

Traditional uses, phytochemistry and pharmacology of *Bauhinia racemosa* Lam - a review

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ABSTRACT

Bauhinia racemosa family, Caesalpiniaceae, is one of the precious resources of the earth. It has played a significant role in human civilization since ancient times. It is tall sized tree growing throughout India, Ceylon, China, and Timor. The different part of this plant contains β -sitosterol and β -amyirin, flavonols (kaempferol and quercetin) and two coumarins (scopoletin and scopolin), tannins etc. Various part of this plant has great pharmacological potential with a great utility and usage as folklore medicine as analgesic, antipyretic, anti-inflammatory, antispasmodic and antimicrobial activity. This review mainly focus on the exclusive review work on the traditional, phytochemical and pharmacological activities of this plant.

Keywords *Bauhinia racemosa* Lam, phytochemistry, ethnopharmacology, traditional uses, pharmacology

INTRODUCTION

Plants have always played a major role in the treatment of human traumas and diseases worldwide. The demand for medicinal plant is increasing for both developed and developing countries due to growing recognition of natural product. Herbal medicine is an important part of both traditional and modern system of medicines (Pandey et al., 2011). The well-known and well-established genus *Bauhinia* comprises of trees and shrubs that grow in warm climate. There are about 300 species of this genus found in tropical regions. It is rare in southern most districts, 5 - 7 m tall tree in deciduous forests which is often planted in gardens along roadside for its large purple beat flowers. *B. racemosa* Lam. is a small crooked, bushy tree with drooping branches found throughout India up to an altitude of 1,650 m above sea level (WHO, 2010). Pharmacological studies of the plant have revealed that the ethanol extract of *B. racemosa* leaves shows analgesic, antipyretic, anti-inflammatory, antispasmodic activities and antimicrobial activity (Ali et al., 1990; El-Khatiba et al., 1995). The fresh flower buds of the plant showed antiulcer activity (Akhtar et al., 1995). Cytotoxicity against CA-9 KB in cell culture, as well as hypotensive and hypothermic activities has been reported from the hydroalcoholic extract of *B. racemosa* Dhar et al., 1968). The stem bark of the plant is an astringent, used in the treatment of headache, fever, skin diseases, tumors, blood diseases, dysentery (Kirtikar and Basu, 1975). β -sitosterol and β -amyirin probably responsible for the popular

use of the plant, were isolated from the stem bark of this plant (El-Hossary et al., 2000). Beside these compounds, at least five flavonols (kaempferol and quercetin) and two coumarins (scopoletin and scopolin) were also isolated from the leaves of the plant. Several other phytoconstituent of *B. racemosa* have been isolated, chiefly includes triterpenoids (α -amyirin) and stilbenes (resveratrol) from the hardwood (Anjaneyulu et al., 1984). A new tetracyclic lupeol, betulin, β -sitosterol, and tetracyclic 2, 2-dimethyl chroman have been isolated from the roots. The seed contains flavonoids, crude protein, and lipid.

Regional and other name (Rastogi et al., 1993)

Common Name	Jhinjha
Sanskrit	Asmantak
English	Mountain ebony
Hindi	Sirhatta, Asimlous, Chomel
Kannada name	Apto
Telugu	Tella arecettu
Bengali	Banraji
Urdu	Gul-e-anehmal

Scientific classification (Khare et al., 2007)

Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliopsida
Order	Fabales
Family	Caesalpiniaceae (Gulmohar family)
Genus	Bauhinia
Species	Racemosa

Distributions

The plant *Bauhinia racemosa* (L) belongs to the Caesalpiniaceae family. It occurs frequently in India, Ceylon, China, and Timor (Gupta, 2008; WHO, 2010).

Cultivation and collection

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Fig.1. Photograph of *Bauhinia racemosa* Lam plant

Throughout India, ascending up to an altitude of 1300 m in the Himalayas. Propagation is from seeds and cuttings. The plant prefers acidic soils and do not tolerate salty conditions. Fertile soil with a mix of sand that can retain water is required. They can be grown under partial sun. Generous watering is needed during summer, moderate moisture required in winter. During establishment it can tolerate drought conditions also (Atal and Kapur, 1982; Sahu and Sahu, 2015).

Botanical description

Bauhinia racemosa Lam. is a small bushy tree with drooping branches. *Bauhinia* comprises of trees and shrubs that grow in warm climate (Fig.1). The leaves are green and broader than long compound, leaflet, ovate, rounded at apex, pubescent beneath when young. The flowers are white or pale yellow, terminal or leaf-opposed racemes. Small flowers are borne in loose racemes, 5 - 10 cm long. Flowers are about 1 cm, greenish white. Petals are 5, narrow lance like, stamens 10. Pods 13 to 25 cm by 1.8 - 2.5 cm in size generally curved, swollen, rigid. The bark bluish black, rough, pinkish red inside, turning brown on exposure and longitudinally fissured. Seeds 12 to 20, glabrous, dark reddish brown or black, compressed, 8 mm long (Anonymous, 1996).

Uses

Traditional

The plant *Bauhinia racemosa* Lam belongs to the family, *Caesalpiniaceae* popularly known as Sittacha (Tamil) used in traditional medicine for the treatment of various ailments. The stem bark of the plant is an astringent and is used in the treatment of headache, fever, skin diseases and in tumors (Gupta et al., 2004; Kirtikar and Basu, 1975). In Ayurveda the bark is useful for the treatment of malaria, dysentery and diarrhea (Fig. 2). The bark and leaves are sweetish and acrid, refrigerant, antipyretic, astringent, vermifugal, cure biliousness, urinary discharges, thirst headache, quartan fever, vatta, anal fistula, tuberculous glands, skin diseases, throat troubles, tumors, diseases of the blood, good in chronic dysentery and diarrhea (Anonymous, 1985; Nadkarni and Nadkarni, 2000). Santhals give root bark decoction with paste of black peppers to epileptic patients (Jain, 1998; Jain and De, 1966).

The fruit is acrid and sweet; refrigerant, astringent to the



Fig.2. Photograph of *Bauhinia racemosa* Lam bark

bowels; removes kapha and vata. The fibre is used to stitch wounds. A decoction of leaves is used to allay headache in malarious fevers the gum is used medicinally in India (Kirtikar and Basu, 1975). Decoction of bark is used to wash abscesses, warts, and wound cleaning and skin disorders. Bark paste is useful in lymphadenitis and inflamed parts. Flowers used in bronchitis and cough (Kirtikar and Basu, 1975). Bhills of rajasthan use the plant bark for diarrhoea and dysentery and eat the fruits (Jain, 1964). The plant is also used to cure skin disease like leprosy and leucoderma. The gum is used medicinally in south India (Jain, 1984)

Industrial uses

Medicinal plants are the richest bio resource of drugs for traditional system of medicine, modern medicine, nutraceuticals, food supplements, folk medicine, pharmaceutical intermediates and chemical entities for synthetic drugs. The first step in the value addition of medicinal bioresource is the production of herbal drug preparations using variety of methods. The extract is further processed to be incorporated in any dosage form such as tablets and capsules. With the increasing demand for herbal and natural products for health care all over the world, medicinal plant extract manufacturers and essential oil producers have started using appropriate extraction technologies in order to produce extracts and essential oils of defined quality with the least variations from batch to batch (Longo, 2008).

Phytochemical constituents

Preliminary phytochemical analysis revealed the presence of steroids, flavonoids, alkaloids, coumarins, triterpenoids, tannins and carbohydrate, novel tetracyclic phenol, racemosol, in the hexane extract of the hard-wood of *B. racemosa* L bark (Anjaneyulu et al., 1984; El-Hossary et al., 2000). Isolation and structural determination of a new tetracyclic 2, 2-dimethylchroman derivative, de-O-methylracemosol is identified (Anjaneyulu et al., 1984). Preliminary phytochemical studies of genus *Bauhinia* revealed the presence of steroidal glycosides, terpenoids, lactones and flavonoids (Brandis, 1972). Two new compounds, pacharin (I) [S] and racemosol, were isolated along with other known compounds (Cox and Pearson, 1962; El-Hossary et al., 2000). β -sitosterol and β -amyrin probably responsible for the popular use of the plant, were isolated from the stem bark of this plant (El-Hossary et al., 2000). Beside these compounds, at least five flavonols (kaempferol and quercetin) and two coumarins (scopoletin and scopolin) were also isolated from the leaves of the plant. Several phyto constituent of *B. racemosa* have been isolated, chiefly include flavonoids (kaempferol and quercetin), coumarins (scopoletin and scopolin), triterpenoids (α -amyrin), steroids (β -sitosterol), and stilbenes (resveratrol). A new tetracyclic lupeol, betulin, β -sitosterol, and tetracyclic 2, 2-

dimethyl chroman have been isolated from the roots (Jain et al., 2002; Prabhaker et al., 1994).

The seed contains flavonoids, crude protein, and lipid (Iribaren and Pomilo, 2007; Kumar et al., 2010). Palanisamy P et al, perform the isolation and structural determination of a new tetracyclic 2, 2-dimethylchroman derivative, de-O-methylracemosol is presented (Brandis, 1972; Cox and Pearson, 1962). Investigation on this species of *Bauhinia* have resulted in the isolation of two new compounds, pacharin (I) [S] and racemosol, along with other known compounds. The present work on roots has resulted in the isolation of a new compound, de-o-methylracemosol along with racemosol, from *B. racemosa* (Sharanabasappa et al., 2007). identified several chemical constituents of *B. racemosa* mainly as flavonols, coumarins, triterpenoids, stilbenes, steroids and tannins (El-Hossary et al., 2000; Kumar et al., 2005), galactolipid and catechin class of the compounds (1-7) from the most active n-butanol fraction (F4) by bioassay guided fractionation of ethanolic extract of the leaves of *B. racemosa*. Among the active galactolipids, 1 emerged as the lead molecule which was active on both forms of lymphatic filarial parasite, *Brugia malayi*. It was found to be better than the standard drug ivermectin and diethylcarbamazine (DEC) in terms of dose and efficacy (Sharanabasappa et al., 2007). One unknown (1) and 10 known compounds (2–11) from the root bark of *Bauhinia racemosa* Lamk (family: Caesalpiniaceae). Racemosolone (1) was characterised as a pentacyclic phenolic compound possessing an unusual skeleton with a cycloheptane ring and a rare furopyran moiety. The structure elucidation was carried out on the basis of UV, infrared (IR), HR-ESI-MS, 1D and 2D NMR spectra and finally confirmed by the single crystal X-ray analysis. The known compounds were characterised as *n*-tetracosane, β -sitosteryl stearate, eicosanoic acid, stigmaterol, β -sitosterol, racemosol, octacosyl ferulate, de-*O*-methyl racemosol, lupeol and 1,7,8,12b-tetrahydro-2,2,4-trimethyl-2*H*-benzo[6,7] cyclohepta [1,2,3-*de*] benzopyran-5,10,11 triol on the basis of spectroscopic data comparison with the literature value (Jain et al., 2013).

Quantification of β -amyirin in flower buds using HPTLC

Identification and quantification of β -amyirin from *B. racemosa* flower buds was done. Silica gel F 254 was used as the stationary phase with a mobile phase consisting of toluene: ethyl acetate (93:07) V/V. The detection of spots was carried out at a visible wavelength by chemical derivatization. The calibration curve was found to be linear between 2 to 20 μ g/spot for β -amyirin. The limit of detection and limit of quantification for the β -amyirin was found to be 0.15 and 0.49 μ g/spot, respectively. The percentage of β -amyirin ranges from 0.070 to 0.075 percent (Mulik et al., 2015).

Phytochemical and analytical evaluation

Pharmacognostical, physicochemical and fluorescence parameters along with pH value of the bark of BR were determined. HPTLC fingerprinting was carried out by the CAMAG HPTLC system. The loss on drying, total ash, water-soluble ash, acid-insoluble ash, yield of alcohol-soluble crude extracts, yield of water-soluble crude extracts and pH (1% aqueous extract) were found to be 9.1%, 12.5%, 1.5%, 3.0%, 9.25%, 12.5% w/w and 6.96 respectively. Phytochemicals like carbohydrate, steroid, saponin, alkaloid, anthraquinone glycosides, flavonoid and phenolic compounds were found to be present in the methanolic extract. The fluorescence seen in UV light was of different colour in different solvents. 5 peaks were revealed in HPTLC analysis at wavelength 254 nm with max R_f values in the range of 0.47 to 0.94. A peak with max R_f

value of 0.55 comparable to that of quercetin was obtained suggesting the presence of quercetin like flavonoid. The present study will help the future scientists for the correct identification, quality and purity of BR bark or pharmaceutical preparations prepared from it (Md et al., 2015).

Pharmacology

Antimicrobial activity

The aqueous and methanol extract of leaves of *B. racemosa* L. were shows good antimicrobial activity against standard bacterial and fungal cultures. *In vitro* antimicrobial test was performed by agar well diffusion method on Mueller hinton agar and Sabouraud dextrose agar for bacterial and fungal cultures respectively. Minimum inhibitory concentration test was performed by modified agar well diffusion method. Methanol extract showed significantly higher inhibitory effect compared to aqueous extract on tested organisms. The methanol extract showed a broad spectrum of antimicrobial activity as it inhibited Gram negative bacteria (*Escherichia coli*, *Micrococcus luteus*, and *Pseudomonas aeruginosa*), Gram positive bacteria (*Bacillus subtilis*) and fungi (*Candida albicans* and *Aspergillus niger*). Phytochemical analysis of crude methanol and aqueous extract suggested the presence of protein, oil and fats, phenolic compounds, flavonoids, saponins tannins and carbohydrates as major phytochemical groups (Dahikar et al., 2011; Kumar et al., 2010).

Anthelmintic activity

Different extracts of whole plant of *B. racemosa* Linn shows good anthelmintic activity. The different successive extracts namely petroleum ether, ethanol and aqueous using adult Indian earthworms, *Pheretima posthuma* as a test worm. Three concentrations (50, 75, and 100 mg/ml) of each extracts were studied in the bioassay which involved the determination of time of paralysis and time of death of the worm. Albendazole in same concentration as that of extract was included as standard reference and normal saline water as control. The results of present study indicate that the crude ethanolic extract significantly demonstrated paralysis and also caused death of worm in dose dependent manner, while aqueous and petroleum extracts show weak anthelmintic effect (Kuma et al., 2011).

Antitumor effect and antioxidant role

Antitumor activity and antioxidant status of methanol extract (50, 100, and 200 mg/kg) of *B. racemosa* stem bark was evaluated against Ehrlich ascites carcinoma (EAC) tumor in mice. The methanolic extract of *B. racemosa* showed decrease in tumor volume, packed cell volume and viable cell count, and increased the nonviable cell count and mean survival time thereby increasing life span of EAC tumor bearing mice. Hematological profile reverted to more or less normal levels in extract treated mice. Treatment with MEBR decreased the levels of lipid peroxidation and increased the levels of glutathione, superoxide dismutase and catalase. The methanol extract of *B. racemosa* stem bark exhibited antitumor effect by modulating lipid per oxidation and augmenting antioxidant defense system in EAC bearing mice (Gupta et al., 2004)

Antihistaminic activity

Antihistaminic activity of an ethanol extract of *B. racemosa* (at a dose of 50 mg/kg, i.p.) was assessed using clonidine-induced catalepsy and haloperidol-induced catalepsy in Swiss albino mice. The results showed that the ethanol extract inhibits

clonidine-induced catalepsy but there is no effect on haloperidol-induced catalepsy. This suggests that the inhibition is through an antihistaminic action and that there is no role of dopamine. Hence, we concluded that the ethanol extract has significant antihistaminic activity. The polar constituents in the ethanol extract of leaves of *B. racemosa* may be responsible for the antihistaminic activity and *B. racemosa* may therefore have a role in the treatment of asthma (Nimal et al., 2011).

Analgesic activity

Aqueous and alcoholic extracts of dried stem bark of *Bauhinia racemosa* Lam. at a 100, 200 mg/kg body weight were used to evaluate the analgesic activity. Aqueous extract of *Bauhinia racemosa* Lam stem bark at a 200 mg/kg body weight produced significant analgesic activity whereas 100 mg/kg dose did not produce significant results when compared with control ($p < 0.01$) The result of analgesic activity of alcoholic extract produced significant results at both the doses ($p < 0.01$). The findings indicated the analgesic activity of the stem bark of the plant (Borikar et al., 2009; Gupta et al., 2004).

Antiulcer effect

Dried fruit powder of the plant *B. racemosa* was used to study the antiulcer effect in Wistar albino rats. Aqueous and alcoholic extract at a dose level of 100 mg/kg and 200 mg/kg body weight were used in study. After one hour all the groups were administered Paracetamol at a dose rate of 200 mg/kg body weight orally. After 24h, the number of ulcers, ulcer score, percent incidence, ulcer index and healing index were recorded. From the results obtained it was concluded that aqueous extract in the dose rate of 200mg/kg body weight and alcoholic extract (100 mg/kg and 200 mg/kg body weight) could produce antiulcer activity (Gupta et al., 2005)

Hepatoprotective effect

To analyze the hepatoprotective effect biochemical parameter such as SGOT, SGPT, total bilirubin, ALP were estimated, the histopathological analysis was also performed. The test material was found effective as hepatoprotective through *in vivo* and histopathological study (Kodangala et al., 2011).

Anxiolytic effects

Anxiolytic effects of methanolic extract of *B. racemosa* in mice was elevated using the plus-maze model (EPM), light dark model, hole board test, foot shock induced freezing behavior. Furthermore, the anxiolytic-like effects of MEBR were compared to a known active anxiolytic drug (Diazepam). The extract administered orally in two different doses of 150 mg/kg and 300 mg/kg, was able to increase the time spent and the number of arm entries in the open arms of the elevated plus-maze, also increases the time spent by mice in the illuminated side of the light-dark test, showed significant increase in nose poking and decrease locomotion in hole board test, as well as caused significant reduction in freezing time in comparison with control animals. This effect was comparable to that of the benzodiazepine diazepam (2.0 mg/kg p.o.). These results indicate that methanolic extract of *Bauhinia racemosa* is an effective anxiolytic agent (Davey et al., 2011).

Lipid lowering effects

Ethanol extract of leaves of *B. racemosa* showed lipid lowering effects on hyperlipidemic hamsters. BR showed significant lowering of lipid profile at a dose of 250 mg/kg body-wt of hamster. Chloroform fraction (F2) obtained from BR showed pronounced activity at lower dose of 100 mg/kg. F2 gave two most active fractions (L and T) whose

chromatographic separations led to the isolation of constituents 1-5, which are being reported for the first time from this natural source. The results of activity profile of the plant were found to be better than the standard drug lovastatin (Sashidhara et al., 2013).

Anti-HIV-1 activity

Anti-HIV-1 activity of *Bauhinia racemosa* Lam. stems and isolated fractions were studied. Different extracts of *B. racemosa* stems were tested for their anti-HIV-1 activity. Methanol 80% extract of *B. racemosa* was the most active as an anti-HIV-1 agent while the other fractions: ethyl acetate, n-butanol and aqueous extracts were less effective. Phytochemical analysis of the methanol extract and other extracts have shown bioactive components, flavonoids, tannins and terpenes while further chromatographic separation of the bioactive components from methanol extract of *B. racemosa* stems resulted in the isolation and identification of two triterpenic acids: oleanolic and ursolic, two hydrolysable tannins, gallic and ellagic acids, and three flavonoids; luteolin, quercetin 3-O- β -glucoside and myricetin 3-O- β -glucoside. The results show that *B. racemosa* methanol extract has potentials as an anti- HIV-1 agent (Khaled et al., 2013).

Anti-diabetic activity

Diabetes is characterised by higher levels of glucose in blood with decrease in insulin secretion (Lippincott, 2009). Daily oral treatment of alloxan induced diabetic rats with methanol and aqueous extracts of *Bauhinia racemosa* for 20 days could restore the normal biotransformation by shifting the balance of carbohydrate metabolism (Vidwanathaswamy, 2011).

Binder for pharmaceutical dosage forms

B. racemosa seed mucilage is used as a binder in pharmaceutical dosage forms. Natural mucilages are economic, easily available and found useful as tablet binder. No work has been reported on it as a tablet binder. Granules were prepared with its varying concentrations and evaluated for tablet characteristics. The binder concentrations used in the formulation were 2, 4, 6, and 8% w/w. The evaluation of granules showed 0.52 to 0.72 mm granule size, 28 to 31°C angles of repose and 20.53 to 11.81% fines. The evaluation of tablets showed 3.52 - 0.89% w/w friability, 4 to 12 min disintegration time and more than 90% dissolution in 60 min. Tablets at 8% w/w binder concentration showed more optimum results as tablet binder. The mucilage was found to be useful for the preparation of uncoated tablet dosage form (Gangurde and Boraste, 2012).

Larvicidal activity

Larvicidal activity of *B. racemosa* and *Lanata camera* Linn., extracted in petroleum ether. Chloroform and ethyl acetate were tested against mosquito larvae of *A. stephensi*. Late third or early fourth instar larvae were used for the screening. The ethyl acetate extract of *B. racemosa* showed highest larvicidal activity. The results suggest the use of the plants in insect control as an alternative method for minimizing the noxious effect of some pesticide compounds on the environment (Malik et al., 2014).

Economic importance

The leaves of *B. racemosa* are used for making bidis, thus the

plant is commonly known as bidi leaf tree. Also the plant makes good fodder for sheep, goats and cattle. The flowers are of much importance in apiculture and also as a pot herb in curries and made into pickle (chutni). The tree yields a useful gum and fibers. The bark is used for tanning and dyeing. Almost each and every part of this tree possesses some medicinal values. It is planted for its value as well as for its extreme beauty. It is one of the loveliest of Indian trees. The tree is stagger. Its flowers can be found in shades of magenta, lavender, purplish blue or even white. The wood is hard and heavy, thus used for making plough and yokes and also used as fuel (Gupta et al., 2004; Kuma et al., 2011).

Nutritional importance

The Indian tribal pulse of *B. racemosa* was analyzed for pod morphology, proximate composition, seed protein fractions, amino acid composition, minerals and antinutritional factors. The seeds of *B. racemosa* were rich in Ca and Fe. Albumins and globulins constituted less predominant fractions of the seed protein whereas glutelins predominated in *B. racemosa*. The contents of the essential amino acids lysine, tyrosine and phenylalanine were fairly high whereas the contents of sulphur amino acids were low. Further, two germplasms of *B. racemosa*, viz., Ayyanarkoil Forest and Mundanthurai Wildlife Sanctuary were analyzed for their nutritional values. Crude proteins, crude lipids, ash and nitrogen free extractives constituted 19.84%, 9.52%, 3.31% and 60.65%, respectively in Ayyanarkoil Forest germplasm. In Mundanthurai Wildlife Sanctuary germplasm they constituted 19.31%, 8.94%, 3.81% and 61.30%, respectively. The caloric values were found to be 407.64 KCal (Ayyanarkoil Forest) and 402.90 KCal (Mundanthurai Wildlife Sanctuary) germplasms.

Essential amino acids like isoleucine, tyrosine, phenylalanine and lysine were found to be high in the seed proteins of both the germplasms. The fatty acids, palmitic, oleic and linoleic acids were found to be relatively higher in the seed lipids of both the germplasms. Both the germplasms seemed to be a rich source of calcium, potassium, magnesium, zinc, manganese and iron. Anti-nutritional substances like total free phenols, tannins, LDOPA and phyto haemagglutinating activity also were investigated (Davey et al., 2011; Gupta et al., 2004; Nirmal et al., 2011).

CONCLUSION

From the time of immemorial, plants have been widely used as curative agents for variety of ailments. Present study gives a broad information about the bioactive constituents, ethnopharmacology along with the scientifically claimed medicinal uses of *B. racemosa* several alkaloids, carbohydrates, fat, proteins and tannins have been reported to be present in different parts of *B. racemosa*. Plant shows various types of activities such as analgesic, antipyretic, anti-inflammatory, antispasmodic activities and antimicrobial activity which may be due to the presence of the investigated active chemical constituents. The pharmacological studies so far have been performed *in vitro* and *in vivo* systems. Therefore there is need of investigation and quantification of phytoconstituents and pharmacological profile.

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CONFLICT OF INTEREST

We declare that we have no conflict of interest.

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