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BAUHINIA TOMENTOSA: A PHYTOPHARMACOLOGICAL REVIEW

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ABSTRACT
Bauhinia tomentosa commonly known as Yellow bell orchid tree belongs to Fabaceae family, one of the best, versatile and most commonly used household remedy for many manifestations. It is an erect shrub with downy branches, leaves broader than long, coriaceous and pubescent below. The plant is reported to contain amino acids, proteins, fatty acids, minerals, alkaloids, phytosteroids, flavonoids, saponins, tannins, phenolic compounds, fixed oils and fats. Pharmacological studies proved its antioxidant, antibacterial, antifungal, anti hyperglcaemic and antilipedemic activities. It is now considered as a valuable source of unique natural products for development of medicines against various diseases and also for the development of industrial products. This review gives a bird's eye view mainly on the pharmacognostic characteristics, traditional uses, phytochemistry, pharmacological actions and safety evaluation of the plant.
KEYWORDS: *Bauhinia tomentosa*, Antioxidant, Flavonoids

INTRODUCTION

Medicinal plants are part and parcel of human society to combat diseases from the dawn of civilization[1]. There is a widespread belief that the green medicines are healthier and safer than synthetic ones[2].There exists a plethora of knowledge, information and benefits of herbal drugs in our ancient literature of Ayurveda (Traditional Indian Medicine), Siddha, Unani and Chinese medicine. According to the World Health Organization, 2003 about 80 % of the population of developing countries being unable to afford pharmaceutical drugs rely on traditional medicines, mainly plant based, to sustain their primary health care needs[3]. Herbal medicines are in great demand in the developed as well as developing countries for primary healthcare because of their wide biological and medicinal activities, higher safety margins and lesser costs[4, 5]. The present attempt is to review and compile updated information on various aspects of *B. tomentosa* Linn.These plants can be found along the coastal strip from southern Kwazulu-Natal to Maputoland, Mpumalanga as well as Mozambique, Zimbabwe, tropical Africa and as far as India and Srilanka[7]. It is found in the plain southwards of Delhi in the peninsular region, West Bengal and in Asia[6-8].

Bauhinia tomentosa Linn

Bauhinia tomentosa commonly known as Yellow bell orchid tree belongs to Fabaceae family is one of the best, versatile and most commonly used household remedy for many manifestations[9]. The generic name commemorates the Bauhin brothers Jean and Gaspard, the Swiss botanists; the two lobes of the leaf exemplify the two brothers. Tomentosa derived from tomentose, meaning with dense, interwoven hairs. *Bauhinia tomentosa* called as variegated bauhinia, St. Thomas tree, bell bauhinia, orchid tree, hairy bauhinia, mountain ebony, yellow tree bauhinia in English; commonly known as "Kanjana" in Tamil, "Phalgu" in Sanskrit[10] and as adavimandaramu in Telugu[11]. Bauhinia is a genus of more than 200 species of flowering plants in the sub family Cesalpinioideae of the large flowering plant family Fabaceae, with a pantropical distribution. The flower from this tree, rich in pollen and nectar, attract various insects such as butterflies and bees. *Bauhinia tomentosa* is deciduous, but can be evergreen in a mild climate. The adult plants can tolerate a moderate amount of frost, but the seedlings and younger plants should be shielded from the frost. It prefers full sun and needs a moderate amount of water[12].

It is usually a scrambling, many-stemmed shrub or small tree reaching 4 m (max. 8) in height, the branches often drooping, with many slender twigs[11].

Bark grey and smooth or slightly hairy on young branches, becoming brown and smooth on the older stem.

Leaves deeply divided for almost half their length, with a small apical appendage between the lobes; each lobe is oval to almost elliptic, most often small about 2.5 x 2.5 cm, but may be up to 8 cm, pale fresh green; apex of each lobe broadly tapering; base of the whole leaf shallowly lobed; margin entire, petiolate; leaf stalk 10-30 mm long[14].

Flowers bell-shaped, up to 7 cm long, beautiful and distinctive, pendulous, solitary, with large, lemon-yellow petals, 1-3 of which have a dark maroon patch at the base and turning to a veined reddish brown with age. The flowers appears usually in pairs (rarely 1 or 3), on short axillary or leaf-opposed peduncles; bracts linear, 6-13 mm long; pedicels 5 mm long, 2-bracteolate[15].

Calyx 3 cm long, velvety-pubescent; tube 5 mm long; limb 1.3 cm. long, broadly ovate, spathaceous. Petals 3.8-5 cm long, much imbricated, obovate- spathulate, yellow, the upper with a purple blotch on the face[13]. The sepal shows the presence of upper and lower epidermis, centrally vascular bundles as phloem surrounds with the xylem, cortex, parenchyma and also trichomes. The petal shows the presence of upper and lower epidermis, centrally vascular bundles as phloem surrounds with the xylem, cortex. The cross section of ovary shows the presence of trichomes, vein trace, locule, ovule and placenta. Stamens 10, all fertile, subequal. Ovary distinctly stalked, densely tomentosa; style 1.3- 1.6 cm long; stigma peltate. Pods stalked 10-12.5 by 1.3-1.6 cm flat, pointed, and slightly puberulous fully ripe, veined. Trees flower in their 2nd year and are usually very floriferous, bearing flowers during most months of the year. In southern Africa, flowering can be observed from December to March. Flowering can be stimulated by pruning the plants once a year during the winter. For planting in dry areas, it is advisable to obtain seeds from plants growing in dry areas[16].

Fruit a woody pod, slender, pale brown, velvety, pointed, 10-11 x 1.5-2 cm, dehiscent, splitting on the tree to release 6-12 seeds. Seeds 7-8.5 x 5.5-7 x 2-3 mm, ovate, compressed, glossy, reddish brown, somewhat rugose to nearly smooth, with V-shaped marginal hilum, often bearing an apical, hook-shaped funicular remnant. Young fruits appear in January and mature in June or later[12]

B. tomentosa is easily cultivated from seed. The seed should be immersed in hot water and soaked overnight. The soaked, swollen seeds are then planted directly into black nursery bags filled with a mixture of river sand and compost (5:1). If sown in flat seedling trays, the seedlings must be planted out into bags at an early stage as they soon develop a long taproot. Germination is usually within 7-15 days[15].

Microscopic study of powder flower revealed the presence of basal cell of the Trichomes, epidermal cell, stomata, vein – islets, vein –

termination. Microscopic study of pollen and seed revealed the presence of fertile pollen, funicle, pollen, sterile pollen and seed. Sclereids in the flower powder revealed the presence of astrosclereids and filiform sclereids

Traditional Uses

The dried leaf, flower bud and a decoction of the root and bark of *Bauhinia tomentosa* are used medicinally by the African doctors. In India and Sri Lanka, the root bark is used internally for conditions of the large intestine, while the flower is used as a remedy for dysentery and diarrhoea. A decoction of the root bark is used in India as a vermifuge and an infusion of the stem bark as an astringent gargle. The fruit is said to be diuretic, and the seed is eaten in India as a tonic and aphrodisiac. In Madura, the leaf is an ingredient in a plaster applied to abscesses. A decoction of the root bark is used for abdominal troubles and as an anthelmintic. An infusion of the root bark is used as an external application to inflamed glands, abscesses and skin conditions, while the fruit is said to be diuretic and an infusion of the rind is used as an astringent gargle. Bruised bark is applied externally to wounds and tumours. A paste of the seed made with vinegar is used as a local application to the wounds produced by venomous animals[18]. Leaves have anti-diabetic action[7]. All the part of the plant is recommended in combination with other drugs for the treatment of snake-bite and scorpion-sting (Sushruta). Buds and flowers are used in dysentery[6-8]. A food supplement 'Kachnar' is made out of this plant as a gargle for sore throats, as a paste for skin diseases, or internally as a remedy for diarrhoea[19].

Chemical Review

It has been reported to contain amino acids, proteins, fatty acids, minerals, lectins, protocatechuic acid, phytohemagglutinins, rutin, quercetin and isoquercetin[11].Studies suggest that ethanolic extract of the dried leaf contain kaempferol-7-O-rhamnoside, kaempferol-3-O-glucoside, quercetin-3-O-glucoside and quercetin-3-O-rutinoside[20]. Petroleum ether, chloroform, acetone, ethanol, and aqueous extracts of the flower of *Bauhinia tomentosa (Linn.)* showed the presence of carbohydrates, glycosides, alkaloids, phytosteroids, flavonoids, saponins, tannins, phenolic compounds, fixed oils & fats. Further, extracts of the flowers showed the absence of proteins, amino acids, gums and mucilage[21]. Phytoconstituents present in the plant with their structures are listed in Table 1.

Pharmacological Review

Although this plant has been widely used in various symptoms and diseases, only a few pharmacological studies have been reported.

Antibacterial activity

The antimicrobial activities of the petroleum ether (40-60ºC), benzene, chloroform, ethanol and water extracts of the bark of *Bauhinia tomentosa* have been evaluated against two gram positive bacteria, *Staphylococus aureus* and *Enterococcus faecalis*; two gram negative bacteria *Escherichia coli* and *Pseudomonas aeruginosa.*

In vitro preliminary screening of the antimicrobial activity of the various extracts of *Bauhinia tomentosa* was studied against the micro-organisms using the filter paper disc diffusion method. Both the ethanol and water extracts inhibited the growth of all tested strains of bacteria. The benzene extract was effective in the *E. coli* only. But the petroleum ether and the chloroform extracts were resistant to all the tested strains of bacteria and fungus. The ethanol extract showed the maximum activity followed by water extract. The difference in the activity may be due to the different secondary metabolites present in the ethanol and the water extracts. The ethanol extract of *Bauhinia tomentosa* at the concentration of 1000 µg/ml shows antimicrobial activity on the tested microorganism in the following decreasing order, *P.auriginosa* (23mm), *E.coli* (20mm), *S. aureus*(18mm) and *E.faecalis* (16mm). The results were also expressed by means of Active Index and Proportion Index. The water extract of *Bauhinia tomentosa* at the concentration of 1000 µg/ml shows antimicrobial activity on the tested microorganism in the following decreasing order, *P.auriginosa* (19mm), *E.coli* (14mm), *S. aureus*(12mm), and *E.faecalis.* The results indicate that the gram negative bacteria, *P.auriginosa* shows the highest activity in both the ethanol and water extracts. The antimicrobial activity of the ethanol extract (23 mm) is higher than that of water extract (19 mm)[21].

Antifungal activity

The antifungal activities of the petroleum ether (40-60ºC), benzene, chloroform, ethanol and water extracts of the bark of *Bauhinia tomentosa* have been evaluated against two fungi, *Candida albicans, Candida tropicalis* by using zone of inhibition method. The antimicrobial effects of plant extract against the different fungi illustrated the effectiveness of both the ethanol and water extracts, whereas the benzene extract was found to be ineffective. The petroleum ether and the chloroform extracts were resistant to all the tested fungus. The ethanol extract showed the maximum activity followed by water extract. The difference in the activity may be due to the different secondary metabolites present in the ethanol and the water extracts.

The ethanol extract of *Bauhinia tomentosa* at the concentration of 1000 µg/ml exhibited higher antimicrobial activity on *C.albicans* (21mm) compared to *C.tropicalis* (19mm). The results were also expressed by means of Active Index and Proportion Index. The water extract of *Bauhinia tomentosa* at the concentration of 1000 µg/ml illustrated higher antimicrobial activity on *C.albicans* (13mm) compared to *C.tropicalis* (11mm)[21].

Antioxidant activity

The antioxidant efficacy of ethanol extracts of the *Bauhinia tomentosa* (Linn.) flower was assessed by streptozotocin induced diabetis[22]. Oxidative damage was studied by assessing parameters such as thiobarbituric acid reactive substances (TBARS), Superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPx), reduced glutathione (GSH) and glutathione-S-transferase (GST) in liver and kidneys, and also serum glutamate oxaloacetate transferase (SGOT), serum glutamate pyruvate transaminase (SGPT), Alkaline phosphatase (ALP), Total Protein in serum, liver and kidneys[23]. Elevated level of TBARS and hydroperoxides in liver and kidneys of diabetic control is a clear manifestation of excessive formation of free radicals and activation of lipid peroxidation system. The significant decline in the concentration of these constituents in *Bauhinia tomentosa* administered rats unveils antioxidant efficacy of *Bauhinia tomentosa*. The results are further supported by the elevation of antioxidant enzymes, such as SOD, CAT, GST and GPx in the treated groups compared to normal control. This may be due to the innate mechanism of the body to combat oxidative stress of a milder nature by secreting the enzymes in elevated levels. When the stress persists for a longer duration, and also turns to be severe, the inbuilt mechanism of the body falls to alleviate the damage. It is at this juncture that the plant extract is suggested to have triggered the secretion of antioxidant enzymes in enhanced levels which in turn stopped the oxidative damage due to diabetis. Further increment in the production of enzymes in liver and kidney of the extract co-administered animals may be due to the capacity of the extract to stop the oxidative damage by hyperlipidemia[24].

Anti hyperglycaemic and antilipidemic activity

The anti hyperglycaemic effect of the ethanolic extract of *Bauhinia tomentosa* (Linn.) flower was evaluated for the management of streptozotocin-induced diabetes[25]. The Streptozotocin-diabetic rats showed significant ($p < 0.05$) reduction in plasma glucose from 251.39 ± 11.45 mmol/L in the diabetic group to 137.01 ± 3.02 mmol/L and 144.41 ± 6.27 mmol/L in the group treated with 100mg/kg and 200mg/kg of Bauhinia tomentosa. Levels of plasma

insulin and glycosylated haemoglobin ($HbA1_C$) were also significantly reduced ($p < 0.05$). STZ is toxic to pancreatic β-cells and is thus widely used for induction of experimental diabetes mellitus in animals, resulting in the production of ROS[26]. STZ causes a significant elevation in the level of blood glucose in rats. Administration of 100 mg/kg and 200 mg/kg body weight of *Bauhinia tomentosa* significantly decreased the blood glucose level in these rats suggesting that it has hypoglycemic properties. Diabetic rats exhibited a reduction in body weight which may be attributed to excessive breakdown of tissue proteins[27]. Treatment with *Bauhinia tomentosa* improved body weight significantly in a dose dependent manner, indicating prevention of muscle wasting due to hyperglycemic condition. The rise in blood sugar is accompanied with the increase in TC, LDL-c, TG and fall of HDL-c. Diabetes is also known to be associated with an increase in the synthesis of cholesterol, which may be due to the increased activity of HMG CoA reductase[28]. Increased LDL-cholesterol may arise from glycosylation of the lysyl residues of apoprotein B as well as from decreasing affinity for the LDL receptor and hence, decreased metabolism[29]. A number of observations indicate that plasma HDL cholesterol is low in untreated insulin-deficient diabetics, which was associated with a decline in HDL-turnover rate[30]. Further the HDL-cholesterol levels correlate with lipoprotein lipase (LPL) levels in IDDM patients[31].

Oral administration of ethanolic extract of *Bauhinia tomentosa* exhibited hypocholesterolemic and hypotriglyceridemic effects while at the same time increasing HDL-c, possibly by controlling the hydrolysis of certain lipoproteins and their selective uptake and metabolism by different tissues. This implies that *Bauhinia tomentosa* can reduce the complications of lipid profile seen in some diabetics in whom hyperglycaemia and hypercholesterolemia coexist quite often[32].

Immunomodulatory / Anti-Inflammatory activity

Study of methanolic extract in mice showed immumodulatory effects and nitric-oxide radical scavenging activity. Also, an anti-inflammatory effect was evidenced by significant reduction in acute inflammation of paw edema induced by carrageenan and formalin[33].

Safety Evaluation

Study to evaluate the toxicological effects of an aqueous leaf extract of B. tomentosa in Wistar albino rats showed the extract to be safe on bone marrow function and no hepatotoxic or nephrotoxic effects on all markers and parameters[34].

CONCLUSION

Medicinal plants have provided copious leads to combat diseases, from the dawn of civilization. The extensive survey of literature revealed that *B. tomentosa can be* regarded as a universal panacea in the herbal medicine with diverse pharmacological activity spectrum. This versatile medicinal plant is the unique source of various types of chemical compounds, which are responsible for the various activities of the plant.

It is strongly believed that detailed information as presented in this review on the phytochemicals and various biological properties of the plant extracts might provide detailed evidence for the use of this plant in different medicines. Historically, *B.tomentosa* has been used for a number of ethnobotanical purposes. Presently it has become an important source of medicine for curing various human and animal diseases.

Unfortunately, most of the compounds have not properly been evaluated for the exploration of new lead molecule or pharmacophore. Moreover mechanisms of action of only a few bioactive compounds have been identified so far. Hence, extensive research is required to find out the mechanisms of action as well as bioactivity of the various phytochemicals and efficacy of the medicinal values. Thus in the near future *B. tomentosa* extracts could be further exploited as a source of useful phytochemical compounds and may play a very important role in modern system of medicine.

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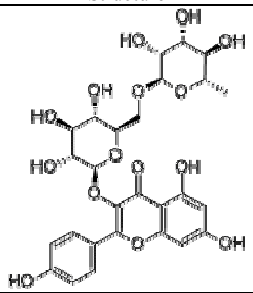
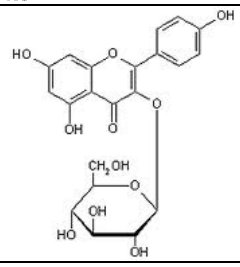
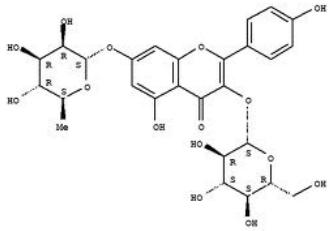
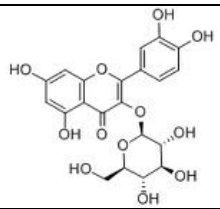
Table 1: PHYTOCONSTITUENTS OF *B. TOMENTOSA*

Chemical constituent	Structure
Kaempferol-7-O-rhamnoside	
Kaempferol-3-O-glucoside	
Quercetin-3-o-rutinoside	
Quercetin-3-O-glucoside	



1(a) **1(b)** **1(c)**

Figure 1(a,b,c) representing the whole plant, fruit and flower of Bauhinia tomentosa