg/ml, different partitionates fractions of *B. acuminata* protected the haemolysis of RBC induced by hypotonic solution and heat as compared to the standard acetyl salicylic acid

Dourandishan et al. (2013) evaluated the antioxidant effects and its mechanism of aqueous leaves extract of *Bauhinia acuminata* (BA) in rat. The extract was screened for its phytochemical contents and antioxidant activity in

Table 1. Ethno medical uses of *Bauhinia acuminta*

Region	Parts	Administration	Ailment
Javanese	Roots	Cold Extract	Cough.
India	Root	Hot Extraction	Urinary Problems
Malaysia	Roots	Boiled	Ulceration Of The Nose.
India	Bark	Decoction	Biliousness (Kirtikarand Basu, 1935)
India	Leaves	Paste	Bladder stone, scrofula, leprosy, asthma, proctotosis and digestive diseases, skin disease (Dongray et al., 2016)
Indonesia	Bark	Boiled	Common Cold
Thailand	Roots	Macerated	Cough
Thailand	Flowers	Paste	Headache And Hypertension
India	Flowers	Paste	Ulcers And Leprosy
Japan	Roots	Cold extract	Cough
India	Leaves	Macerated	Biliousness, inflammatory
India	Leaves	paste	throat troubles
India	leaves/root	Tonic	Drugs for liver.

vitro. Moreover, the extract was studied in rats to evaluate its effects in vivo. Rats were orally administered with the extract at the dose of 50, 100 and 200 mg/kg for 28 days. The extract contained phenolic compounds 53.36 ± 1.01 mg of gallic acid equivalents per gram BA extract. The free radical scavenging activity assessed by DPPH assay gave IC50 of 44.47 ± 2.83 µg/mL, which is relatively lower than that of BHT with IC50 of 12.34 ± 1.14µg/mL.

Antidiabetic activity

Antidiabetic activity of *B. acuminata* was evaluated in normal and Streptozotocin induced diabetic mice. It showed remarkable lowering of blood glucose levels (90.19%) by leaf and bark extract compared to positive control of 76.86%. The methanolic leaf and bark extracts exhibited significant property ($P<0.05$) compared to diabetic control group (Ray et al., 2017).

Antibacterial activity

Plants belonging to the genus Bauhinia are also frequently used in folk medicine to treat infectious diseases, and several experimental studies have confirmed their antimicrobial potential, especially against pathogenic fungi and bacteria .*B. acuminata* crude extract showed interesting antibacterial activities which could inhibit all tested gram positive and gram negative bacteria. Crude extract of *B. acuminata* L. seeds showed strong antibacterial activity against various pathogenic bacteria both gram positive and gram negative with the MICs ranging from 8.34 to 66.72µg/mL. The extract of *B. acuminata* L. seeds was well active on gram negative bacteria (Phansri et al., 2011).

Hemolytic Activity

B. acuminata L. crude extract in which peptides were tested for hemolytic activity against human erythrocytes. It was found that *B. acuminata* crude extract showed hemolytic activity against human erythrocytes in a dose-dependent manner. Krishna et al. (2015) evaluated that the aqueous extracts of leaves of *B. acuminata* towards human erythrocytes they showed very low haemolytic activity was recommended as safe for RBC count.

Anti-Nociceptive Activity

Padgaonkar, et al. (2018) evaluated *Bauhinia acuminata* for anti-nociceptive activity, in Swiss albino mice by hot plate, acetic acid induced writhing and tail immersion tests at three different dose levels (250, 500 and 1000mg/kg) of aqueous and alcoholic extracts. Formalin induced nociception test was performed in Sprague Dawley rats at three dose levels. Both aqueous and alcoholic extracts were found safe at dose of 5000mg/kg. In hot plate test, both extracts showed significant ($p<0.001$) anti-nociceptive activity. In acetic acid writhing test, both aqueous and alcoholic extracts significantly reduced number of writhes ($p<0.001$). In Tail immersion test, both the extracts showed significant increase in tail withdrawal response ($p<0.001$). Treatment with aqueous and alcoholic extracts significantly reduced nociception in formalin induced nociception model ($p<0.001$).

Brain shrimp lethality test

Islam et al. (2014) investigated the cytotoxic and thrombolytic activity of methanolic extract of leaves of *B. acuminata* with the Brine shrimp lethality bioassay. The methanolic extract of *B. acuminata* was assessed with human blood to evaluate thrombolytic effect. The extract showed remarkable cytotoxic activity, LC50 value of the extract was 15.41µg/ml compared to vincristin sulphate. It also evaluated for thrombolytic agent compared to streptokinase. It has the significant thrombolytic

effect which was about 10.058%. These findings demonstrate that the leaves extract of *B. acuminata* have significance cytotoxic and thrombolytic activities.

Membrane stabilizing activity

Md. Reyad-Ul-Ferdous et al. (2014) investigated that the thrombolytic activity of the extractives of leaves of *B. acuminata* were highly effective in the membrane stabilizing activity as the extractives prevented the lysis of erythrocyte induced by hypotonic solution and heat. In hypotonic solution induced condition the highest membrane stabilizing activity was exhibited by the Pet ether soluble fraction (PESF-418.26%) followed by carbon tetra chloride soluble fraction (CTCSF-418.26%). Significant amount of membrane stabilizing activity were also present in methanol soluble fraction (MESF-13.46%) and aqueous soluble fraction (AQSF-167.30%).

Antihelmintic activity

Prabhu et al. (2018) evaluated *Bauhinia acuminata* to its anthelmintic quality against the *Musca domestica*. In vitro anthelmintic assay revealed both extracts have shown significant effect in paralysis and death of the housefly worms in a dose dependent manner. Aqueous and ethanolic extracts with different concentrations (12.5, 25, 50, 100 and 200 mg/ml) were tested on the *Musca domestica* worms *in vitro* assay. Albendazole was used as standard and distilled water as a control. The leaves of *Bauhinia acuminata* could be used as an anthelmintic remedy, to carry out in vivo using laboratory animals to confirm the safety, efficacy, and toxicity profile of this plant.

Antidiarrheal study

Islam et al. (2014) investigated that the castor oil-induced diarrheal experiment in mice, the methanol extract of leaves of *Bauhinia acuminata* at the doses of 200 and 400 mg/kg, reduced the total number of faeces as well as the total number of diarrheal faeces in a dose dependent manner. But also Magnesium sulphate induced diarrheal model in mice, the methanolic extract of leaves of *Bauhinia acuminata* above dose levels significantly ($P < 0.01$) reduced the extent of diarrhea in test animals. Both the doses were shown to reduce the total number of faeces and wet faeces when compared to the control group.

Hepatoprotective Activity

Porandla Ravali et al. (2015) evaluated that the hepatoprotective activity of *Bauhinia acuminata*.L against Carbon tetra chloride induced hepatotoxicity in rats. Hepatic damage was induced by administration of CCL_4 in combination with olive oil. *Bauhinia acuminata*.L showed the hepatoprotective activity by lowering CCL_4 induced elevation of SGOT, SGPT, ALP & Bilirubin levels ($p<0.01$) and was confirmed by the histopathological examination of liver tissues treated with test compound. This result strongly supports the protective effect of EEBA against liver injury.

Dourandishan et al. (2015) provides evidence that *Bauhinia acuminata* was well tolerated by the animals throughout the 28 days of study as shown by normal serum levels AST, ALP, ALT, BUN and Cr as well as normal histology of liver and pancreatic and kidney tissue. Significantly, reduction of serum oxidative stress markers malondialdehyde (MDA) was found in rat treated with BA extract compared with control.(Sebastian and Albin,2018) evaluated EA fraction of chloroform extract of *Bauhinia acuminata* showed a subsequent recovery towards normal level in the activities of the serum biochemical parameters after the induction of lung carcinogen benzopyrene strongly suggests the possibility of as a conditioner of the hepatocytes.

Anticancer Study

Sebastian (2018) evaluated *in vivo* anti-cancer activity of *Bauhinia acuminta* was assessed in a lung cancer model of C57BL/6 mice using benzopyrene as the cancer causing agent. Disease induced animals were treated with EA fraction from crude chloroform extract of *B. acuminata* at four doses i.e. very low, low, mid and high dose of 20, 100, 250 and 500 mg/Kg b.wt. respectively. The high dose of 500 mg/Kg b. w t. showed decrease in tumor size and volume in a dose dependent manner. The changes observed in the animals treated at the high dose of EA fraction from crude chloroform extract of *B. acuminata* was comparable to that of the standard drug (5-FU) used in the study.

Membrane stabilizing activity

Reyad-Ul-Ferdous (2014) explained that the *B. acuminata* leaf extract showed a valid membrane stabilizing activity, it also prevented the lysis of erythrocyte triggered by hypotonic solution and heat. These findings put forward the significant role of *B. acuminata* anti-inflammatory activity which may be due to the high content of flavonoids and tannins.

Nano synthesis of *bauhinia acuminata*

Alharbi et al. (2018) synthesized AgNPs using the *Bauhinia acuminata* leaf extract have promising potential in antimicrobial food packaging, as well as foliar spray to control plant pathogens in the field, and to synergize the efficacy of fungicidal and larvicidal formulations.. AgNPs tested at 60 µg/mL inhibited the growth of 5 bacteria and 3 fungal pathogens. In the insecticidal assays on important mosquito species, LC_{50} of the aqueous extract of *B. acuminata* leaves on the larvae of *Anopheles stephensi*, *Aedes aegypti*, and *Culex quinquefasciatus* were 204.07, 226.02, and 249.24 µg/mL, respectively. The *B. acuminata*-synthesized AgNPs exhibited higher larvicidal efficacy.

Sebastian and Albin (2017) evaluated the antimicrobial activity of BAAgNPs have multiple targets and found to be effective against *C. freundi* and *M. luteus* was found to be <1000 and 750 µg using MIC assay.

Conclusion

Bauhinia acuminata is one of the traditional plant used for the treatment of a large range of diseases .There is a still a lack of clinical data for its efficacy, and clinical trials are warranted to justify its traditional use .it also possesses many hidden medicinal properties which can be further evaluated in the future.

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