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# Heptoprotective potential of *Bauhinia variegata*: A review

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**Abstract**

Native Indians employ the plant *Bauhinia variegata* (Fabaceae) extensively for therapeutic purposes. It is well-known in many traditional medical systems, including Ayurveda, Unani, and homoeopathy. Traditional medicine made use of every part of the plant, including the leaves, flower buds, flower, stem, stem bark, seeds, and roots. These days, liver disease is one of the biggest global health issues, with a high prevalence in underdeveloped nations. The main causes of them are chemicals and some medications when taken in extremely high concentrations. Despite the advancements in contemporary medicine, there is still no cure that can protect the liver from harm or promote the regeneration of hepatic cells. As a result, the demand for efficient medications to complement or replace those now in use is essential. According to scientific studies, Bauhinia variegata has enormous biological potential. The health-promoting phenolic compounds, proteins, vitamin C, and flavonoids found in Bauhinia variegata have been demonstrated to have good anti-oxidative and anti-inflammatory qualities both in vitro and in vivo. These chemicals can scavenge free radicals and shield the liver from harm. Because Bauhinia variegata has a variety of phytomedicines that work synergistically to treat liver illnesses, this review aims to support researchers studying this plant as potential hepatoprotective mediators.

**Keywords:** Hepatoprotective, liver disorders, hepatoprotective action, *Bauhinia variegata*.

## Introduction

The liver is essential for the detoxification and removal of several endogenous and exogenous substances. Any damage to its functionality could have a significant impact on a person's health. Contemporary science still faces difficulties in managing liver illnesses [1]. The main causes of liver illnesses are alcohol intake, infections, autoimmune disorders, and toxic substances. The liver's fundamental function in the metabolism and deposition of foreign chemicals appears to be the reason for its increased

susceptibility to chemical agent harm. However, fibrosis, the creation of scars, and the modification of normal tissue architecture are frequently the results of chronic liver injury [2]. Lipid peroxidation and other forms of oxidative damage are the principal ways that the majority of hepatotoxic substances harm liver cells [3, 4]. Additionally, the liver can heal itself following acute injury by hepatocellular regeneration, which is the growth of new cells that return the liver's normal tissue homeostasis and functioning. Thus, prevention of hepatic damage requires restriction of the production of free radicals. For a very long time, plants have been a vital source of natural materials to preserve human health; as a result, a lot of research has been done on the medicinal uses of plants. Plants are a natural supply of antioxidants, which makes them useful in the treatment of many disorders like liver damage that are caused by oxidative stress.

A deciduous plant belonging to the Fabaceae family, Bauhinia variegata is found across tropical and subtropical regions of the world, including China and India. It goes by the indigenous Indian names "Kachnar" and "kanchana," but it is also referred to as "orchid-tree" and "mountain ebony" [5]. Indian tribes utilise it extensively as a medicinal plant and cattle feed [6, 7]. It has also been incorporated into a number of traditional medical systems, including Unani and Ayurveda. A wide range of diseases can be treated with different components of plants, including as leaves, flower buds, flowers, stems, stem bark, seeds, and roots. Traditionally, this plant's parts have been utilised for a variety of purposes, including liver tonic, antimicrobial, and suppression of edoema resulting from kidney failure [8]. This vegetable was utilised by people living in the mountainous regions of Punjab's northeast to treat a variety of illnesses, including liver problems. Over the last ten years, this plant has been the subject of extensive pharmacological testing, and numerous experimental animal models have shown it to have positive effects against a variety of illnesses. This study examines the body of research on the hepatoprotective properties of Bauhinia variegata, including identified specified compounds and crude plant extracts. These results increase the likelihood and flexibility of assisting researchers in identifying substances with higher potential for hepatoprotection.

**Methodology**

Using Elsevier-Science direct, SpringerLink, Wiley Interscience (Wiley), Pubmed, and Google Scholar, we searched the literature up until December 2021. The following keywords were used in the search: hepatoprotective, liver disorders, hepatoprotective action, and medicinal plants, Bauhinia variegata.

**Medicinal importance of *Bauhinia variegata***

In most tropical nations, including those in Africa, Asia, and South America, the plant is widely distributed. In folk medicine, Bauhinia's leaves, blossoms, and stem bark have been used repeatedly to treat a variety of illnesses [9].The leaves have strong nutritional content and are enhanced with decreasing sugar to support the proper development of tasar silk worms. To make biddies, the leaves are utilised. The carminative root is used to treat dyspepsia, flatulence, and as a snake venom countermeasure [10]. The bark is used for scrofula and other skin conditions; it is also astringent, tonic, and anthelmintic. The flower juice is used to treat stomach issues such as dysentery and diarrhoea. The dried buds are used to cure tumours, piles, diarrhoea, and dysentery [11]. According to Ayurvedic literature, the plant is said to possess Katuvipaka, Rukshaguna, Kasaya rasa, and Shitavirya. The stem bark of Bauhinia variegata is used to treat wounds, cervical lymphadenitis, gandamala (scrofula), and krinnroga (worm infection) [12].

Traditional medicine made use of every part of the plant, including the leaves, flower buds, flower, stem, stem bark, seeds, and roots. It was frequently used to treat tumours, leprosy, and bronchitis. Stem bark was employed as a tonic, anthelmintic, astringent, and antidiabetic. The leaves were infused and used for piles as well as a laxative. Dried buds were applied topically to cure piles, diarrhoea, tumours, and worm infestations [13–18].

The flower buds of B. variegata were used by the locals of Ghatigaon woods, Gwalior, Madhya Pradesh, to treat diarrhoea, dysentery, and haemorrhoids [19]. The flowers are employed as a laxative, an anthelmintic, and in the treatment of piles, including edoema and dysentery [20, 21]. Moreover, the bark has tonic properties for the liver and is astringent for the intestines [22]. The researcher has attempted to substantiate the efficacy of B. variegata as a restorative agent by pharmacological tests, in response to numerous assertions regarding its curable characteristics.

**Pharmacological importance of *Bauhinia variegata***

Plant-based healthcare systems are still vital, and the World Health Organisation estimates that 80% of people worldwide receive their basic medical treatment mostly from traditional medicine [23]. According to recent research, Bauhinia variegata has anti-inflammatory, anti-cancer, hypolipidemic, antibacterial, nephroprotective, hepatoprotective, immunomodulating, molluscicidal, and wound-healing properties [18, 24].

Antipathogenic activity

Bipolaris sorokiniana's resistance against the pathogen was shown by the aqueous extract of leaves, which was connected with higher PAL and β-1, 3-glucanase enzyme activities as well as the presence of coumaric acid [25].

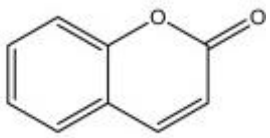


Figure 1: Molecular structure of coumaric acid

Antioxidant activity

The polar sub-fractions of the methanolic extract of Bauhinia variegata bark show strong antioxidant properties and the ability to shield pBR322 DNA from oxidative damage caused by $H_2O_2$. The abundance of phenolic and flavonoid chemicals in Bauhinia variegata bark extract/fractions may be responsible for their strong $H_2O_2$ antioxidant activity and capacity to protect DNA [26].

Antihyperlipidemic activity

Rats with induced hyperlipidemia due to Triton WR-1339 (tyloxapol) were used to test the antihyperlipidemic activity of the leaf methanolic extract. Previous research findings indicated that the butanol component of B. variegata increased HDL levels while also significantly reducing levels of cholesterol, triglycerides, LDL, and VLDL [27].

Immunomodulatory activity

When compared to a control group, stem bark Bauhinia variegata dramatically boosted human neutrophil phagocytic function, suggesting a potential immunostimulating impact. The increased number of cells reaching the lower surface of the filter indicates that the stem bark extracts from Bauhinia variegata Linn greatly boosted the neutrophil chemotactic migration [28].

Antimicrobial activity

E. coli, S. flexneri, gramme negative P. aeruginosa, gramme positive S. aureaus, gramme positive S. epidermis, and gramme negative E. coli were used to determine the antimicrobial efficacy of the methanolic extract of Bauhinia variegata flower. Research reveals that the development of microorganisms was dose-dependently suppressed by the methanolic extract of Bauhinia variegata flower [29].

Antitumor activity

The ethanolic extract of Bauhinia variegata was found to have anticancer effect in rat liver tumours and Dalton's ascetic lymphoma (DAL) in Swiss albino mice. When compared to the carcinogen-treated control, the topical administration of Bauhinia variegata leaves extract during the pre-promotion period shown a substantial reduction in tumour occurrence, tumour load, tumour weight, tumour size, and cumulative number of papillomas [30].

Cytotoxic activity

In Swiss albino mice, the ethanolic extract of Bauhinia variegata demonstrates strong cytotoxic action against Ehrlich ascites cancer. The growth of solid tumour masses brought on by EAC cells was effectively inhibited by the oral administration of Bauhinia variegata's ethanolic extract [31].

Anti-inflammatory activity

An examination was conducted using the carrageenan-induced hind paw edoema method to examine the anti-inflammatory properties of an ethanolic extract of Bauhinia variegata root in albino rats. There was a moderate reduction in inflammation caused by the plant extract [32].

Antipyretic activity

Rats that were given pyrexia generated by Brewer's yeast had their ethanolic extracts of Bauhinia variegata and Glycosmis pentaphylla examined for their antipyretic properties. The hypothalamus's suppression of prostaglandin production was the cause of activity [33].

Wound healing properties

The following herbs were combined to make 10% weight/weight ointment: Bauhinia variegata, Rhododendron arboreum, and Myrica esculenta, in that order. Rats treated with herbal ointment in the excision wound model showed complete healing after nine days of observation, but the wound areas of the rats treated with framycetin, the blank group, and the control group remained at 2.72%, 4.5%, and 5.73%, respectively [34].

Anti-eosinophilic properties

A substantial dose-dependent decrease in total leucocyte and eosinophil was seen when the reaction of aqueous and ethanolic extracts of Bauhinia variegata was assessed against milk-induced leucocytosis and eosinophilic in mice [35].

Antidepressant property

At doses of 100 and 200 mg/kg given for 7 and 14 consecutive days, Bauhinia variegata methanolic extract demonstrated a strong antidepressant-like effect, as evidenced by a decrease in mice's immobility in the Tail Suction Test (TST) and Forced Swim Test (FST). When compared to imipramine, Bauhinia variegata demonstrated considerable antidepressant efficacy. [36]

Antianxiety property

Swiss albino mice were subjected to the elevated plus maze (EPM) apparatus in order to assess the antianxiety activity. The study determined that a methanolic extract (100 mg/kg, p.o.) of seeds and leaves (200 mg/kg) considerably lengthened the duration of time spent in the EPM's open arms. Its antianxiety action was good and it was comparable to that of buspirone from Bauhinia variegata [37].

Anti-stress property

An assessment was conducted on the effects of Bauhinia variegata's ethanolic bark extract on oxidative stress caused by iron overload (IO) and cold restraint stress (CRS). Changes in the antioxidant enzymes GSH, CAT, SOD, and LPO were discovered. In stress models, the extract effectively controlled the changes in biochemical levels and antioxidant enzymes brought on by stress [38].

Neuroprotective property

The acetone-soluble leaf extract of Bauhinia variegata was tested for its neuroprotective properties using a rat model of reserpine-induced catalepsy. When comparing the drug-treated groups to the disease-induced group, the extract dramatically reduced the levels of Bauhinia variegata lipid peroxidation, increased the levels of antioxidant enzymes, and decreased catalepsy [39].

Anticataract property

The anticataract research employed a flavonoid called rhamnocitrin (10, 20, 40, and 80 µg) that was extracted from the stem bark of Bauhinia variegata to evaluate the effects on ovine and chick embryo lens models. The study's conclusion was that, in a dose-dependent way, rhamnocitrin protected the lens from cloudiness brought on by hydrocortisone and hydrogen peroxide [40].

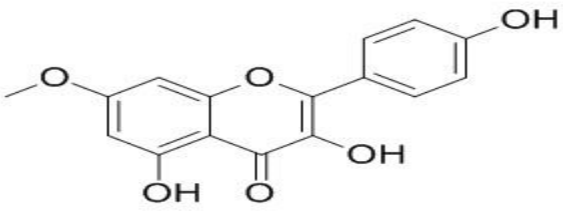


Figure 2: Molecular structure of rhamnocitrin

Anti-ulcer property

Rats were used to test the anti-ulcer properties of an alcoholic stem extract (250 mg/kg) against stomach ulcers brought on by aspirin and pylorus ligation. The study determined that the stem extract of Bauhinia variegata considerably reduced the amount of stomach secretions, which in turn reduced the ulcer index [41].

Antidiabetic property

In normoglycemic rats, an aqueous extract of Bauhinia leaves shown hypoglycemic activity; this action may have been attributed to the presence of glycosyl flavonoids, as numerous natural flavonoids also demonstrated antidiabetic activity [42].

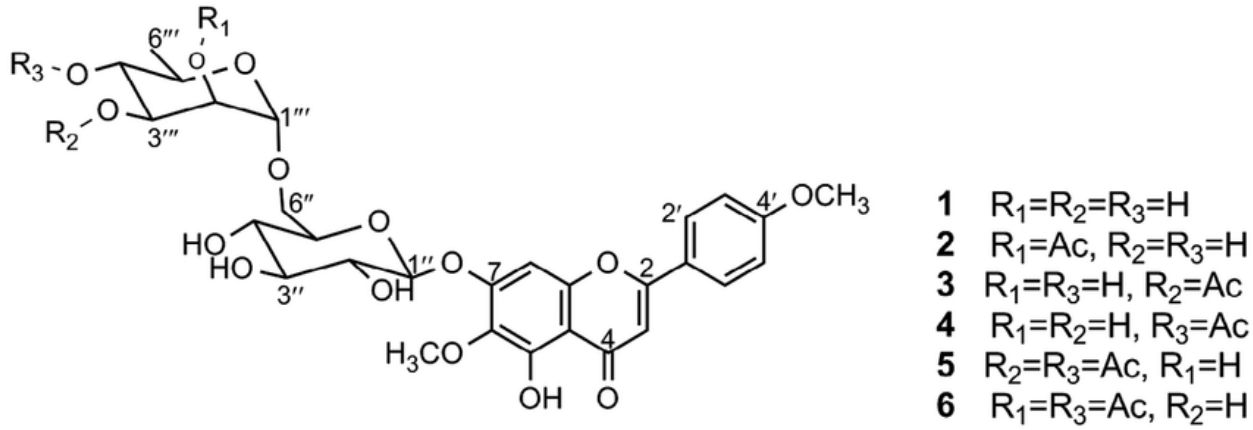


Figure 3: Molecular structure of glycosyl flavonoids

Roseoside, a prominent metabolite of the ethanolic extract of leaves, was found to have antidiabetic action. It exhibits insulinotropic activity towards pancreatic ßcells of the INS-1 cell line and may work in tandem with the chloroplast protein to further enhance the antidiabetic effects [43]. In a different investigation, the ethanolic extract of B. variegata leaves was used to isolate and identify D-pinitol (3-o-methyl D-chlroinositol), a bioactive carbohydrate. Pinitol is a chemical that is a member of the cyclic polyol group. The cyclic polyol group's natural product is what causes hypoglycemia effects [44].

Hepatoprotective potential of *Bauhinia variegata*

At doses of 100 and 200 mg/kg, an ethanolic extract of B. variegata's stem bark has hepatoprotective efficacy against hepatotoxicity produced by carbon tetra chloride in Sprague-Dawley rats. When ethanolic extract is taken orally, it reduces the levels of total lipids, gamma-glutamyl transferase, alkaline phosphatase, aspartate aminotransferase, and alanine aminotransferase. However, it increases total protein levels, which also decrease after hepatotoxicity. [45].

Intoxicated Sprague-Dawley rats treated with $CCl_4$ demonstrate notable hepatoprotective effects from B. variegata alcoholic stem bark extract [46]. Rats treated with stem bark extract showed a significant increase in total lipid content in their serum and liver, which was subsequently restored to almost normal levels. This is a blatant sign that the liver cells' functional integrity has improved. Albumin synthesis in

the liver is hampered by $CCl_4$. Thus, in such circumstances, the serum's protein level drops. Its hepatoprotective function is further confirmed by the return of protein concentration to normal.

Bauhinia variegata ethanolic extract (400 mg/kg and 600 mg/kg) was found to be a more effective hepatoprotective agent than 200 mg/kg and 100 mg/kg. Silymarin, a common medication, and carbon tetrachloride (1 ml/kg) poisoned the liver in this investigation. Histopathology was performed after a number of biochemical markers, including aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase, total bilirubin, malondialdehyde, glutathione, and catalase, were examined. [47].

The hepatoprotective effect of an ethanolic extract of Bauhinia variegata leaves was demonstrated by a considerable decrease in SGOT, SGPT, SALP, and bilirubin levels. It also prevents rats' liver histological alterations brought on by hepatotoxicity from paracetamol [48].

Bauhinia variegata ethanolic root extract (200 mg/kg and 400 mg/kg) shown a significantly significant reduction in AST, ALT, ALP, GGT, and total protein during its hepatoprotective activity. Comparing the extract group to the carbon tetrachloride group histopathologically showed that the extract had a hepatoprotective impact by reducing the amount of centrilobular necrosis, fatty alterations, and sinusoidal congestion. Additionally, rats treated with an ethanolic root extract of Bauhinia variegata demonstrated a notable dose-dependent hepatoprotective effect [49].

Thin layer chromatography-2,2-diphenyl-1-picrylhydrazyl (TLC-DPPH) was used to assess the antioxidant and hepatoprotective capabilities of acetone and methanol in defatted seed extracts of B. variegata in relation to FeCl3-induced lipid peroxidation in chicken liver homogenate. When compared to controls, an experimental study demonstrated the antioxidant and free radical scavenging ability of B. variegata seed extracts by shielding the liver homogenate in a concentration-dependent manner. Lipid peroxidation in chicken liver homogenate was proven to be induced by ferric chloride in a time- and concentration-dependent manner. This finding bolsters the hepatoprotective potential of B. variegata seed extracts against lipid peroxidation mediated by FeCl3 [50].

Using both invitro and invivo techniques, the hepatoprotective ability of the ethanolic extract of the whole stem (BV) of Bauhinia variegata was examined in relation to liver failure produced by carbon tetra chloride (CCl4). The levels of the marker enzymes were markedly reduced at a dose of 3.3 mg/ml of extracts. After giving Bauhinia variegata extract to rats treated with CCl4 for seven days, at doses of 200 and 400 mg/kg of body weight, the marker enzyme level of the liver decreased in a dose-dependent way. The hepatoprotection exhibited by the dose is significant and comparable to that of the conventional polyherbal medication Liv-52 [51].

Purified Bauhinia variegata leaves and flower extract (200 mg/kg, taken orally once daily) was tested for its ability to protect rats' livers from carbon tetrachloride injury. At the studied concentrations, the carbon tetrachloride-induced rise in alanine aminotransferase, aspartate aminotransferase, and alkaline phosphatase levels was considerably decreased by the purified Bauhinia variegata leaves and flowers, respectively. The histology result [52] further supported the hepatoprotective action.

**Future prospective**

In this study, we have compiled the phytochemical and pharmacological data on Bauhinia variegata by reviewing pertinent literature. According to a review of the literature, the plant has potential benefits for

wound healing, nephroprotection, immunomodulation, hepatoprotection, anticancer, antioxidant, hypolipidemia, antibacterial, anti-inflammatory, and hepatoprotection. A comprehensive review of the literature also reveals that, despite the fact that Bauhinia variegata is used as a medication for a good variety of disorders, its therapeutic efficacy has only been evaluated in a small number of cases. Given the extensive array of therapeutic applications for Bauhinia variegata documented in ethnobotanical surveys, Ayurveda, the Unani system, and other sources, it is imperative that additional clinical and pharmacological investigations be carried out to explore the untapped potential of this plant.

From crude plant extracts, a number of chemically characterised compounds with demonstrated hepatoprotective action have been identified. Therefore, studies should be conducted to standardise various Bauhinia variegata extracts in order to prepare herbal formulations and examine potential mechanisms of action for separated active ingredients. These active ingredients may provide valuable leads for the development of novel medications for the treatment of liver disorders. Nevertheless, there are not many clinical studies available for many of these substances. Before suggestions for the routine use of these medicines can be recognised, more research is needed to determine the clinical efficacy and potential toxicity of these compounds in larger trials. Based on clinical trials, more research should be done on the chemical components and pharmacological properties of Bauhinia variegata.

## Conclusion

Many chemically defined substances with proven hepatoprotective effect have been found from crude plant extracts. Therefore, in order to construct herbal formulations and investigate potential modes of action for separated active components, investigations aimed at standardising different Bauhinia variegata extracts should be done. These active components might offer insightful leads for the creation of cutting-edge drugs to treat liver diseases. However, for many of these drugs, there are not many available clinical data. More investigation is required to ascertain the clinical efficacy and possible toxicity of these substances in larger trials before recommendations for the routine use of these medications can be acknowledged. Further investigation of the chemical composition and pharmacological characteristics of Bauhinia variegata is warranted in light of the results of clinical trials.

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