The Pharmacological Importance of Bauhinia variegata. A Review

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Abstract:

Bauhinia variegata L. was widely used in traditional medicine to treat a wide range of complains. It contained many secondary metabolites which are suitable to be used as medicines. The phytochemical screening revealed that *Bauhinia variegata* contained terpenoids, flavonoids, and tannins, saponins, reducing sugars, steroids and cardiac glycosides. The pharmacological studies showed that *Bauhinia variegate* exerted anticancer, antioxidant, hypolipidemic, antimicrobial, anti-inflammatory, nephroprotective, hepatoprotective, antiulcer, immunomodulating, molluscicidal and wound healing effects. This review aimed to highlight the chemical constituents and the pharmacological and therapeutic effects of *Bauhinia variegate.*

Keywords: *Bauhinia variegate*, phytochemistry, pharmacology

Introduction:

Plants are a valuable source of a wide range of secondary metabolites, which are used as pharmaceuticals, agrochemicals, flavors, fragrances, colors, biopesticides and food additives.

Plants have been used as drugs by humans since thousands of years ago. As a result of accumulated experience from the past generations.

Bauhinia variegata L (Synonyms: *Phanera variegata* Benth**)** [(1-2)]**,** which commonly known as mountain ebony, orchid-tree, poor-man's orchid, camel's foot and Napoleon's hat [(2-3)], belongs to the family Leguminosae. It was planted in garden, park and roadsides as ornamental plant in many warm temperate and subtropical regions. It was native to Southeast Asia and grows in tropical and subtropical climate [(4-6)]. All parts of the plant (leaves, flower buds, flower, stem, stem bark, seeds and roots) were used in traditional medicine. It was traditionally used in the treatment of bronchitis, leprosy, and tumors. The stem bark was used as astringent, tonic, anthelmintic and antidiabetic. Infusion of the leaves was used as a laxative and for piles. Dried buds were used in the treatment of worm infestations, tumors, diarrhea, and piles [(7-12).]

The phytochemical screening revealed that *Bauhinia variegata* contained terpenoids, flavonoids, tannins, saponins, reducing sugars, steroids and cardiac glycosides. Pharmacological studies showed that *Bauhinia variegate* exerted anticancer, antioxidant, hypolipidemic, antimicrobial, anti-inflammatory, nephroprotective, hepatoprotective, antiulcer, immunomodulating, molluscicidal and wound healing effects. The objective of the present review is to highlight the chemical constituents and the pharmacological and therapeutic effects of *Bauhinia variegate.*

Physicochemical properties:

The physicochemical characteristics of the oils for *B. variegate* were investigated , and mean values were found to be **:** refractive index (40 ºC) 1.4589 ± 0.001 , iodine value (g of I2/100g of oil) 84.5 ± 1.6 , saponification values (mg of KOH /g of oil) 191.3 ± 1.9 , peroxide value (meq O2 / kg of oil) 1.9 ± 0.6 , unsaponifiable matter (%) 0.9 ± 0.4 , color (1″ cell) red unit 2.2 ± 0.5 , yellow unit 30.0 ± 1.1 , moisture (%) 6.7± 0.46, ash (%) 4.8± 0.1 and fiber (%) 6.9 ± 0.8[(13)] **.**

Extractive values of the leaves were: methanol 11.50%, alcohol 17.60%, benzene 5.84%, petroleum ether 0.45% and chloroform 1.10%. While the extractive values of the bark were: methanol 13.2% , alcohol 19.00% , benzene 5.70% , petroleum ether 0.52%and chloroform 1.25%[(13-14)].

Chemical constituents:

The phytochemical screening of *n*-hexane chloroform, ethyl acetate and methanolic fractions of *B. variegata* flowers revealed the presence of terpenoids, flavonoids, tannins, saponins, reducing sugars, steroids and cardiac glycosides [15].

Phytochemical analysis of non woody aerial parts yielded 6 flavonoids, namely kaempferol, ombuin, kaempferol 7,4'-dimethylether-3-o-β-D- glucopyranoside, kaempferol-3-o-β-D-glucopyranoside, isorhamnetin-3-o-β-D-glucopyranoside and hesperidin together with one triterpene caffeate, 3β trans-(3,4 dihydroxycinnamoyloxy) olean-12-en-28-oic acid[16].

The stem bark is reported to contain 5,7 dihydroxy and 5,7 dimethoxy flavanone-4-O--L rhamnopyrosyl-β-D-glycopyranosides, Kaempferol-3-glucoside, lupeol, and betasitosterol [17-19]

Constituents isolated from the leaves were included lupeol, alkaloids, oil, fat glycoside, phenolics, lignin, saponins, terpinoids, β-sitosterol, tannins, kaempferol-3-glucoside , rutin, quercetin, quercitrin, apigenin, apigenin-7-O-glucoside, amides, carbohydrates, reducing sugars, protein, vitamin C, fibers, calcium and phosphorus[14,20-23].

B. variegate seeds contained 18.0 ± 0.9% total oils and 41.9 ± 1.6% total proteins, 0.6 ± 0.1 % free fatty acids and 28.4 ± 1.6% carbohydrates. Fatty acids contents of *Bauhinia variegata* oil (%), were included palmitic 22.1 ± 1.5 , palmitoleic 0.4 ± 0.1 , margaric 0.3±0.04 ,stearic 17.5 ±1.7 , oleic (C18:1 cis 9) 13.4 ± 0.8 , oleic (C18:1 cis 7) 0.5 ± 0.1 , linoleic 42.1± 1.8 , linolenic (C18:3 n-3) 0.6 ± 0.4 , linolenic (C18:3 n-6) 0.5 ± 0.1 , archidic 1.3 ± 0.6 , behenic 0.5 ± 0.2 , eicosapentaenoic 0.2 ± 0.4 and nervonic acid 0.6 ± 0.6 . The total saturated fatty acids were 41.7%, total monounsaturated fatty acids were 15.1 % and total polyunsaturated fatty acids 43.2% of the total lipids [13].

Anticancer effects:

The ethanolic extract of *B. variegata* possessed antitumor effect in Dalton's ascitic lymphomas [24]; it was also protected liver from the cytotoxic effect of diethyl nitrosamine [25]. The ethanolic extract was also showed cytotoxicity on EAC mouse cell lines [6]. The methanolic extract of stem bark of *B. variegate* (at a dose of 500 and 1000 mg/kg bw) exerted anticancer effects in skin papilloma model against 7, 12- dimethylbenz (a) anthracene and croton oil induced skin carcinogenesis in mice. It was effective in decreasing the rate of tumor incidence and the cumulative number of papillomas. Tumor yield and tumor burden were also found to be reduced. The depleted level of glutathione was restored in *B. variegata* bark extract treated groups [26].

Ethanolic extract of the stem of *B. variegata* showed chemoprevention and cytotoxic effect against N-nitrosodiethylamine induced experimental liver tumor in rats at a dose of 200mg/kg, and also on human cancer cell lines. Ethanolic extract suppressed liver tumor induced by N-nitrosodiethylamine as revealed by decrease in N-nitrosodiethylamine induced elevated level of serum glutamate pyruvate transaminase , serum glutamate oxaloacetate transaminase , alkaline phosphatase , total bilirubin, gamma glutamate transpeptidase , lipid peroxidase , glutathione peroxidase and glutathione-S-transferase [25]. Ethanolic extract was found to be cytotoxic against human epithelial larynx cancer and human breast cancer (HBL-100) cells [25].

Antioxidant effects:

The crude extracts and fractions of *B. variegata* were evaluated for their antioxidant potential. The antioxidant activity was performed by DPPH radical scavenging assay. Generally the lowest antioxidant activity was found in chloroform fraction. The ethyl acetate, methanol and *n*-hexane fractions showed moderate scavenging activity as compared to standard querceitin [15].

The ethanolic and aqueous extracts of the stem bark and root of *B. variegata* L. were assessed for in vitro antioxidant activity by various methods including , total reducing power, scavenging of various free radicals such as 1,2-diphenyl-2-picrylhydrazyl (DPPH), super oxide, nitric oxide, and hydrogen peroxide. Significant antioxidant activity was observed in all the methods ($P \geq 0.01$) for reducing power and ($P \geq 0.001$) for scavenging DPPH, super oxide, nitric oxide, and hydrogen peroxide radicals [19].

Hypolipidemic effects:

The ethanolic and aqueous extracts of the root of *B. variegata* (200 and 400 mg/kg body weight) in rats, showed significant reduction ($P \geq 0.01$) in cholesterol and significant reduction ($P \geq 0.01$) in triglyceride level. The VLDL level was also significantly ($P \geq 0.05$) reduced, with a significant increase in HDL [19]. The anti-hyperlipidemic activity of fractions of total methanol extract of leaves of *Bauhinia variegata* was investigated against Triton WR-1339 induced hyperlipidemia in rats. Fractions were administered at a dose of 100mg/kg orally. Butanol fraction showed significant reduction ($p<0.05$) in serum cholesterol, triglyceride, LDL, VLDL and increase in HDL level in comparison with standard drug fenofibrate ($p<0.05$) [12].

The antiobesity effect of methanolic extract of stem and root barks of *Bauhinia variegata* was examined in female rats fed with hypercaloric diet. The methanolic plant extract (200 and 400 mg/kg) exhibited a significant hypolipidemic effect with a reduction in the feed intake and body weight. Treatment of obese animals with the

methanolic extract of *B. variegate* exhibited an increased brain serotonin level and high density lipoprotein with a concomitant decrease in total cholesterol, triglycerides and low density lipoprotein. Thus the antiobesity activity of methanolic extract of *B. variegata* could be attributed to tendency of the extract to reduce lipid profile and elicit the brain serotonin level [27]

Antimicrobial effects:

The antibacterial (against *Escherichia coli* MTCC 64, *Enterobacter aerogenes* MTCC 111, *Klebsiella pneumoniae* MTCC 39, *Pseudomonas aeruginosa* MTCC 424, *Salmonella typhi, Bacillus subtilis* MTCC 121) , of the ethanolic extracts of *Bauhinia variegata* were investigated *in vitro* . It appeared that the extracts were more effective against gram positive compared to gram negative bacteria [6].

The extracts of *B. variegata* and fractions were evaluated for their antibacterial potential against selected bacterial strain (*Staphylococcus aureus, Bacillus subtilis* and *Klebsiella pneumonia*). The chloroform and methanolic fractions of *B.variegata were* found to be active against *Staphylococcus aureus, Klebsiella. pneumonia, Bacillus subtilis* and showed high inhibitory zone of (14 nm) at the concentration of 22 mg/ml [15]. The antimicrobial effect of *Bauhinia variegata* L. leaf and bark extract was evaluated on Gram positive species *Staphylococcus aureus* and *Bacillus subtilis* and Gram negative species *Escherichia coli* and *Pseudomonas aeruginosa.* The alcoholic extract of leaves of *Bauhinia variegata* shows maximum antimicrobial activity compared with petroleum ether and chloroform extracts [14]. Ethanolic extract of the stem bark of *B. variegata* exerted antimicrobial activity against *B. subtilis, P. aeruginosa, S. typhi, S. dysenteriae, S. aureus* and *Vibrio cholerae*. It was more effective against gram positive than gram negative bacteria [28-29]. Methanolic extracts of leaves of *Bauhinia variegata* also showed antifungal activity against *Aspergillus fumigates* and *Aspergillus niger* [30].

Anti-inflammatory effects:

Phytochemical analysis of non woody aerial parts of *Bauhinia variegata* yielded 6 flavonoids with one triterpene caffeate. These seven compounds showed anti- inflammatory activity, they inhibited the lipopolysaccharides and interferon γ induced nitric oxide (NO) and cytokines [31]**.**

Nephroprotective effect:

The antioxidant and nephroprotective effect in gentamicin-induced nephrotoxicity of the ethanolic and aqueous extracts of root of *Bauhinia variegata* Linn (200 and 400 mg/kg bw, orally) was examined in rats. Both ethanolic and aqueous root extracts of *Bauhinia variegata* produced significant free radical scavenging activity. Both extracts produced significant nephroprotective activity in gentamicin induced nephrotoxicity model as evident by decrease in elevated serum creatinine, serum urea, urine creatinine and BUN levels, which was further confirmed by histopathological study [32].

Nephroprotective activity of the ethanolic and aqueous extracts of root of *Bauhinia variegata* at a dose of 400 mg/kg bw was evaluated by gentamicin and cisplatin induced nephrotoxicity in rats**.** Both extracts showed nephroprotective activity in both gentamicin and cisplatin induced nephrotoxicity models as evident by decrease in serum creatinine, serum urea, urine creatinine and BUN levels in extract treated groups which was elevated by gentamicin and cisplatin in the respective models, which also confirmed by histopathological study[1].

Hepatoprotective effect:

The ethanolic extract of the stem of *B. variegata* showed chemoprevention against N- nitrosodiethylamine induced experimental liver tumor in rats. Ethanolic extract suppressed liver tumor induced by N-nitrosodiethylamine as revealed by decrease in N-nitrosodiethylamine induced elevated level of serum glutamate pyruvate transaminase , serum glutamate oxaloacetate transaminase , alkaline phosphatase , total bilirubin, gamma glutamate transpeptidase , lipid peroxidase , glutathione peroxidase and glutathione-S-transferase[25]. The ethanolic extract of the stem bark of *B. variegate* (at the dose of 100 and 200 mg/kg orally) showed hepatoprotective activity against carbon tetrachloride induced hepatotoxicity in rats, it decreased the level of AST, ALT, ALP and GGT [33].

Antiulcer effects:

In gastric ulcer induced by pyloric ligation and in aspirin induced ulcer model in rats, the ethanolic extract of *B.variegata* decrease the volume of gastric secretion, total free acidity and ulcer index [34].

Immunomodulatory effect:

The ethanolic extract of the stem bark of *B. variegata* showed immunomodulatory activity on the primary and secondary antibody responses. It was also increased phagocytic index and percentage neutrophil adhesion [35].

Effect on wound healing:

Excision and incision wound models in albino Wistar rats, were used to evaluate the wound healing activity of the ethanolic and aqueous extracts of root of *Bauhinia variegata* at dose of 200 and 400 mg/kg bw. Both aqueous and ethanolic extracts of root of *Bauhinia variegata* at both doses produced significant wound healing by excision and incision wound models, which was comparable to that of standard (framycetin) in excision wound model[(1)] .

Molluscicidal effects:

The molluscicidal activity of *Bauhinia variegata* leaf was studied against vector snail *Lymnaea acuminata*. The toxicity of the plant was time and concentration-dependent. Among organic extracts, ethanol extracts of the plant were more toxic. The toxicity of *B. variegata* leaf ethanolic extract was (96h LC_{50}- 14.4 mg/L). The 24h LC_{50} of column purified fraction of *B. variegata* was 20.3 mg/L. Saponin and quercetin were characterized and identified as active molluscicidal component[(36-37)].

Contraindication and adverse effects:

There was no mortality and noticeable behavioral changes in rats treated by the aqueous and ethanolic extracts of stem and root of *B. variegata* Linn. The aqueous and ethanolic extracts of the stem and root of *B. variegata* Linn were found to be safe up to 2000 mg/kg body weight[(19)].

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