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PHYTOCHEMISTRY, ETHNOBOTANY, AND PHARMACOLOGICAL ACTIVITIES OF *BARLERIA STRIGOSA* WILLD. (ACANTHACEAE): A COMPREHENSIVE REVIEW

Dipesh Raj[1*], Chudamani[2], Yamuna[3], Harsha Soni[4], Rahul Yadav[5], Anamika Banjare[6], Deeplata Bunker[7]

[1]MD Scholar, Department of Kaumarabhritya, Shri Narayan Prasad Awasthi Government Ayurved College, Raipur (C.G.) 492010.

[2]MD Scholar, Department of Kaumarabhritya, Shri Narayan Prasad Awasthi Government Ayurved College, Raipur (C.G.) 492010.

[3]MD Scholar, Department of Kaumarabhritya, Government Ayurved College, Raipur (C.G.).

[4]Assistant Professor, Department of Pharmacy, Chouksey Engineering College, Bilaspur (C.G.).

[5]MD Scholar, Department of Kaumarabhritya, Shri Narayan Prasad Awasthi Government Ayurved College, Raipur (C.G.) 492010.

[6]MD Scholar, Department of Kaumarabhritya, Government Ayurved College, Raipur (C.G.).

[7]MD Scholar, Department of Kaumarabhritya, Government Ayurved College, Raipur (C.G.).

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***Corresponding Author: Dipesh Raj**
MD Scholar, Department of Kaumarabhritya, Shri Narayan Prasad Awasthi Government Ayurved College, Raipur (C.G.) 492010.

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ABSTRACT

Background: *Barleria strigosa* Willd. (Acanthaceae) — known as *'Vajradanti'* or *'Nilajhinti'* in Ayurvedic tradition — is a perennial shrub native to tropical India, Thailand, Myanmar, and Southeast Asia. Traditionally employed across Ayurvedic, Siddha, and Thai folk medicine systems for inflammatory conditions, dental disorders, fever, skin ailments, and cancer-supportive care, the species has been the subject of increasing pharmacological investigation over the past two decades.

Objective: This review consolidates published evidence on the taxonomic classification, geographic distribution, ethnobotanical applications, phytochemical constituents, and biological activities of *B. strigosa*, and identifies critical gaps warranting future research.

Methods: This is a narrative review. A structured literature search was conducted across PubMed/MEDLINE, Scopus, ScienceDirect, and Google Scholar (1990–2025), complemented with classical Ayurvedic texts and ethnobotanical monographs. Primary studies specifically

reporting data on *B. strigosa* were prioritised; genus-level reports without species-specific data were used only for contextual comparison.

Results: *B. strigosa* contains a pharmacologically rich phytochemical profile: iridoid glycosides (barlerin, 8-acetylbarlerin, strigoside), species-exclusive phenylethanoid glycosides (verbascoside, parvifloroside A and B), flavonoids (luteolin, apigenin, kaempferol), phenolic acids, terpenoids (ursolic acid, β-sitosterol), and essential-oil components. A UHPLC-ESI-QTOF-MS analysis detected 82 compounds from leaf extracts. Documented pharmacological activities include antioxidant (DPPH IC_{50}: 45.2–92.7 µg/mL), anti-inflammatory (NO IC_{50}: 38.4 µg/mL; 35–40% carrageenan oedema inhibition), antimicrobial (S. aureus MIC: 125–250 µg/mL), antidiabetic (α-glucosidase IC_{50}: 81.56 µg/mL, superior to acarbose), antiproliferative/anticancer (IC_{50} < 50 µg/mL vs oral squamous carcinoma; apoptosis and CYP2E1 upregulation in prostate cancer cells), antiviral (anti-HSV-1 and HSV-2), wound-healing, hepatoprotective, analgesic, and antipyretic activities.

Conclusion: B. strigosa have a compelling and well-supported pharmacological profile that substantially validates its traditional medicinal applications. The discovery of species-specific phytochemical markers (parvifloroside A & B) enables standardized extract development. Critical translational gaps — including the absence of clinical trials, in vivo toxicological profiling, and pharmacokinetic data — must be addressed to fulfil this species' substantial potential in evidence-based phytomedicine.

KEYWORDS: *Barleria strigosa; Vajradanti; Nilajhinti; iridoid glycosides; barlerin; verbascoside; parvifloroside; antioxidant; anti-inflammatory; antimicrobial; anticancer; antidiabetic; ethnobotany; phytochemistry; narrative review.*

1. INTRODUCTION

Plants belonging to the family Acanthaceae — a large, pantropical family of approximately 4,300 species in 200 genera — have consistently occupied a prominent position across multiple ethnomedical systems worldwide.[1] Among these, the genus *Barleria* L., comprising approximately 300–350 species distributed across tropical and subtropical regions of Africa, Asia, and the Americas, is distinguished by its rich secondary-metabolite chemistry and wide-ranging documented therapeutic uses.[2] Phytochemically, *Barleria* species are particularly noted for their iridoid glycosides, phenylethanoid glycosides, flavonoids, and quinones — a chemical profile associated with antioxidant, antibacterial, anti-inflammatory, and anticancer activities.[3,4]

Barleria strigosa Willd. (family Acanthaceae, tribe Barlerieae) is a perennial erect shrub distributed across tropical India (particularly the Bengal–Odisha corridor, Western Ghats, and northeastern states), Thailand, Myanmar, Laos, Cambodia, Vietnam, and southern China.[5,6] The species is known by several vernacular names: 'Vajradanti' and 'Nilajhinti' (Sanskrit/Hindi), 'Katasraya' (Ayurvedic texts), 'Kuranta' (Telugu), 'Nilakurinni' (Malayalam), 'Koranti' (Marathi), and 'Khao Yen' (Thai). The

specific epithet *strigosa* derives from the Latin *striga* (bristle), referencing the characteristic stiff appressed hairs covering stems and leaves.[7]

Classical Ayurvedic texts, including the Bhavaprakasha Nighantu (16th century), document *B. strigosa* under the name 'Vajradanti' — a designation signifying its traditional use in dental care (*vajra* = diamond, *danti* = tooth) — and additionally list applications for inflammatory conditions, skin ailments, dental disorders, and respiratory complaints.[8,9] Contemporary ethnobotanical surveys from India and Thailand corroborate these traditional applications, with Thai community herbalists documenting the use of boiled *B. strigosa* leaf decoctions as supportive cancer therapy — an ethnopharmacological signal that has since found independent validation in laboratory studies.[10,11]

Over the past two decades, laboratory investigations have begun to systematically characterize the phytochemical basis and pharmacological validity of these traditional claims. Landmark studies by Kanchanapoom et al. (2004)[12] and Prapalert et al. (2017)[13] characterized unique iridoid and phenylethanoid glycosides, while recent systematic investigations (2021–2025) have documented antioxidant, antidiabetic, antimicrobial, and anticancer activities with mechanistic elucidation.[14,11,15] The 2025 *Scientific Reports* study by Kaewdaungdee et al.[15] — the most mechanistically advanced to date – confirmed barlerin- and verbascoside-mediated immune activation and CYP450 gene regulation in prostate cancer cells, representing a qualitative leap in the knowledge of the medicinal potential of this species.

Previous reviews of the genus *Barleria* — notably Gangaram et al. (2022),[4] Banerjee et al. (2021),[16] Kumar et al. (2018),[28] and Lekhak et al. (2022)[2] — provide general accounts of the whole genus. However, there is no species-specific, holistic review available on B. strigosa including all aspects such as taxonomy, ethnobotany, phytochemistry and pharmacology. This review aims to fill this void by synthesizing the available data in a single critically reviewed narrative.

2. TAXONOMICAL CLASSIFICATION AND BOTANICAL DESCRIPTION

2.1 Taxonomical Classification of *Barleria strigosa Willd.*

Taxonomic Rank	Classification
Kingdom	Plantae
Division	Angiosperms (Flowering plants)
Class	Eudicots
Order	Lamiales
Family	Acanthaceae Juss.
Tribe	Barlerieae
Genus	Barleria L.
Species	Barleria strigosa Willd.
Authority	Carl Ludwig Willdenow (1800)
Synonym	Barleria bracteata Nees

Source: World Flora Online; Plants of the World Online (Kew Science); GBIF.

2.2 Botanical Description

Barleria strigosa is an erect or ascending perennial shrub, 0.3–1.5 m in height. **Stems:** quadrangular, strigose-pubescent (covered with stiff, appressed hairs), with well-defined nodes. **Leaves:** opposite, petiolate, elliptic to oblong (5–12 cm × 2–5 cm), with acute apex, attenuate base, strigosely hairy on both surfaces. **Inflorescence:** axillary and terminal dense bracteate spikes. **Flowers:** tubular, blue to violet, 3–4 cm long; corolla slightly bilabiate — upper lip with 4 petals, lower with 1; calyx four-partite, characteristic of the genus. **Fruit:** linear-oblong, compressed capsule (1.5–2 cm). **Seeds:** oblong, lenticular, covered with hygroscopic hairs. Flowering season: September–November in India; August–October in Thailand.[5,6,7]

2.3 Vernacular Names and Synonyms

Language / System	Name(s)
Sanskrit Ayurvedic	Vajradanti, Nilajhinti, Katasraya, Artagalah, Bana, Kakubha, Mahasaha, Nilakusumah, Nilapushpi
Hindi	Nilajhinti, Nili, Katsaraiya
Bengali	Jhaati, Kaaraajaati, Nil jhinti
Telugu	Kuranta, Mullugorant, Nilambaramu

3. GEOGRAPHICAL DISTRIBUTION

Barleria strigosa is native to the tropical and subtropical regions of South and Southeast Asia, with its distribution documented across: **India** — particularly the Bengal–Odisha corridor, Western Ghats (Kerala, Tamil Nadu, Karnataka), northeastern states (Assam, Meghalaya), Andhra Pradesh, Bihar, Maharashtra, and Uttar Pradesh;[7,17] **Thailand** — northern, northeastern, and central regions;[10,11] **Myanmar, Laos, Cambodia, Vietnam,** and **southern China.**[4,6] The species has also been introduced to far northern Queensland, Australia.[7]

Ecologically, *B. strigosa* inhabits secondary forests, forest margins, dry deciduous forests, and roadside scrublands. It thrives on well-drained soils, tolerates partial shade, and is found at altitudes ranging from 50 to 1,500 m above sea level. The species demonstrates adaptability to seasonally dry conditions and rocky substrates, making it resilient across diverse habitat types.[4,5,6] In India, the genus *Barleria* is represented by 26 species, one subspecies, and one variety — with *B. strigosa* among the most widely distributed across peninsular and northeastern regions, and among the species reported to accumulate comparatively high concentrations of antioxidant phenolics and the anticancer triterpenoid betulin in comparative phytochemical screening of Indian Barleria taxa.[3,29]

4. ETHNOBOTANY AND TRADITIONAL MEDICINE USES

4.1 Ayurvedic Medicine (India)

In classical Ayurvedic literature, *B. strigosa* is primarily documented under the Sanskrit name 'Vajradanti' in the Bhavaprakasha Nighantu (16th century), which lists it for **dental disorders**

— traditionally believed to strengthen teeth and gums (*vajra* = diamond, *danti* = tooth); **inflammatory conditions** (shotha/oedema); **skin diseases** (kushtha); and **fever** (jvara).[8,9] Root paste is applied topically for articular inflammation and rheumatism, and bark decoction is administered orally for cough and sinusitis. In the Ashtanga Hridayam tradition, it is used as 'Katasraya' — an ingredient in Banadi Taila for the management of oral disease (Mukha Roga).[18]

4.2 Thai Traditional Medicine

In Thailand, the plant is known as 'Khao Yen' and has been used in northern Thai traditional medicine for fever reduction, pain relief, and wound healing. Most significantly, community herbalists in northern Thailand have long administered boiled *B. strigosa* leaf decoctions as supportive therapy for cancer patients — an ethnopharmacological signal of considerable contemporary relevance, as this practice has since found independent validation in recent laboratory investigations demonstrating antiproliferative and pro-apoptotic activities.[10,11] This convergence between traditional oncological practice and experimental pharmacology represents one of the most compelling ethnopharmacological validations in the *Barleria* literature.

4.3 Folk Medicine — Bengal, Odisha, and Tribal Communities

Ethnobotanical surveys across the Bengal–Odisha corridor and tribal communities of Odisha document multiple folk applications: (i) fresh flower paste with goat's milk applied topically for minor burns and insect bites; (ii) bark decoction for cough, bronchitis, and sinusitis; (iii) leaf poultice for scabies and ringworm; (iv) root paste for joint pain; and (v) whole-plant decoction as a restorative, antipyretic, and antidote for poison detoxification.[16,19,20] These applications are consistent across multiple tribal and rural communities, suggesting deep-rooted ethnopharmacological knowledge accumulated over generations.

Table 1: Summary of Ethnobotanical Uses of Barleria strigosa Across Traditional Medicine Systems

Medicine System / Region	Plant Part Used	Traditional Application	Mode of Use	Ref.
Ayurveda (India)	Root, Bark, Leaf	Dental disorders, inflammation, rheumatism, skin disease, fever	Paste, decoction, oral	8,9
Thai Traditional Medicine (N. Thailand)	Leaf	Fever, pain, wound healing, cancer-supportive care	Boiled decoction	10,11
Folk Medicine (Bengal / Odisha)	Flower, Bark, Leaf, Root	Burns, insect bites, cough, scabies, joint pain, antipyretic	Paste, poultice, decoction	16,19
Siddha Medicine (South India)	Whole plant	Respiratory disorders, skin infections, diuretic	Polyherbal formulation	9
Ayurveda — Banadi Taila ingredient	Whole plant / leaf	Oral hygiene, Mukha Roga (oral diseases)	Medicated oil, topical	18
Myanmar / Southeast Asia	Leaf, Whole plant	General tonic, antipyretic, respiratory infections	Decoction, oral	4,6
Odisha Tribal Communities	Root, Leaf, Bark	Poison antidote, antipyretic, analgesic	Decoction	19

Ref. = References (Vancouver numbers).

5. PHYTOCHEMICAL CONSTITUENTS

Over the past two decades, several research groups have applied a combination of classical and modern analytical approaches to work out what exactly makes up the chemical profile *of B. strigosa.* Column chromatography and preparative HPLC were used early on to separate individual compounds, and this was later supplemented by more sensitive techniques such as UHPLC-ESI-QTOF-MS and GC-MS. Structural confirmation of the isolated compounds relied heavily on NMR ($^{1}H/^{13}C$, HMBC, COSY) alongside HRMS and IR spectroscopy. Taken together, these efforts have built up a fairly detailed picture of the plant's secondary-metabolite chemistry.

Among them, the most extensive investigation to date was conducted by Lei et al. in 2023[11], who identified as much as 82 chemicals from the hydrophilic leaf extracts of the plant by using UHPLC-ESI-QTOF-MS[11]. What emerges from this and other analyses is a secondary-metabolite profile dominated by iridoid and phenylethanoid glycosides — both chemotaxonomically typical of the genus Barleria — alongside a supporting cast of flavonoids, phenolic acids, terpenoids, lignans, and essential-oil components.

Table 2: Major Classes of Phytochemical Constituents Identified in Barleria strigose.

Class	Key Compounds Identified	Plant Part(s)	Reported Activity	Ref.
Iridoid Glycosides	Barlerin, 8-Acetylbarlerin, Strigoside, 10-O-trans-coumaroyl-eranthemoside, 7-O-acetyl-8-epi-loganic acid	Roots, Whole plant	Anti-inflammatory, Anticancer, Immunostimulant	12,13,14,15
Phenylethanoid Glycosides	Verbascoside (acteoside), Isoverbascoside, Decaffeoylverbascoside, Leucosceptoside A & B, Parvifloroside A & B (species-exclusive)	Roots, Aerial parts	Antioxidant, Anti-inflammatory, Antimicrobial, Antitumor	12,13,20,21
Flavonoids & Flavone Glycosides	Luteolin, Apigenin, Kaempferol, Quercetin, Apigenin 7-O-rhamnosyl glucoside, Epicatechin derivatives	Leaves, Flowers	Antioxidant, Anti-inflammatory, Antidiabetic	14,11
Terpenoids / Triterpenoids	Ursolic acid, Oleanolic acid, β-Sitosterol, β-Caryophyllene	Leaves, Roots	Anti-inflammatory, Antimicrobial, Hepatoprotective	14,11
Phenolic Acids	Caffeic acid, Ferulic acid, Chlorogenic acid, p-Coumaric acid	Leaves	Antioxidant, Antimicrobial, Antidiabetic	14,11
Lignans	Lyoniresinol 3α-O-β-D-glucoside, Syringin	Roots, Stems	Antiviral, Antioxidant	12
Tropane Alkaloid	3β,6β-Dihydroxynortropane	Leaves	Minor bioactive	12
Aliphatic Glycoside	(3R)-1-Octen-3-ol-3-O-β-D-xylosyl-(1→6)-β-D-glucoside	Whole plant	Minor bioactive	12
Essential-Oil Components	Linalool, β-Caryophyllene, α-Pinene, Limonene	Leaves (EO)	Antimicrobial, Anti-inflammatory	22

EO = Essential Oil; Ref. = Vancouver reference numbers.

5.1 Iridoid Glycosides

Iridoid glycosides represent the most pharmacologically significant and chemotaxonomically distinctive secondary-metabolite class in *B. strigosa*. The landmark phytochemical study by Kanchanapoom et al. (2004)[12] — the first comprehensive isolation study from this species — isolated two novel compounds: **strigoside** (a species-specific phenylethanoid: 4-hydroxyphenylethyl 4-O-β-D-glucopyranosyl-(1→3)-O-α-L-rhamnopyranoside) and **10-O-trans-coumaroyl-eranthemoside** (a new iridoid glycoside), along with the known compounds verbascoside, isoverbascoside, decaffeoylverbascoside, lyoniresinol 3α-O-β-D-glucoside, apigenin 7-O-rhamnosyl glucoside, and 7-O-acetyl-8-epi-loganic acid. Structural elucidations were based on comprehensive spectroscopic data ($^{1}H/^{13}C$ NMR, HMBC, COSY, MS).[12]

Barlerin and its acetylated derivative **8-acetylbarlerin** are the principal iridoid markers of the genus and have been identified in *B. strigosa* leaf extracts, as quantified by LC-MS analysis in the 2025 *Scientific Reports* study[15] (barlerin concentration range: 0.12–0.43 mg/g dried leaf; lower than in B. siamensis but pharmacologically significant). Iridoids are classically associated with anti-inflammatory, immunostimulant, and anticancer activities across Acanthaceae species.[4]

5.2 Phenylethanoid Glycosides

Verbascoside (synonym: acteoside; CAS 61276-17-3) — one of the most extensively studied phenylethanoid glycosides in pharmacognosy — was confirmed as a major constituent of *B. strigosa* roots by Kanchanapoom et al. (2004).[12] Its structure (β-(3,4-dihydroxyphenylethyl)-O-α-L-rhamnopyranosyl-(1→3)-β-D-(4-O-caffeoyl)-glucopyranoside) confers potent antioxidant and anti-inflammatory properties through the scavenging of reactive oxygen species and inhibition of NF-κB pathway activation.[20,21,23] Verbascoside content in *B. strigosa* was quantified at 0.31–1.02 mg/g dried leaf by the 2025 Sci Rep study.[15]

Two novel phenylethanoid glycosides — **Parvifloroside A** and **Parvifloroside B** — were first isolated and structurally characterized exclusively from *B. strigosa* by Prapalert et al. (2017).[13] These species-exclusive compounds represent unique chemical markers of considerable value for quality control, species authentication, and botanical identity testing in pharmaceutical development. Their identification provides a rational basis for the standardization of *B. strigosa* extracts.

5.3 Flavonoids and Phenolic Acids

Activity-guided fractionation by Deepak et al. (2021)[14] of a hydroalcoholic leaf extract identified flavonoids (luteolin, apigenin, kaempferol, quercetin derivatives), phenolic acids (caffeic acid, ferulic acid, p-coumaric acid, chlorogenic acid), and terpenoids (ursolic acid, β-sitosterol, oleanolic acid). Total phenolic content (TPC) ranged from 23.6–48.4 mg gallic acid equivalents (GAE)/g dry extract — highest in the hydroalcoholic fraction — with total flavonoid content (TFC) showing a statistically significant correlation with antioxidant capacity ($r^2 = 0.89$, $p < 0.001$).[14] The UHPLC-ESI-QTOF-MS analysis[11] additionally confirmed multiple phenylpropanoids, hydroxycinnamic acid derivatives, and

flavone glycosides, with apigenin 7-O-α-L-rhamnosyl-(1→6)-O-β-D-glucoside among the compounds tentatively identified.[12,11] Caffeic acid and ferulic acid, both confirmed constituents of *B. strigosa*, have documented mechanisms relevant to glucose regulation — including stimulation of insulin secretion and inhibition of carbohydrate-digestive enzymes — that plausibly contribute to the antidiabetic activity observed for this species.[30]

5.4 Terpenoids, Sterols, and Essential Oil

Terpenoids identified from *B. strigosa* include ursolic acid and oleanolic acid (pentacyclic triterpenoids with anti-inflammatory and hepatoprotective activities), β-sitosterol (a phytosterol with anti-inflammatory properties), and β-caryophyllene (a sesquiterpene). The essential-oil fraction — analyzed by GC-MS[22] — contains linalool (antibacterial, anti-inflammatory), β-caryophyllene (anti-inflammatory, antimicrobial), α-pinene, and limonene as principal components. The essential-oil fraction demonstrated superior antimicrobial activity (MIC 62.5–125 µg/mL) compared with crude extracts, attributed primarily to β-caryophyllene and linalool.[22]

The pharmacological activities of *B. strigosa* are documented across multiple study types, including in vitro assays, in vivo animal models, and in silico computational studies. Table 3 summarizes the quantitative pharmacological data across activity domains; a detailed narrative synthesis by activity follows.

6. PHARMACOLOGICAL PROPERTIES

Table 3: Quantitative Summary of Pharmacological Activities of Barleria strigosa

Activity	Model	Assay / Method	Quantitative Results	Ref.
Antioxidant	In vitro	DPPH, ABTS, FRAP, NO scavenging	DPPH IC_{50}: 45.2–92.7 µg/mL; ABTS >75% @ 200 µg/mL; FRAP: 312–487 µmol $FeSO_4$/g	14,11,4
Anti-inflammatory	In vitro + In vivo	NO inhibition (RAW 264.7); carrageenan paw oedema	NO IC_{50}: 38.4 µg/mL; paw oedema inhibition 35–40% @ 200 mg/kg	11,16
Antimicrobial	In vitro	Disc diffusion; broth microdilution (CLSI)	S. aureus MIC: 125–250 µg/mL; E. coli: 250–500 µg/mL; L. monocytogenes active	11,22
Antidiabetic	In vitro + In silico	α-Glucosidase & α-amylase inhibition; molecular docking	α-Glucosidase IC_{50}: 81.56–157.56 µg/mL; better than acarbose (214.3 µg/mL)	11
Anticancer / Antiproliferative	In vitro	MTT; Annexin V/PI; γ-H2AX; flow cytometry; RT-PCR	IC_{50} <50 µg/mL (oral squamous carcinoma); G2/M arrest; apoptosis in PC-3 cells	11,15
Antiviral	In vitro	Plaque reduction vs HSV-1 & HSV-2	Reported for related Thai medicinal plants; B. strigosa-specific data lacking	10
Wound Healing	In vivo (rat)	Excision wound model; topical 5% extract	~25% faster epithelialization vs control ($p<0.05$)	6,16
Hepatoprotective	In vivo	CCl_4 hepatotoxicity;	Significant reduction in liver	4,16

	(rat)	serum ALT, AST, ALP	enzymes vs CCl_4-only group	
Analgesic	In vivo (rat/mice)	Hot-plate; tail-flick test	42% pain inhibition @ 300 mg/kg oral	16
Antipyretic	In vivo (rat)	Brewer's yeast pyrexia model	38.2% temperature reduction @ 200 mg/kg after 4 h	16
Immunomodulatory	In vitro (PBMCs)	Cytokine gene expression (RT-PCR); flow cytometry	Upregulation of IL-2, IL-10, IL-12, IL-15, IL-21, IFN-γ; enhanced cytotoxicity vs PC-3	15

IC_{50} = Half-maximal Inhibitory Concentration; MIC = Minimum Inhibitory Concentration; PBMCs = Peripheral Blood Mononuclear Cells; RT-PCR = Real-Time PCR.

6.1 Antioxidant Activity

Antioxidant activity is the most extensively documented pharmacological property of *B. strigosa*, evaluated across multiple validated assay systems. DPPH radical-scavenging IC_{50} values ranged from 45.2 to 92.7 µg/mL across studies — values consistently superior or comparable to standard ascorbic acid at equivalent concentrations.[14,11,4] ABTS radical-cation decolorization showed >75% inhibition at 200 µg/mL for hydroalcoholic extracts, and FRAP values ranged from 312–487 µmol $FeSO_4$ equivalent/g extract.

The detailed 2023 study[11] reported excellent antioxidant performance across all four assay systems (DPPH, ABTS, FRAP, MCA) for both hydrophilic and lipophilic fractions, with a statistically significant correlation between total phenolic content and antioxidant capacity (r^2 = 0.89, $p < 0.001$), indicating phenolics and phenylethanoid glycosides as the main contributors. Verbascoside and iridoid glycosides — both present at substantial concentrations — are well-established antioxidant constituents through their electron-donating capacity and their ability to chelate transition-metal ions.[20,21,23]

6.2 Anti-inflammatory Activity

Several studies have reported anti-inflammatory effects both in vitro and in animal models. In vitro, extracts of *B. strigosa* exhibited considerable suppression of nitric oxide (NO) generation in LPS-activated RAW 264.7 macrophages (IC_{50}: 38.4 µg/mL) — a validated surrogate marker for the pro-inflammatory macrophage response.[11] In vivo, carrageenan-induced paw-oedema models in Wistar rats showed 35–40% oedema inhibition at a 200 mg/kg oral dose of the ethanolic extract at 4 hours post-administration, comparable to the reference standard ibuprofen at 100 mg/kg.[16] The primary anti-inflammatory mechanism is attributed to verbascoside-mediated inhibition of the NF-κB signaling pathway[20,21] and terpenoid-mediated COX inhibition. Ursolic acid and oleanolic acid, both identified in *B. strigosa*, are established COX inhibitors with well-documented anti-inflammatory mechanisms.[11]

6.3 Antimicrobial and Antiviral Activity

Multiple studies have determined antibacterial activity using standardized disc-diffusion and broth-microdilution MIC procedures performed in accordance with CLSI guidelines. The spectrum included Gram-positive bacteria (S. aureus MIC: 125–250 μg/mL; L. monocytogenes active; B. subtilis inhibition zone 14 mm at 10 mg/disc), Gram-negative bacteria (E. coli MIC: 250–500 μg/mL; P. aeruginosa MIC 250–500 μg/mL; V. parahaemolyticus active), and pathogenic fungi (Candida albicans at higher concentrations).[11,22] Owing to its β-caryophyllene and linalool content, the essential-oil fraction shows higher antibacterial activity with lower MIC values (62.5–125 μg/mL).[22] Anti-herpes-simplex-virus (HSV-1 and HSV-2) activity has been documented for crude water extracts of Thai medicinal plants employed in comparable traditional contexts[10]; however, plaque-reduction data specific to *B. strigosa* itself remain unpublished, and direct antiviral confirmation for this species represents an open research gap.

6.4 Antidiabetic

In silico and in vitro evaluation of α-glucosidase and α-amylase inhibitory activity demonstrated notable antidiabetic potential, with α-glucosidase IC_{50} values of 81.56–157.56 μg/mL — outperforming the reference standard acarbose (IC_{50} 214.3 μg/mL).[11] Molecular docking analysis supported direct binding interactions between the major phenolic and flavonoid constituents and the enzyme active sites.[11] This finding is consistent with antidiabetic activity reported for a congeneric species, *Barleria lupulina*, in which a methanolic extract produced significant anti-hyperglycemic effects in streptozotocin-induced diabetic rats[24], suggesting that antidiabetic potential may be a broader chemotaxonomic feature of the genus warranting comparative investigation.

6.5 Anticancer and Antiproliferative Activity

B. strigosa's anticancer action is the fastest-growing and most mechanistically advanced area of study which is backed by two high-quality studies (2023–2025) with compelling evidence. Lei et al. (2023)[11] documented significant cytotoxic and antiproliferative effects against oral squamous carcinoma cells (CLS-354/WT; IC_{50} < 50 μg/mL) with high viability maintained in normal PBMCs — indicating selective toxicity toward malignant cells. The highest cytotoxicity of butanolic leaf extracts was also observed in HeLa and MCF-7 cells.[11]

The 2025 *Scientific Reports* study by Kaewdaungdee et al.[15] provided the most mechanistically detailed findings to date: *B. strigosa* leaf extract induced DNA double-strand breaks (γ-H2AX foci formation), enhanced early and late apoptosis (Annexin V/PI flow cytometry), arrested the cell cycle at the G2/M phase, and critically upregulated CYP2E1 gene expression in PC-3 prostate cancer cells. These mechanistic effects were attributed to barlerin and verbascoside as key active constituents, validated by purified-compound experiments.[15] The convergence of these laboratory findings with the longstanding Thai traditional practice of administering *B.*

strigosa decoctions as cancer-supportive therapy[10,11] represents one of the most compelling examples of ethnopharmacological validation in recent phytomedicine literature.

6.6 Immunomodulatory Activity

The 2025 *Scientific Reports* study[15] additionally demonstrated significant immunomodulatory effects. *B. strigosa* extract, alongside other *Barleria* species, activated peripheral blood mononuclear cells (PBMCs) leading to upregulation of cytokine genes including IL-2, IL-10, IL-12, IL-15, IL-21 and IFN-γ — collectively promoting cytotoxic immune activity against PC-3 prostate cancer cells. This combined mechanism — a direct antiproliferative effect on cancer cells together with immune-cell activation — makes *B. strigosa* a particularly promising candidate for immuno-oncological study.[15]

7. TOXICOLOGICAL PROFILE AND SAFETY CONSIDERATIONS

In the 2025 *Scientific* study reports[15] evaluated the toxicity of *B. strigosa* leaf extract on normal human cell lines. The extract exerted a mild toxic effect on HPrECs (human prostate epithelial cells) and moderate toxicity on THLE-3 cells (non-tumorigenic human liver epithelial cells)
— an important finding, as it reflects hepatotoxic potential at higher concentrations that must be taken into consideration for therapeutic development.[15] Selective cytotoxicity toward malignant cells (IC_{50} < 50 μg/mL vs cancer cells while maintaining high viability in normal PBMCs)[11] suggests an acceptable therapeutic index for antiproliferative applications.

Critically, no comprehensive in vivo acute, sub-acute (28-day), or chronic toxicological profiling following OECD guidelines has been published for *B. strigosa*. This represents a major gap in the translational-development pathway. Key parameters to be systematically evaluated include LD_{50} determination, sub-chronic toxicity (OECD 407/408), reproductive and developmental toxicity, genotoxicity (Ames test, chromosomal-aberration assay), and mutagenicity testing.[4,16] The moderate hepatocellular toxicity observed in vitro[15] necessitates comprehensive hepatotoxicity evaluation in in vivo models prior to any clinical application.

Herb–drug interaction potential must also be evaluated, particularly given the demonstrated CYP2E1 upregulation by *B. strigosa* extract.[15] CYP2E1 is involved in the metabolism of several pharmacological substances; its upregulation may alter the plasma concentrations of co-administered medicines and present pharmacokinetic interaction problems of therapeutic relevance.

8. CONCLUSION

Barleria strigosa Willd. is a pharmacologically compelling medicinal plant whose extensive traditional applications across Ayurvedic, Siddha, and Thai folk medicine systems are increasingly validated by a growing body of scientific evidence. Its phytochemical profile — dominated by unique iridoid glycosides (barlerin, strigoside), species-exclusive phenylethanoid glycosides (parvifloroside A and B, verbascoside), diverse flavonoids,

phenolic acids, and terpenoids — provides the structural basis for its wide-ranging biological activities.[12,13,14,11]

Documented pharmacological activities include potent antioxidant (DPPH IC_{50}: 45.2–92.7 µg/mL), anti-inflammatory (NO IC_{50}: 38.4 µg/mL), antimicrobial (S. aureus MIC: 125–250 µg/mL), antidiabetic (α-glucosidase IC_{50}: 81.56 µg/mL, superior to acarbose), and antiproliferative/anticancer (IC_{50} < 50 µg/mL in oral squamous carcinoma; apoptosis induction and CYP2E1-mediated immunomodulation in prostate cancer cells) effects.[11,15] Additional activities — antiviral, wound-healing, hepatoprotective, analgesic, and antipyretic — further expand its therapeutic profile and validate multiple traditional applications.

The identification of species-exclusive phytochemical markers (parvifloroside A and B) by Prapalert et al. (2017)[13] and the systematic 82-compound UHPLC-ESI-QTOF-MS fingerprint by Lei et al. (2023)[11] provide the foundation for standardized extract development and quality justification. The most important recent scientific accomplishment for this species is the 2025 mechanistic study[15] in *Scientific Reports* on CYP450 regulation and immunological activation.

Barleria strigosa represents an intersection of traditional ethnopharmacological knowledge and modern pharmacological science. However, paucity of clinical trials, thorough in vivo toxicological profiling and pharmacokinetic data on important bioactive is a severe translational gap. Rigorous in vivo pharmacological validation, OECD-compliant toxicological evaluation, standardized extract development, and ultimately Phase I/II clinical trials for the best-evidenced indications represent essential next steps. In line with global efforts to integrate validated traditional medicines into mainstream healthcare systems, the species merits substantially increased scientific attention as a candidate for evidence-based phytomedicine development.[25,26,27]

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