Natural Resources for Human Health
eISSN: 2583-1194

Original Research

Received 09 July 2026
Revised 24 Aug 2026
Accepted 07 Sep 2026

Natural Resources for Human Health 2026, Vol. 6 (19s): 317–332

KEYWORDS:
Bauhinia genus, Phytochemical, Pharmacological, B. phoenicea

Exploring the Therapeutic Potential of The Bauhinia genus: A Phytochemical and Pharmacological Review

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ABSTRACT: The Bauhinia genus, which encompasses a broad range of species across tropical and subtropical regions, has been extensively studied for its phytochemical diversity and pharmacological potential. This review collates findings on key species such as Bauhinia variegata, Bauhinia racemosa,Bauhinia. purpurea, Buhinia championii, Bauhinia phoenicea and Bauhinia kockiana, highlighting their bioactive compounds and therapeutic effects. Phytochemical evaluation exposed the presence of flavonoids, stilbenes, steroids, saponins, tannins, and phenolic acids, which shows the biological activities. Notable compounds include quercetin, kaempferol, resveratrol, and β-sitosterol, which exhibit anti-inflammatory, antioxidant, antimicrobial, and antidiabetic properties, respectively.

Pharmacological investigations validated the traditional medicinal uses of the Bauhinia species. The antidiabetic effects, as demonstrated by B. candicans and B. variegata, are supported by enzyme inhibition and glucose regulation in experimental models. Antioxidant activity in B. kockiana and B. phoenicea underscores their protective effects against oxidative stress and related diseases. The genus also exhibits significant antimicrobial, anti-inflammatory, and cytotoxic effects, with B. championii and B. racemosa displaying potent anticancer properties. Additionally, B. rufescens offers neuroprotective benefits through AChE inhibition, suggesting its therapeutic potential in neurodegenerative disorders.The genus Bauhinia demonstrates remarkable versatility in traditional and experimental medicine. This review highlights its potential as a natural resource for the advancement of curing for diabetes, inflammation, cancer, and cardiovascular diseases

INTRODUCTION

Bauhinia is a genus within the family Fabaceae, subfamily Cercidoideae, and tribe Bauhinieae, the genus comprises approximately 150–300 species, depending on taxonomic interpretation.[1] These species are predominantly found in tropical regions across Asia, Africa, and the Americas, and exhibit a pantropical distribution. In Asia, they are present in India, Sri Lanka, Vietnam, Nepal.[2] Bauhinia species have a significant value in traditional medicine. For instance, Bauhinia variegata has been used for its anticancer, antioxidant, hypolipidemic, antimicrobial, anti-inflammatory, nephroprotective, hepatoprotective, antiulcer, immunomodulatory, molluscicidal, and wound healing effects. Bauhinia species contribute to nitrogen fixation and

enhance soil fertility in their native habitats. Their flowers attract various pollinators, including bats and insects, thereby supporting local biodiversity. In addition, some species are cultivated as ornamental plants, contributing to urban greening and landscape aesthetics.

Taxonomy

Kingdom : Plantae

Phylum : Magnoliophyta

Subphylum: Angiospermae

Class : Magnoliopsida

Order : Fabales

Family : Fabaceae

Subfamily : Caesalpinioideae

Genus : Bauhinia

Bauhinia is a diverse genus within the family Fabaceae and is dispensed mainly in the tropical and subtropical regions of the Americas, Asia, and Africa. Key species include Bauhinia variegata, known for its medicinal properties and ornamental use;[3] Bauhinia racemosa, valued in traditional medicine for its phytochemical and pharmacological activities;[4] Bauhinia purpurea, widely used for landscaping and medicinal purposes;[5] Bauhinia acuminata, an ornamental species with striking white flowers; and Bauhinia galpinii, a drought-resistant species used in gardens and landscaping.[6]

Bauhinia species exhibit various forms of growth, including shrubs, trees, and lianas. Some species may have tendrils for climbing, whereas others are unarmed or occasionally spiny, such as Bauhinia pauletia. The leaves are characteristically bilobed or deeply notched, resembling butterfly wings. They are simple, occasionally bifoliolate, and are prominently nerved from the base. The stipules are small, deciduous, and sometimes foliaceous.

Inflorescences are typically arranged in racemes, panicles, or corymbs with flowers that can be solitary or paired. They are terminal or subterminal and are often conspicuous. The flowers are hermaphroditic, large, and showy. The hypanthium is tubular to slightly cup-shaped, and the calyx is spathaceous or split into two to five lobes. The petals are five in number, free, and often clawed, stamens vary between one and ten, are fertile, and may or may not be accompanied by staminodes. Anthers dehisce longitudinally.

The fruit is typically a legume that varies in shape from oblong to linear. Depending on the species, it may be dehiscent, splitting open elastically, or indehiscent. The seeds are compressed, orbicular to ovate, and may have a small aril.

Bauhinia species contribute significantly to biodiversity by attracting pollinators, such as bats, bees, and butterflies. Their nitrogen-fixing ability enhances soil fertility, making them ecologically beneficial.[7,8] This combination of distinctive morphological traits makes the Bauhinia genus scientifically fascinating and of high practical value in traditional medicine, pharmacology, and environmental applications.

Table 1. Important species of Bauhinia

Region	Species	Common Name	Key Features/Uses
Asia	Bauhinia variegata	Mountain Ebony	Medicinal properties; ornamental plant
	Bauhinia purpurea	Purple Orchid Tree	Vibrant purple flowers; medicinal uses
	Bauhinia acuminata	Dwarf White Bauhinia	Striking white flowers; ornamental use

	Bauhinia vahlii	Maloo Creeper	Large climber; medicinal properties
	Bauhinia racemosa	Bidi Leaf Tree	Used in traditional medicine and bidi production
Americas	Bauhinia forficate	Brazilian Orchid Tree	Antidiabetic properties
	Bauhinia monandra	-	Ornamental tree with unique flowers
	Bauhinia ungulate	Hooked Bauhinia	Native to Central and South America
Africa	Bauhinia galpinii	Pride of De Kaap	Drought-resistant; used in landscaping
	Bauhinia petersiana	-	Adaptable; ecological importance
	Bauhinia thonningii	-	Used in African traditional medicine
Australia	Lysiphyllum cunninghamii	Kimberley Bauhinia	Native to northern Australia; previously classified under Bauhinia

B. candicans

Bauhinia candicans, a part of the Fabaceae , is a small tree native to South America, particularly Chile, where it is traditionally used in folk medicine to manage diabetes. This plant has gained attention for its significant phytochemical and pharmacological properties. Its phytochemical profile includes lignans, such as D-pinitol, and steroids, such as cholesterol, campesterol, sitosterylhexadecanoate, which contribute to its diverse biological activities.

Pharmacological studies have demonstrated that aqueous ethanol leaf extract of B. candicans significantly decreases fasting blood sugar levels in alloxan-diabetic rats, highlighting against diabetic activity.[9] Furthermore, the methanolic extract and butanolic fraction have been shown to effectively lower blood glucose levels in diabetic rabbits, further supporting their traditional use in diabetes management.

Table 2. Phytochemical and Pharmacological profile of B. candicans

Species Name	**Type of Phytochemicals**	**Name of Phytochemicals Isolated**
B. candicans	Lignans	D-Pinitol
	Steroids	Cholesterol, Campesterol, β-Sitosterylhexadecanoate
Pharmacological Activity		**Details**
Hypoglycemic		Methanolic extract and butanolic fraction reduced blood glucose levels in diabetic rabbits, supporting its traditional use for diabetes management.[10]

B. championii

Bauhinia championii is a medicinal plant of Fabaceae family and is traditionally in Chinese medicine to treat various ailments, including rheumatoid arthritis and cardiovascular diseases. The plant is rich in bioactive phytochemicals, including vanillic acid, bauhinin, and flavones such as 5,7,3',4',5'-pentamethoxyflavone, catechin, and dihydroflavones such as strobopinin. These compounds exhibit diverse pharmacological activities.

B. championii exhibits strong anti-inflammatory effects by modulating miRNA-145-5p and the TLR4/NF-κB signaling pathway, making it effective for the management of rheumatoid arthritis. Its flavones also demonstrate antifibrotic effects in diabetic nephropathy and cardioprotective properties by reducing apoptosis and autophagy. This plant has notable antitumor activity and antibacterial properties against Streptococcus mutans, supporting its use in dental health. Furthermore, its antioxidant, analgesic, and anti-arthritic properties make it beneficial for the treatment o rheumatic pain. Traditionally, its extracts have been used in teas to strengthen bones, promote circulation, and treat bruises and malnourishment. With its flavonoid content, including myricetin, quercetin, and kaempferol, B. championii also serves as an active ingredient in oral care products and demonstrates a wide array of therapeutic potential.

Table 3. Phytochemical and Pharmacological profile of B. championii[11]

B. championii	Miscellaneous	Vanillic acid, Bauhinin
	Flavones	5,7,3',4'-Tetramethoxyflavone, 5,7,3',4',5'-Pentamethoxyflavone
	Dihydroflavones	Strobopinin
	Flavans and Catechins	Catechin
Pharmacological Activity		**Details**
Anti-inflammatory		Bauhinia championii mitigate extracellular matrix degradation in chondrocytes by upregulating miRNA-145-5p and inhibiting the TLR4/NF-κB signaling pathway. Traditionally used to treat rheumatoid arthritis.[12]
Antifibrotic		PMF (5,7,3',4',5'-pentamethoxyflavone) isolated from B. championii shows antifibrotic effects in diabetic nephropathy in vivo and in vitro.[13]
Dental Health		Ethanol extract exhibits antibacterial activity against Streptococcus mutans, suggesting potential for preventing dental caries.
Antioxidant		Enhances antioxidant capacity, reduces harmful protein levels, and inhibits cell apoptosis and autophagy, beneficial for coronary heart disease.
Anti-arthritic		Used in tea for expelling wind-damp, strengthening bones, and promoting blood circulation. The n-butyl alcohol extract is effective in treating chronic infectious arthritis.[15]
Rheumatological Benefits		Treats rheumatoid arthritis by exerting anti-inflammatory effects in collagen-induced arthritis rat models.
Hypoxia/Reoxygenation Protection		Flavones from B. championii reduce TNF-α and iNOS levels, maintain eNOS, and modulate apoptosis-related proteins (Bcl-2 and Bax).
Apoptosis Modulation		Flavones protect neonatal rat cardiomyocytes against H_2O_2-induced apoptosis by enhancing viability and regulating apoptosis-related proteins like Bcl-2 and Bax.
Antibacterial		Ethanolic extract shows significant antibacterial activity against S. mutans by inhibiting growth, adherence, and acidogenicity.
Anti-oxidative and Cardioprotective		BCF (Bauhinia championii flavones) reduces myocardial ischemia/reperfusion injuries by inhibiting excessive autophagy and apoptosis.[16]
Herbal Tea Benefits		Used in traditional tea for various health benefits including treating bruises, hemiplegia, infantile malnutrition, and strengthening bones.

Oral Care	Extract used in toothpaste, mouthwash, and tooth powder to prevent and treat decayed teeth.
Flavonoid Content	Contains flavonoids such as myricetin, quercetin, and kaempferol, contributing to its pharmacological effects.

B. guianensis

Bauhinia guianensis is a medicinal plant to Fabaceae family and traditionally in Amazonian phytotherapy for the treatment ofvarious ailments, including diabetes, inflammation, and malaria. Its phytochemical profile includes steroids such as Sito sterol-3-O-β-D-riburonofuranoside, which contribute to its therapeutic properties.

Pharmacological reports have described that hydroethanolic extracts of B. guianensis significantly inhibit edema in zebrafish, validating their traditional use as anti-inflammatory agents. This plant also exhibited antinociceptive action and improved pain-related behavioral responses in zebrafish models. Furthermore, its extracts demonstrate promising antimalarial effects, alleviating symptoms associated with malaria and reinforcing its role in traditional medicine. Additionally, B. guianensis is widely used for managing diabetes in Amazonian folk medicine, showing potential therapeutic effects in related metabolic disorders.

Table 4. Phytochemical and Pharmacological profile of B. guianensis

B. guianensis	Steroids	3 Sito sterol-3-O-B-D-riburonofuranoside
Pharmacological Activity		**Details**
Anti-inflammatory		Hydroethanolic extracts of Bauhinia guianensis showed significant inhibition of edema in zebrafish, supporting its traditional use in treating inflammation.[17]
Antinociceptive		Exhibits analgesic activity by improving behavioral responses in zebrafish models, indicating pain-relieving properties.[18]
Antimalarial		Demonstrates promising antimalarial effects, alleviating symptoms associated with malaria, further supporting its traditional use in folk medicine.[19]
Antidiabetic		Traditionally used in Amazonian phytotherapy for managing diabetes, showing potential therapeutic effects in related ailments.

B. hupenhara

Bauhinia hupenhara is a medicinal plant known for its therapeutic applications in metabolic disorders such as diabetes and obesity. The plant contains dihydroflavonol taxifolin, a bioactive compound that contributes to its pharmacological effects.

Studies have demonstrated that extracts of B. hupenhara effectively lower blood sugar levels, showing its antidiabetic potential in managing diabetes. Additionally, plant extracts reduce fat accumulation, supporting their use in treating obesity.[21]

Table 5. Phytochemical and Pharmacological profile of B. hupenhara

B. hupenhara	Dihydroflavonols	Taxifolin
Activity		**Details**
Antidiabetic		Extract of Bauhinia hupehara C lowers blood sugar, demonstrating its effectiveness in managing diabetes.
Anti-obesity		Extract reduces fat accumulation, supporting its use in treating obesity.

B. malabarica

Bauhinia malabarica is a plant known for its bioactive stilbenes, including preracemosol A, preracemosol B, and racemosol, which contribute to its pharmacological properties.[20]

Plant extracts have shown significant antidiabetic effects by lowering blood sugar levels, supporting their traditional use in

managing diabetes. Additionally, B. malabarica extracts exhibit anti-obesity activity by reducing fat accumulation, making them a promising candidate for addressing obesity-related health issues mainly Jaundice.[21,22]

Table 6. Phytochemical and Pharmacological profile of B. malabarica

B. malabarica	Stilbenes	Preracemosol A, Preracemosol B, Racemosol
Pharmacological Activity		**Details**
Antidiabetic		Extract of Bauhinia hupehara C lowers blood sugar, demonstrating its effectiveness in managing diabetes.
Anti-obesity		Extract reduces fat accumulation, supporting its use in treating obesity.

B. manca

Bauhinia manca is a plant rich in diverse phytochemicals, including flavans, catechins, lignans, dihydroflavones, and flavones, which contribute to its significant biological activities. Among its notable compounds are flavans like 7,4'-dihydroxyflavan and 3-O-galloylepicatechin, along with lignans such as syringaresinol and (7S, 8R, 8'R)-5,5'-dimethoxylariciresinol. The plant also contains dihydroflavones, such as naringenin, eriodictyol, and liquiritigenin, as well as flavones, such as luteolin 5,3'-dimethylether and chrysoeriol. Additionally, miscellaneous compounds, such as gallic acid and ω-hydroxypropioguaiacone, further enhance its phytochemical diversity.[22]

Table 7. Phytochemical and Pharmacological profile of B. manca

Flavans and Catechins	7,4'-Dihydroxyflavan,4'-Hydroxy-7-methoxyflavan,7,4'-Dihydroxy-3'-methoxyflavan, 3-O-Galloylepicatechin
Miscellaneous	Gallic acid, Î©-Hydroxypropioguaiacone
Lignans	Syringaresinol
Dihydroflavones	Naringenin, Eriodictyol, Liquiritigenin
Flavones	Luteolin 5,3'-dimethylether, Chrysoeriol

B. purpurea

Bauhinia purpurea is a well-studied medicinal plant, recognized for its extensive phytochemical diversity and significant pharmacological activities. It contains biologically active constituents, including flavones like chrysin and 6,8-dimethylchrysin, flavonols such as kaempferol and quercetin, and dihydroflavonols such as taxifolin. Other notable compounds include steroids, such as β-sitosteryloctadecanoate, esters, fatty acids, such as hexadecanoic acid, and chalcones, including 3,4-dihydroxychalcone derivatives. These phytochemicals contribute to a wide range of biological activities.[25]

The pharmacological properties of B. purpurea have been investigated extensively. Its methanolic bark extract reveals potent antidiabetic in STZ- and alloxan-induced diabetes models. Dichloromethane root extract exhibits antimalarial activity against Plasmodium falciparum as well as antifungal and antimycobacterial properties. Ethanolic leaf extracts provide protection against hyperthyroidism and nephrotoxicity while also showing significant anti-inflammatory, anti-arthritic, and wound-healing effects. The plant exhibits cytotoxicity against cancer cell lines and antioxidant activity, and its aqueous leaf extract shows free radical-scavenging properties. Moreover, B. purpurea has anti-obesity, anti-ulcer, antimicrobial, and antidepressant effects, and its bioactive compounds offer significant therapeutic potential for various health conditions.

Table 8. Phytochemical and Pharmacological profile of B. purpurea

B. purpurea	Flavones	Chrysin, 6,8-Dimethylchrysin
	Flavonols	Quercetin-3-methyl ether, Quercetin-3-O-B-D-glucopyranoside
	Dihydroflavonols	Taxifolin, 6-(3'-Oxobutyl)taxifolin
	Miscellaneous	5,7-Dihydroxychromone, Isotachioside, Bornesitol
	Steroids	B-Sitosteryloctadecanoate
	Fatty Acids	Hexadecanoic acid, 1-Tetracosonol, 1-Hexacosonol, 1-Octacosonol, Glycerol

Pharmacological Activity	Details
Antimalarial	Dichloromethane extract of root showed activity against Plasmodium falciparum at 5.8–11.2 μM concentrations.
Cytotoxic	Dichloromethane extracts from leaves, bark, and roots exhibited cytotoxicity (10.5–72.3 μM) in Brine shrimp lethality, KB, and BC cell lines.
Antifungal	Root extract (dichloromethane) displayed antifungal activity (49.6–130.1 μM) against Candida albicans.
Anti-diarrheal	Ethanolic leaf extract (100, 200, 300 mg/kg) reduced castor oil-induced diarrhea and improved gastrointestinal motility in a charcoal meal test.[30]
Fibrolytic	Bark powder (6 g/kg for 7 days) ameliorated chronic mastitis with induced fibrosis.
Antiepileptic	Ethanolic extract of leaves (100, 250, 500 mg/kg) was effective in PTZ and MEZ seizure models.[32]
Nephroprotective	Ethanolic extracts of unripe pods and leaves (300 mg/kg) prevented nephrotoxicity induced by gentamicin.
Wound Healing	Methanol and chloroform extracts of leaves (100–500 mg/kg) enhanced healing in excision, burn, dead space, and incision wound models.[33]
Anti-ulcer	Methanolic leaf extract (100, 500, 1000 mg/kg) reduced gastric ulcers induced by indomethacin, absolute ethanol, and pylorus ligation.
Hepatoprotective	Methanolic leaf extract (50, 250, 500 mg/kg) protected against paracetamol-induced hepatotoxicity.

B. racemosa

Bauhinia racemosa is a medicinal plant known for its diverse phytochemical composition and pharmacological activities. It contains terpenes such as β-amyrin, lupeol, lupenone, and betulin, along with stilbenes including resveratrol, racemosol, and 3-hydroxy-de-O-methylracemosol. These bioactive compounds are key to their therapeutic potential.

Pharmacologically, B. racemosa exhibits significant anti-inflammatory[34] and neuroprotective properties, particularly resveratrol, which has antiviral effects. Lupeol contributes to its anti-inflammatory, antimicrobial, and cholesterol-lowering activities, whereas β-amyrin has antibacterial, antioxidant, and hepatoprotective effects.[35] Racemosol inhibits acetylcholine esterase, highlighting its neuroprotective benefits. The plant also possesses potent antidiabetic properties, with β-sitosterol and rutin playing roles in glucose regulation and metabolic health. Additionally, B. racemosa exhibits anti-cancer, anti-angiogenic, and cardiovascular protective effects, with compounds such as kaempferol and galactolipid reducing tumor proliferation and vascular stress.

Table 9. Phytochemical and Pharmacological profile of B. racemosa

B. racemosa	Terpenes	B-Amyrin, Lupeol, Lupenone, Betulin
	Stilbenes	Resveratrol, Racemosol, 3-Hydroxy-de-O-methylracemosol
Pharmacological Activity		**Details**
Anti-proliferative		Mome inositol exhibits anti-proliferative properties.
Carminative and Antiparasitic		Neophytadiene acts as a carminative, gastric inhibitor, anticulcerative, antiprotozoal, and antiparasitic agent.
Anti-bacterial		Octacosane exhibits anti-bacterial activity.[36]
Anti-diabetic and Anti-inflammatory		β-sitosterol has anti-diabetic, anti-inflammatory, anxiolytic, sedative, analgesic, antibacterial, and immunomodulatory properties. It also protects against NAFLD, pulmonary fibrosis, and liver ailments.[36]

Anti-bacterial and Neuroprotective	Racemosol displays anti-bacterial activity and acetylcholine esterase inhibitory effects.[37]
Cardiovascular Protection	Galactolipid acts as an anti-aggregator, reducing vascular tone and blood pressure. It prevents cardiovascular diseases, Type 2 diabetes, obesity, stress, and cancer.
Anti-inflammatory and Anti-bacterial	Betulin has anti-inflammatory and anti-bacterial properties.[38,39]
Antioxidant and Anticancer	Quercetin exhibits antioxidant, anti-allergy, anti-cardiovascular, anti-cancer, anti-diabetic, and anti-inflammatory effects. It also has neuroprotective and anti-obesity effects.

B. rufescens

Bauhinia rufescens is a medicinal plant known for its diverse bioactive compounds, including stilbenes such as de-O-methylracemosol and other derivatives, which underlie its pharmacological significance. Traditionally, its roots are used externally to treat ulcers and rheumatism.Methanol extracts demonstrate significant anti-diarrheal effects in mice, and the plant is traditionally employed for malaria and mycosis treatments. Its leaves contain 3-O-methyl-D-inositol, an acetylcholinesterase inhibitor that has potential applications in Alzheimer's disease therapy. Additionally, titanium oxide nanoparticles derived from stem bark extract showed anti-obesity effects by reducing lipid accumulation. The plant exhibits strong antioxidant properties due to phenolic compounds, such as quercetin and rutin, along with xanthine oxidase and lipoxygenase inhibition, contributing to its anti-inflammatory effects. [40]

Table 10. Phytochemical and Pharmacological profile of B. rufescens

B. rufescens	Stilbenes	De-O-methylracemosol
Pharmacological Activity		**Details**
Anti-ulcer and Anti-rheumatic		Roots are traditionally used externally to treat ulcers and rheumatism.
Anti-diarrheal		Methanol extract demonstrated significant anti-diarrheal activity in mice.
Anti-malarial		Traditionally used in Africa for malaria treatment.
Anti-mycotic		Traditionally employed for treating mycosis.
Acetylcholinesterase Inhibition		Leaves contain cyclitol 3-O-methyl-D-inositol, which exhibits acetylcholinesterase inhibitory activity, suggesting potential for Alzheimer's disease treatment.[41]
Anti-obesity		Stem bark extract modified into titanium oxide nanoparticles (BR-TO2-NPs) reduces lipid accumulation and proinflammatory adipokine levels in maturing adipocytes.
Antioxidant		Exhibits antioxidant properties, attributed to phenolic compounds like quercetin, rutin, and p-coumaric acid found in its aqueous acetone extract.[42]
Xanthine Oxidase Inhibition		Shows xanthine oxidase inhibitory activity, contributing to its antioxidant and anti-inflammatory effects.[43]
Lipoxygenase Inhibition		Demonstrates lipoxygenase inhibitory activity, which may contribute to its anti-inflammatory properties.[43]

B. splendens

Bauhinia splendens is a medicinal plant valued for its therapeutic applications in traditional medicine, particularly in Africa. Its phytochemical profile includes stilbenes, such as de-O-methylracemosol,which contribute to its biological activities.

Pharmacologically, the roots of B. splendens are traditionally used externally to treat ulcers and rheumatism, whereas the methanol extract has shown significant antidiarrheal activity in mice. The plant is used against malaria, mycosis. Its leaves contain cyclitol 3-O-methyl-D-inositol, which exhibits acetylcholinesterase inhibitory activity, indicating its potential for Alzheimer's disease therapy.

Additionally, B. rufescens stem bark extracts, when modified into titanium oxide nanoparticles (BR-TO2-NPs), reduce lipid accumulation and proinflammatory adipokine levels, highlighting their anti-obesity potential. The antioxidant action of plant, shows the phenolic compounds such as quercetin, rutin, and p-coumaric acid, is complemented by its xanthine oxidase and lipoxygenase inhibitory activities, further enhancing its anti-inflammatory properties.

Table 11. Phytochemical and Pharmacological profile of B. splendens

B. splendens	Flavones	7-Methoxy-5,6,3',4'-dimethylenedioxyflavone
Pharmacological Activity		**Details**
Analgesic		Hydroalcoholic extract from leaves and stems demonstrates significant dose-related inhibition of pain in mice, particularly effective against acetic acid-induced abdominal constriction and formalin-induced pain.
Mechanism of Action		Analgesic effects are not related to opioid systems, as confirmed in experimental models.[44]

B. tarapotensis

Bauhinia tarapotensis, traditionally known for its medicinal properties,its phytochemical composition includes flavones along with miscellaneous compounds such as isoacetoside, and indole-3-carboxylic acid.

Pharmacological studies highlight plant's significant anti-inflammatory properties, primarily attributed to the triterpenic acids of the ursane and oleanane series, validating its traditional use for inflammation. Its leaves are also employed as decongestant remedies, while the bark demonstrates anti-diarrheal effects, supporting its role in traditional medicine for gastrointestinal ailments.[45]

Table 12. Phytochemical and Pharmacological profile of B. tarapotensis

B. tarapotensis	Flavones	Luteolin 4'-O-B-D-glucopyranoside
	Miscellaneous	Isoacetoside
Pharmacological Activity		**Details**
Anti-inflammatory		Leaves possess significant anti-inflammatory properties, primarily due to triterpenic acids of the ursane and oleanane series, justifying traditional use.
Decongestant		Leaves are traditionally used as decongestant remedies.[46]
Anti-diarrheal		Bark exhibits antidiarrheal effects, supporting its medicinal use in traditional medicine.

B. vahlii

Bauhinia vahlii is known for its extensive medicinal applications and diverse phytochemical profiles. It contains steroids, such as campesterol, stigmasterol, β-sitosterol, and betulinic acid, along with flavonols, such as kaempferol and quercetin, which

contribute to its pharmacological effects.

The plant demonstrated significant anti-inflammatory activity, with petroleum ether, chloroform, and ethanol extracts showing effects comparable to those of ibuprofen in paw edema models. Its ethanolic and chloroform extracts exhibited strong antidiabetic properties, effectively reducing blood sugar levels similar to glibenclamide.The seeds displayed potent antioxidant properties, with raw seed extracts outperforming the standards in β-carotene/linoleic acid emulsion and superoxide scavenging assays.

Ethnopharmacological uses of B. vahlii are also notable, with roots used for treating pulmonary tuberculosis, dysentery, and fever, leaves for abrasions, bark for skin diseases and diarrhea, and seeds for pimple treatment and aphrodisiac.

Table 13. Phytochemical and Pharmacological profile of B. vahlii

B. vahlii	Steroids	Campesterol, Stigmasterol, B-Sitosterol, Betulinic acid
B. vahlii	Flavonols	Kaempferol, Quercetin
Pharmacological Activity		**Details**
Anti-inflammatory		Petroleum ether, chloroform, and ethanol extracts of the whole plant showed anti-inflammatory effects induced by paw edema at a dose of 353 mg/kg, comparable to Ibuprofen (100 mg/kg).[47,48]
Ethno-pharmacological uses		Roots are used for pulmonary tuberculosis, dysentery, and fever; leaves for abrasions; bark for skin diseases and diarrhea; seeds for pimple treatment and aphrodisiac purposes.[49,50]

B. variegata

Bauhinia variegata plant owing to its rich phytochemical diversity and extensive traditional applications. It contains flavones, such as apigenin and dihydroflavones including and flavonols, such as kaempferol and quercetin derivatives, which contribute to its therapeutic potential.[51]

The flowers are consumed as vegetables, used in preparing curries and pickles, and as flavoring agents. They are also used to treat leucorrhea, mumps, dysentery, and gastrointestinal issues. Decoctions from flowers serve as galactagogues and laxatives, whereas paste is applied to ulcers, snakebites, and bleeding piles. The leaves are utilized as vegetables, flavorings, and fodder, and their decoctions are used to treat headaches, jaundice, stomach tumors, and wounds. The buds are employed in preparing pickles and curries, and as flavoring agents, with dried buds traditionally used for treating dysentery, diarrhea, tumors, and piles.

The bark of B. variegata is highly valued for the treatment of piles, leprosy, malaria, and various skin diseases. Its decoction is effective for amoebic dysentery and stomach disorders, whereas bark paste accelerates wound healing and bone fracture recovery. Roots are used in powdered form for rheumatism and wound care, while stem bark and root bark are traditionally employed for ailments such as dysentery, worm infections, and menorrhagia.

Table 14. Phytochemical and Pharmacological profile of B. variegata

B. variegata	Flavones	Apigenin, Apigenin 7-O-B-D-glucopyranoside
	Dihydroflavones	4'-Hydroxy-5,7-dimethoxyflavanone-4'-O-Î±-L-rhamnopyranosyl-B-D-glucopyranoside
Part Used		**Traditional Uses**
Flowers		Cooked as a vegetable, used in raita, curry, flour, and pakoras, and as a flavoring for meat and fish. Flowers are also made into pickles and decoctions used as a galactagogue for women. They are employed as laxatives and in treating leucorrhea, mumps, dysentery, diarrhea, gastrointestinal, and genitourinary

	problems. Additionally, they are used in Ayurvedic and Yunani medicine, for ulcers, snakebite,[53] bleeding piles, malaria, and as antifertilizing agents.[52]
Leaves	Used as vegetables, in curry preparation, and as fodder. They are consumed as a side dish with rice or as flavoring for fish and meat. Decoctions treat headaches during malarial fever, jaundice, stomach tumors, and wounds. Leaf paste is applied for urinary infections, boils, and as a laxative. Leaf infusions are used as laxatives for piles by Bhils and Andh tribes.
Bud	Utilized in pickles, curry, flour, broths, and as flavoring agents. Bud powder regulates vaginal discharge and treats menorrhagia. Dried buds are employed for dysentery, diarrhea, worms, tumors, and piles.[54]
Bark	Treats piles, dysentery, leprosy, flatulence, malaria, tumors, scrofula, snakebite, obesity, indigestion, and smallpox. Decoctions address[55] amoebic dysentery and stomach disorders. Bark powder is used for blood pressure, as an astringent, tonic, and for skin diseases. It remedies goiter, scrofula, and accelerates the healing of cuts, wounds, and bone fractures. Fresh bark juice is used as an expectorant for asthma and cough.
Root	Powdered root mixed with water (2:3) is used for rheumatism; with Brassica oil, it treats wounds and cuts.
Stem Bark	Used for dysentery, leprosy, syphilis, worm infections, scrofula, and skin diseases. In pounded form, it treats rheumatism. Mucilage is used for healing bone fractures in cattle. Decoction is given for menorrhagia.[56]
Root Bark	Juice (15 ml/day) is used for obesity, indigestion, and ripening boils when mixed with rice water (3:1).

B. phoenicea

Bauhinia phoenicea is a plant with diverse pharmacological actions and a rich phytochemical composition. Its leaves and bark contain bioactive compounds, such as steroids, terpenoids, phenols, tannins, saponins, alkaloids, and flavonoids, which contribute to its therapeutic potential.

This plant exhibits significant antidiabetic properties through α-amylase inhibition, supporting its traditional use in diabetes management. Its leaves also demonstrated hepatoprotective effects in vitro, validating its role in treating liver ailments. Ethanol and chloroform extracts showed strong cytotoxicity against tumor cell lines, and aqueous extracts improved the lifespan of ascites tumor-bearing mice, indicating their antitumor potential.

B. phoenicea also exhibits antimicrobial activity, and ethanolic extracts effectively inhibit Salmonella typhi, Candida albicans, and Aspergillus niger. Its crude ethanolic extract displayed dose-dependent anthelmintic activity, comparable to that of albendazole, targeting Pheretima posthuma (earthworms).

Table 15. Phytochemical and Pharmacological profile of B.Phoenicea

Phytochemical Composition	Presence of steroids, terpenoids, phenols, tannins, saponins, alkaloids, and flavonoids, contributing to its biological activities.
Pharmacological Activity	**Details**
Anti-diabetic	Leaves exhibited significant antidiabetic activity via α-amylase inhibition assays, supporting traditional claims.[57]
Hepatoprotective	Leaves demonstrated hepatoprotective properties in in-vitro studies, confirming its role in treating liver ailments.

Cytotoxic and Antitumor	Ethanol and chloroform extracts of leaves showed strong cytotoxicity against tumor cell lines, with aqueous extract increasing lifespan in ascites tumor-bearing mice.
Anthelmintic	Crude ethanolic extract exhibited dose-dependent activity against Pheretima posthuma (earthworms), comparable to albendazole.

B. kockiana (Phanera kockiana)

Bauhinia kockiana (Phanera kockiana) is a medicinal plant with diverse pharmacological activities and phytochemical composition. The plant contains flavonoids, phenols, tannins, and saponins, which underpin its therapeutic potential.

The ethanolic of B. kockiana leaves shows significant antioxidant activity, as demonstrated by the DPPH and FRAP assays, and showed strong anti-inflammatory effects by reducing carrageenan-induced paw edema in rats. Methanolic and aqueous extracts possess antimicrobial activity against both Gram-positive and Gram-negative bacteria, including E. coli and S. aureus. Additionally, plant extracts show promise in preventing or mitigating cognitive dysfunction owing to their antioxidant properties. Its methanolic extract accelerated wound healing by promoting wound contraction and epithelialization in excision wound models.

Table 16. Phytochemical and Pharmacological profile of B. kockiana (Phanera kockiana)

Phytochemical Composition	Rich in flavonoids, phenols, tannins, and saponins, which contribute to its pharmacological properties.
Pharmacological Activity	**Details**
Antioxidant	Ethanolic extract of B. kockiana leaves exhibited significant free radical scavenging activity in DPPH and FRAP assays.[58,59]
Anti-inflammatory	Ethanolic extract reduced inflammation in carrageenan-induced paw edema models in rats.
Cytotoxic	Chloroform and ethanolic extracts displayed cytotoxic effects against selected human cancer cell lines, indicating potential anti-cancer properties.[60]
Cognitive Dysfunction Prevention	Extracts have potential in preventing or ameliorating cognitive dysfunction, particularly due to its antioxidant properties.
Antidiabetic	Leaf extracts inhibited α-amylase and α-glucosidase enzymes, supporting traditional use for diabetes management.
Wound Healing	Methanolic extract accelerated wound contraction and epithelialization in excision wound models.

SUMMARY

The Bauhinia genus demonstrates remarkable diversity of phytochemicals, contributing to their wide range of biological activities. Key phytochemicals identified across species include flavonoids, such as apigenin, kaempferol, quercetin, and catechin derivatives, which are particularly abundant in B. purpurea, B. variegata, and B. kockiana. Stilbenes, such as resveratrol and racemosol, are known for their antioxidant and cytoprotective effects, while dihydroflavonols, such as taxifolin, provide anti-inflammatory and hepatoprotective effects. Phenolic acids, including gallic acid and vanillic acid, were found in B. championii and B. racemosa. Steroids and triterpenoids, such as β-sitosterol, lupeol, and betulinic acid, enhance anti-inflammatory, anticancer, and lipid-lowering activities. Additionally, saponins and tannins, which are prominent in B. kockiana and B. phoenicea, exhibit antimicrobial, wound healing, and antioxidant properties.

This diverse phytochemical composition translates into multiple pharmacological activities that have been validated through experimental studies. B. candicans aqueous-ethanol leaf extracts significantly reduced fasting blood sugar and improved vascular

relaxation in diabetic models, while B. kockiana and B. variegata demonstrated α-amylase and α-glucosidase inhibition, supporting their traditional use in diabetes management. The antioxidant activity of leaf extracts from B. kockiana and B. phoenicea was demonstrated through strong free radical scavenging effects in DPPH and FRAP assays, protecting against oxidative stress.

Anti-inflammatory properties are prominent across species, with B. championii flavones modulating inflammatory pathways, such as TLR4/NF-κB and B. tarapotensis triterpenes, reducing inflammation, justifying their traditional applications. Ethanolic extracts of B. phoenicea have also been shown to be effective against fungi and bacteria.

Flavonoids in B. championii and B. phoenicea mitigate hepatotoxicity and myocardial damage through antioxidant and apoptosis-regulating pathways, demonstrating their hepatoprotective and cardioprotective properties. Cytotoxic and anti-cancer activities have been observed for compounds such as racemosol, kaempferol, and strobopinin from B. racemosa and B. championii, which induce apoptosis in cancer cells and offer therapeutic potential. Methanolic extracts of B. kockiana and B. phoenicea promoted faster wound contraction and epithelialization, demonstrating significant wound-healing capabilities.

The genus also exhibits neurological benefits, with B. rufescens leaves showing acetylcholinesterase inhibitory activity, highlighting its potential in Alzheimer's disease treatment, whereas B. variegata displays antidepressant and antianxiety effects. Other pharmacological properties include anti-ulcer effects in B. rufescens and B. variegata, and lipid-lowering and anti-obesity effects in B. hupehara and B. candicans.

FUTURE RECOMMENDATIONS

Future research on the genus Bauhinia should prioritize clinical validation to confirm its pharmacological properties in humans, ensuring efficacy and safety.Standardization of extracts and the development of advanced formulations, such as nanoparticles, can enhance bioavailability and therapeutic consistency. Investigating the synergistic effects between Bauhinia-derived compounds and existing drugs could improve efficacy and minimize side effects. Conservation strategies are essential to ensure sustainable use, and comprehensive documentation of ethnopharmacological knowledge may uncover novel applications. Additionally, exploring understudied species and conducting detailed toxicological assessments are vital for identifying the untapped potential and ensuring long-term safety. Addressing these recommendations will help to unlock the full therapeutic potential of the Bauhinia genus.

CONCLUSION

The Bauhinia genus and its related species exhibit rich phytochemical diversity that underpins their traditional and experimental pharmacological uses. Their therapeutic potential spans diabetes management, inflammation, cancer treatment, and cardiovascular health. Future research should focus on clinical validation and mechanistic insights to optimize their medicinal applications, especially for unexplored varieties of B. phoenicea.

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