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REVIEW

Poikilospermum suaveolens (Blume) Merr.: Phytochemical, Ethnomedicinal Uses, and Pharmacological Potential

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Purpose: The *Poikilospermum* genus, which belongs to the Urticaceae family, has historically been used for medicinal purposes in Southeast Asia. However, its phytochemical potential and pharmacological mechanisms have not yet been adequately investigated. This review consolidates current data on the bioactive chemicals and therapeutic potential of *Poikilospermum* spp. with an emphasis on *Poikilospermum suaveolens* (Blume) Merr.

Methodology: A comprehensive search was performed using the PubMed, Scopus, Google Scholar, and Web of Science databases. This study examined publications from 2015 to 2025 that explored the phytochemical composition and pharmacological properties of *Poikilospermum* species. Terms such as "Poikilospermum", "inflammatory", "phytochemicals", "anticancer", "ethnobotany", "phytochemistry", "pharmacological", "antimicrobial", and "antioxidant".

Results: The investigation revealed various bioactive components such as flavonoids, tannins, alkaloids, and terpenoids, which contribute to the antibacterial, anti-inflammatory, and antioxidant capabilities of *Poikilospermum*. Initial data indicated possible anticancer properties of *P. suaveolens*; however, additional research is required to validate these effects and elucidate the underlying pathways.

Conclusion: *Poikilospermum* species, particularly *P. suaveolens*, is a promising source of bioactives; priority next steps include standardized in vivo studies, toxicity assessment, and targeted mechanistic work. Subsequent studies should focus on clinical trials and more in-depth inquiries into the mechanisms of action of identified substances.

Keywords: *Poikilospermum*, phytochemicals, ethnobotanical, pharmacological, antioxidant

Introduction

The *Poikilospermum* genus, belonging to the Urticaceae family,[1] is primarily located in tropical areas of Southeast Asia,[2] especially Malaysia and Indonesia.[3–5] Numerous species of this genus have been used in traditional medicine for the past several decades. Ethnobotanical records indicate that various components of these plants, including the leaves, roots, bark, and flowers, are utilized to treat ailments such as gastrointestinal disorders, inflammation, fever, and dermatological illnesses.[6–8] Despite its extensive application in traditional medicine, the pharmacological characteristics and phytochemical makeup of *Poikilospermum* have not been adequately investigated, particularly the potential for therapeutic advancement.

Phytochemical studies have indicated that *Poikilospermum* species possess many bioactive chemicals including flavonoids, tannins, alkaloids, and terpenoids,[9,10] which are associated with notable pharmacological effects. These chemicals exhibit antibacterial,[3] anti-inflammatory,[11] antioxidant, and analgesic activities,[3,12] indicating that species

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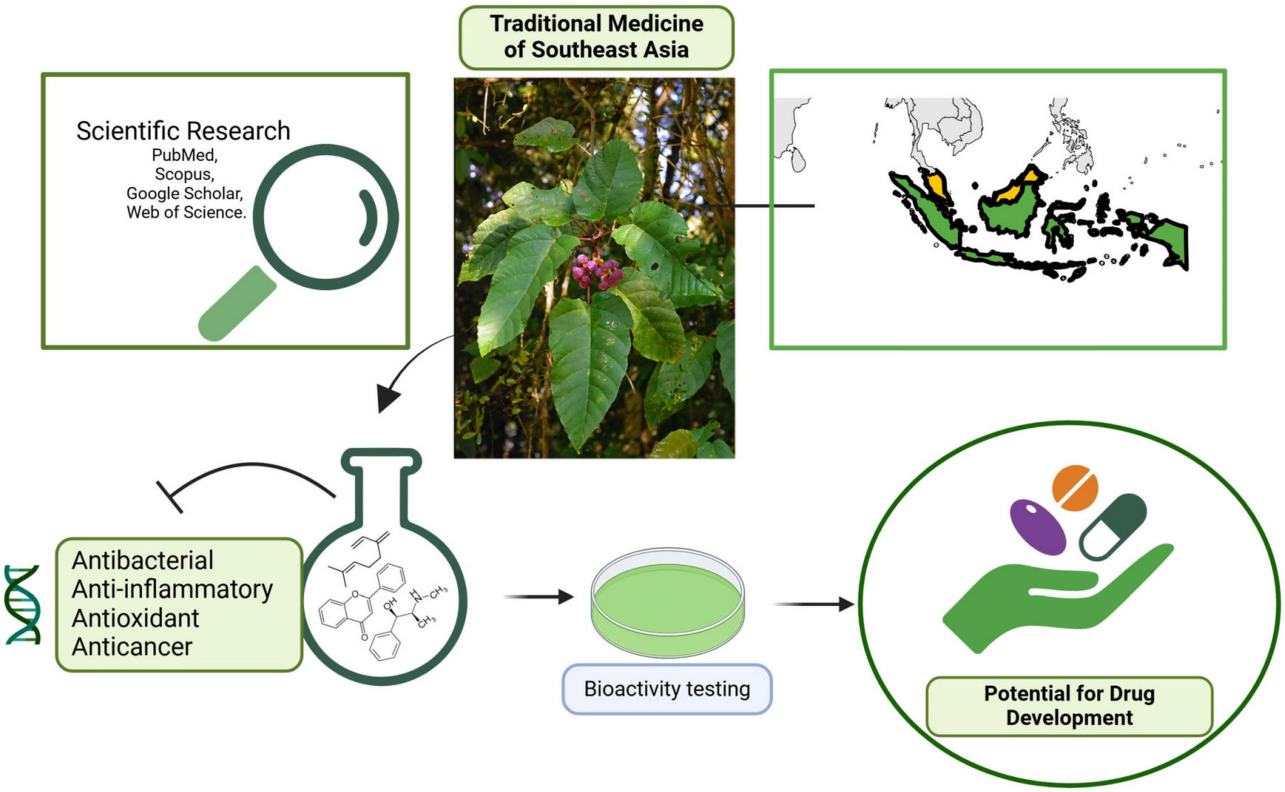
Graphical Abstract



within this genus have significant potential for medicinal use. Nevertheless, extensive evaluations of these discoveries are scarce, and most investigations thus far have concentrated on discrete pharmacological effects without integrating overarching conclusions regarding the genus in its entirety.

In this review, we focus on *Poikilospermum suaveolens* (Blume) Merr. the most extensively studied species within the genus, and emphasize its bioactive components and medicinal qualities.

P. *suaveolens*, a climbing shrub belonging to the family Urticaceae, is widely distributed across the tropical forests of Southeast Asia, particularly Malaysia, Indonesia, Thailand, and Vietnam. This species thrives in humid, shaded environments and is commonly found in secondary forests, riverbanks, and lowland areas. Traditionally, *P. suaveolens* has been used for various ethnomedicinal applications. In Indonesian and Malaysian folk medicine, its leaves and roots are employed in traditional medicine for gastrointestinal ailments such as diarrhea and dysentery, as well as inflammatory conditions, skin infections, and fever. The decoction of its bark or leaf is also consumed as a general health tonic and has been reported to have wound-healing and analgesic properties in certain tribal communities. Pharmacological investigations have identified that *P. suaveolens* contains a diverse array of phytoconstituents, including flavonoids, alkaloids, tannins, and terpenoids, many of which exhibit promising biological activities such as antibacterial, anti-inflammatory, antioxidant, and cytotoxic effects. This pharmacodynamic richness underscores its potential as a source of therapeutic agents, positioning *P. suaveolens* as a compelling candidate for the further development of herbal-based drug formulations.

Although several studies have documented the phytochemical profile and pharmacological activities of *P. suaveolens*, these findings are scattered across individual studies, with a limited scope. To date, there are no comprehensive review articles that systematically compile, analyze, and synthesize current knowledge on *P. suaveolens*. The absence of such an integrative review limits the scientific community's ability to assess its full pharmacotherapeutic potential. This study

sought to fill this gap by offering a cohesive and critical evaluation of the phytochemistry, pharmacology, and therapeutic relevance of *P. suaveolens*, drawing connections between its traditional uses and modern pharmacological findings. By doing so, this review not only consolidates existing knowledge but also highlights key areas for future research and drug development.

This review aimed to provide a comprehensive synthesis of the current scientific literature on the genus *Poikilospermum*, with a particular focus on *P. suaveolens*. The primary objectives were to (1) document the distribution and ethnomedicinal uses of *P. suaveolens*, (2) analyze the phytochemical constituents and their structural characteristics, (3) evaluate its pharmacological activities with an emphasis on antibacterial, anti-inflammatory, antioxidant, and anticancer mechanisms, and (4) discuss the molecular pathways influenced by its bioactive compounds. This review emphasizes the therapeutic potential of *P. suaveolens* as a natural drug candidate, by integrating ethnobotanical knowledge with pharmacological evidence. Using this approach, we aimed to establish a scientific foundation for future preclinical and clinical investigations, formulation development, and potential integration into modern phytopharmaceuticals. Ethnomedicinal records are treated as hypothesis-generating context rather than confirmatory evidence, any pharmacological inference is based strictly on experimental data.

This review consolidates fragmented evidence on *P. suaveolens* by bridging ethnobotany, phytochemistry, and pharmacology within a single, hypothesis-generating framework. We synthesize reports from 2015–2025, map recurrent chemical classes to reported bioactivities using cautious evidence qualifiers, and situate *P. suaveolens* within the broader Urticaceae context. By outlining a focused research agenda (standardized chemistry, in vivo validation, safety, and delivery optimization). We believe this review will serve as a foundational scaffold for future discovery and translational research, inspiring the next generation of studies aimed at advancing the rational design and clinical development of anti-lung cancer therapeutics.

Methodology

This review used a structured search method to collect pertinent information on *Poikilospermum* and its pharmaceutical applications. The investigation was performed using various databases, including PubMed, Scopus, Google Scholar, and Web of Science, encompassing studies published between 2015 and 2025. The keywords utilized include "Poikilospermum", "inflammatory", "phytochemicals", "anticancer", "ethnobotany", "phytochemistry", "pharmacological", "antimicrobial", and "antioxidant". The inclusion criteria were peer-reviewed original research articles or reviews published in English (or with an English abstract), studies reporting the phytochemical composition, traditional uses, pharmacological activities, or safety/toxicity data of *Poikilospermum* species, experimental investigations (in vitro, in vivo, or clinical), and ethnobotanical documentation. Exclusion criteria included non-peer-reviewed sources; conference abstracts, editorials, commentaries, or book chapters lacking original data; articles without relevant data on pharmacological activity, phytochemistry, or traditional use; and studies published outside the designated year range. The initial search retrieved 314 records, of which 287 remained after duplicates were removed. Following title and abstract screening, 57 articles were selected for full-text review and 26 met all eligibility criteria for inclusion in the final synthesis. Reports limited to ethnobotanical description were summarized qualitatively and not weighed as efficacy data. Pharmacological conclusions were drawn only from experimental studies that reported methods, controls, and outcomes. This article is a narrative literature review, not a full systematic review; therefore, PRISMA 2020 was not applied in full. To enhance transparency, we adapted PRISMA 2020 principles for the identification, screening, eligibility, and inclusion steps (PRISMA 2020), no protocol registration, formal risk-of-bias assessment, or meta-analysis was performed. Figure 1 presents the PRISMA 2020 adapted flow diagram of the study selection process.[13] Data extraction focused on the *Poikilospermum* species and plant parts investigated, extraction methods, identified metabolites, reported pharmacological activities (including experimental model, concentration, and outcomes), safety or toxicity findings, and ethnobotanical context of traditional medicinal uses. As this is a narrative review, a formal risk-of-bias assessment and meta-analysis were not undertaken; accordingly, PRISMA 2020 was applied in an adapted manner limited to the study identification and selection steps. All figures in this manuscript, including mechanistic diagrams, were created using BioRender and chemical structures were drawn using ChemDraw Professional (Version 16.0.1.4; licensed to Supriatno Salam,

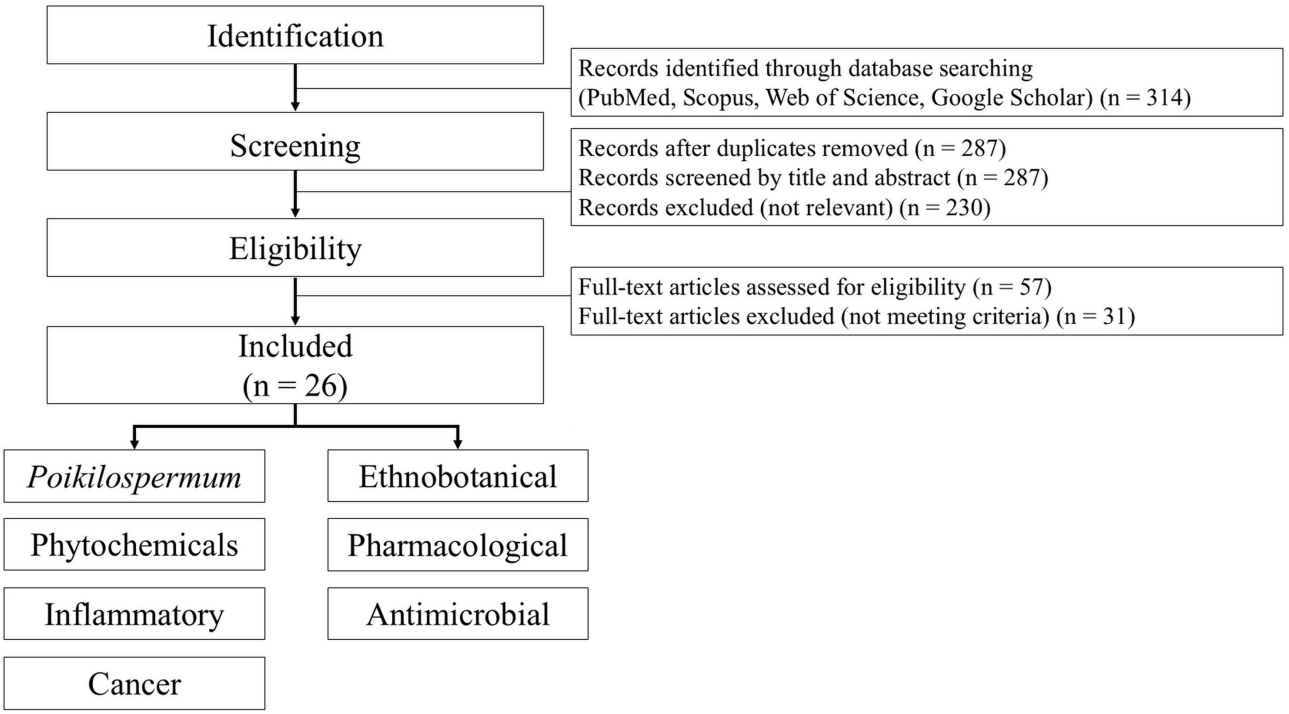


Figure 1 PRISMA 2020 adapted flow diagram of the study selection process (2015–2025).

Universitas Padjadjaran, License ID: 112-920429-8380) based on data from the PubChem database, ensuring accuracy and clarity in the representation of the studied compounds.

To situate *Poikilospermum* within its family, we extended the search beyond Southeast Asia to include global Urticaceae genera (eg, *Urtica, Boehmeria, Debregeasia, Girardinia, Laportea, Pilea*). We combined genus/species names with pharmacology terms (eg, anti-inflammatory, antioxidant, antimicrobial, cytotoxicity) and screened records (2015–2025) for comparative value to the present review. Ethnobotanical only reports were summarized qualitatively and not weighed as efficacy evidence. Given heterogeneity across study designs and outcomes, we used a narrative comparative synthesis and explicitly indicate the primary evidence level (in vitro, in vivo, clinical) in the Discussion.

Botanical Overview of Poikilospermum Genus

The genus *Poikilospermum* Zipp. ex Miq. (1864) from the family Urticaceae, Juss. (1789) comprises approximately 33 recognized species that are predominantly distributed in tropical Southeast Asia, especially in Borneo and the Malay Peninsula. Although several species occur regionally, *P. suaveolens* stands out because of its broad ethnomedicinal use, unique morphological characteristics, and the highest number of pharmacological and phytochemical studies in recent literature. Therefore, this review focuses on *P. suaveolens* as a model species, with other congeners included only in the comparative chemotaxonomic context.[3,14]

While several species, such as *P. borneense, P. acuminatum*, and *P. lanceolatum* have been documented in regional floras, most studies on their pharmacological activity and phytochemistry have concentrated on *P. suaveolens*. Table 1 summarizes the main recognized species within the genus along with their taxonomic status and key distribution. Comparative evaluation with *P. suaveolens* aids in understanding the chemotaxonomic patterns and unique secondary metabolite profiles across the genus.[15] *P. suaveolens* is among the most extensively documented species in ethnobotanical and pharmacological research. This species thrives at elevations between 500 and 600 meters[16] and is distributed across India, southern China, Myanmar, Vietnam, the Philippines, Malaysia, Singapore, and Indonesia.[3] Its broad geographical presence and traditional applications in various local medicinal systems make *P. suaveolens* a compelling candidate for phytochemical and pharmacological investigations, specifically as a model species within the genus.

Table 1 Phylogenetic and Taxonomy of *Poikilospermum*

General Aim of Study	Key Result/Outcome	Chemotaxonomic Relevance	Ref
DNA metabarcoding of fecal samples from primates	Identified significant consumption of *Poikilospermum* spp.; insight into ecological interactions	Supports link between plant occurrence and potential secondary metabolite transfer via food webs	[17]
Phylogenetic analysis using rbcL, chloroplast, and nuclear DNA	The study revealed new insights into evolutionary divergence and relationships among genera within the family, supporting reclassification based on genetic data for more refined taxonomic relationships.	Refined taxonomy supports grouping species with shared chemotypes/ metabolite patterns	[18–20]
Phylogenetic studies of *Urticalean rosids*	The study clarified relationships within the Urticaceae family, contributing to understanding *Poikilospermum* taxonomy and its phylogenetic position.	Establishes evolutionary context for secondary metabolite comparisons	[20]
Phylogenomics of the *Urera clade* with Sanger/ target-enrichment	The study improved generic delimitation, clarified distinctions among genera, and refined evolutionary relationships, correcting previous ambiguities in classification.	Accurate classification aids prediction of phytochemical diversity	[21]
Comparative carpology (seed and fruit morphology)	The study revealed significant differences and similarities among species, refining taxonomic classification and understanding of evolutionary relationships within the genus.	Seed/fruit traits often linked with unique metabolite profiles (eg, triterpenoids)	[22]
Phylogenetic framework for genus *Pilea* (comparison)	The study provided a revised classification, addressing species diversity and relationships within the genus, and offering a clearer taxonomic structure.	Comparative model for taxonomic and chemotaxonomic approaches	[19,23]
Next-generation sequencing (NGS) and plastome data	The study highlighted previously unrecognized clades and relationships, refining the overall phylogenetic tree and improving understanding of species diversification within the family.	Plastid genome variation correlates with diversity in biosynthetic pathways	[24]

Phylogenetic and Taxonomic Insights

Phylogenetic and taxonomic investigations of *Poikilospermum* and related species within the family Urticaceae have provided significant insights into evolutionary relationships and genetic diversity. This study used a range of molecular methods, including sequencing of the rbcL gene and chloroplast DNA, to resolve infrafamilial and tribal-level phylogenies.[18,19] The application of next-generation sequencing (NGS) technologies, combined with analyses of nuclear and plastid DNA, has revealed previously unrecognized clades and novel character states, prompting the reclassification of several genera within the family.[25]

Focused phylogenomic research on *Poikilospermum* such as comprehensive chloroplast genome sequencing of *P. lanceolatum* has generated critical genomic data for comparative analyses, improving our understanding of the placement of this genus within the Urticeae tribe.[26] Additionally, Sanger sequencing and target enrichment markers have enhanced taxonomic clarity within the Urera clade by addressing inconsistencies in earlier classifications.[18,21,27] Morphological analyses, particularly carpological research on seed and fruit structures, have complemented molecular evidence and contributed to refining the genus classification.[22]

The integration of genetic, genomic, and morphological datasets has significantly advanced phylogenetic interpretations and taxonomic revisions of *Poikilospermum*. These results redefine generic boundaries within Urticaceae and lay a foundation for future analyses exploring species diversity, adaptive evolution, and the potential pharmacological relevance of the genus.[23] Table 1 summarizes key phylogenetic and taxonomic studies on Poikilospermum and related Urticaceae, emphasizing advances that have clarified evolutionary relationships, supported chemotaxonomic differentiation, and underpinned the study of secondary metabolite diversity across the genus. Chemotaxonomic analysis within the genus *Poikilospermum* has revealed both conserved and distinct secondary metabolite patterns that correlate with taxonomic relationships and ecological adaptation. Notably, *P. suaveolens* exhibits a unique phytochemical profile rich

in flavonoids, triterpenoids, and saponins, differentiating it from other closely related species that may be dominated by other phenolic compounds or alkaloids.[28–30] These chemotaxonomic traits not only support phylogenetic classification but also underpin the pharmacological potential highlighted in this review.

Phytochemical Composition of Poikilospermum Genus

Poikilospermum genus is characterized by a diverse phytochemical profile, with bioactive compounds distributed across various plant parts. The leaves contain high concentrations of flavonoids, including quercetin and kaempferol, which are primarily responsible for their antioxidant and anti-inflammatory properties (Jumania et al, 2020). Additionally, tannins, such as catechin and ellagic acid, along with saponins, including oleanolic acid, contribute to the astringent and antimicrobial activities of the leaves. Phenolic compounds (gallic acid and caffeic acid) and glycosides (beta-sitosterol glycoside) further enrich the therapeutic potential of the leaves. Moreover, essential oils such as lupan-3-yl acetate, phytol, and vitamin E (tocopherol) have been identified and show significant antimicrobial and anti-inflammatory activities.[11]

The stems of *Poikilospermum* species contain alkaloids and glycosides that are associated with analgesic, antispasmodic, cardiovascular, and antidiabetic effects.[17] High concentrations of tannins and saponins have been observed in the roots, contributing to their anti-inflammatory, antimicrobial, immune-enhancing, and antidiabetic properties.[17,31] The essential oils and alkaloids present in the roots further augment their therapeutic potential and offer analgesic and antimicrobial benefits.[31]

Similarly, bark is rich in flavonoids and tannins, which have antioxidant, anti-inflammatory, antidiabetic, and wound-healing activities.[32,33] Essential oils extracted from the bark have been reported to have additional antimicrobial and anti-inflammatory effects.[34,35] *Poikilospermum* flowers contain flavonoids and phenolic compounds that are known for antioxidant potential.[36] In addition to these compounds, *Poikilospermum* species contain phenolic acids and steroids such as beta-sitosterol.[17] The broad spectrum of phytoconstituents, including flavonoids, tannins, saponins, alkaloids, and essential oils, demonstrates the significance of this genus in traditional medicinal systems and promising prospects for pharmaceutical development.[3,12,31] The major bioactive compounds identified in *P. suaveolens* extracts, including triterpenoids, phytosterols, fatty acids, chromones, and vitamins, are shown in Figure 2. These components contribute to the broad spectrum of pharmacological activities observed in this species.

Ethnobotanical Applications of Poikilospermum Species

Historically, local cultures in Borneo and broader Southeast Asia have used various *Poikilospermum* species for a wide range of medicinal and cultural purposes. In indigenous communities, leaves are traditionally used to manage skin diseases, wounds, and insect stings, often prepared as decoctions or applied directly to affected areas.[37] The bark and roots are also widely used in traditional remedies to alleviate fever, gastrointestinal disturbances, and respiratory ailments, particularly in remote villages where access to modern healthcare is limited.[37] These preparations are commonly administered as herbal infusions or ground pastes for oral or topical application.

Beyond medicinal uses, *Poikilospermum* has significant cultural and ritual value. In the Dayak communities of Kalimantan, the plant is incorporated into healing rituals, symbolizing purification and recovery, and is used during spiritual ceremonies, specifically postpartum practices, to reduce maternal fatigue and prevent excessive hemorrhage.[37,38] Leaves are frequently included in traditional bathing mixtures for mothers and newborns, reflecting the plant's central role in maternal health care practices. The stems also contribute economically and culturally by providing fibers for weaving handicrafts, such as baskets and mats, used in ceremonial contexts. In certain regions, the plant serves as a source of natural dye for textiles, emphasizing its broader role in sustaining cultural identity and traditional livelihoods.[37] Owing to its documented ethnobotanical significance, broad geographical distribution, and extensive pharmacological evidence, *P. suaveolens* is the focus of this review. Other species have been primarily discussed to provide chemotaxonomic comparisons and evolutionary contexts.

P. suaveolens is classified within angiosperms, the order Rosales, and the family Urticaceae.[2,33,39] This perennial climbing plant has woody stems that ascend trees or rocks but is not classified as a tree. Morphologically, the plant is suggested to possess simple leaves with pinnate venation, acuminate apices, rounded bases, and small purplish flowers

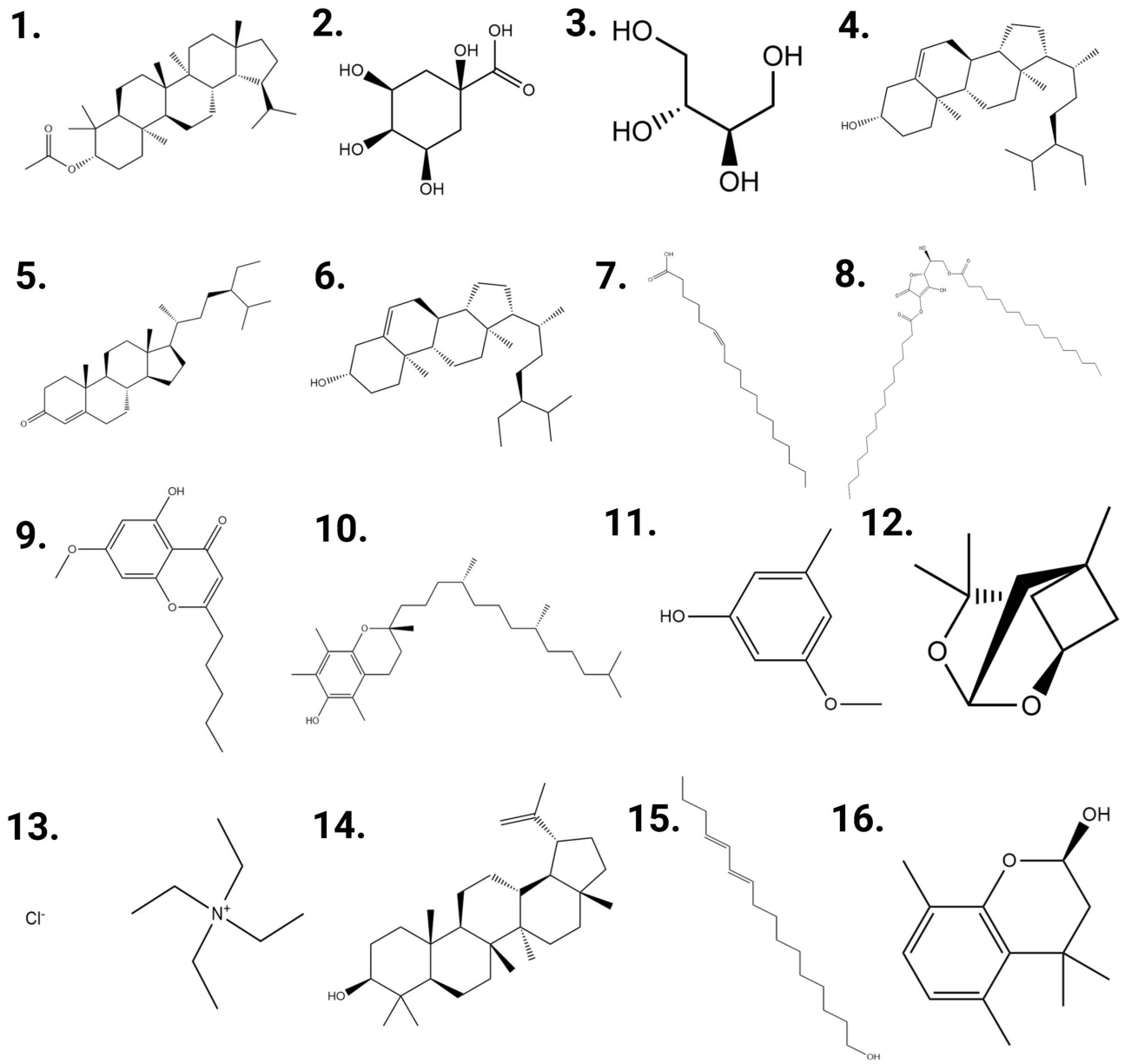


Figure 2 Components of *P. suaveolens* extract identified in this review: (1) Lupan-3-yl acetate, (2) 1,3,4,5-tetrahydroxy-cyclohexanecarboxylic acid, (3) DL-threitol, (4) beta-sitosterol, (5) sitostenone, (6) gamma-sitosterol, (7) 6-octadecenoic acid (Z)-, (8) L-(+)-ascorbic acid 2,6-dihexadecanoate, (9) 5-hydroxy-7-methoxy-2-pentylchromone, (10) vitamin E, (11) 3-methoxy-5-methylphenol, (12) 4,6-Dioxatricyclo[3.3.1.02.7] Nonane, 1,3,3-Trimethyl-, (1S)-, (13) Tetraethylammonium Chloride, (14) lupeol, (15) 10,12-hexadecadien-1-ol, and (16) 4,4,5,8-tetramethylchroman-2-ol.
Notes: Compound occurrence varies with extraction analytical platform reported in the cited studies; structures are illustrative.

near the petiole. Ethnobotanical and ethnopharmacological research have recorded traditional use of *P. suaveolens* for managing menstrual discomfort, numbness, pregnancy complications, and postnatal care to reduce fatigue and prevent postpartum hemorrhages.[37,38,40] These results demonstrate a significant role for the reproductive and maternal health systems.

Various parts of *P. suaveolens* are widely used in traditional therapies, as stated in the ethnobotanical surveys (Tables 2 and 3). The leaves are extensively used for their analgesic effect[3,12] and are used topically for dermatological conditions such as eczema and psoriasis. In addition to medicinal applications, the leaves are also incorporated into local diets and brewed into herbal teas, which are believed to promote general health and well-being. Root extracts and decoctions are traditionally prepared to treat digestive diseases, fever, and infections, providing a broad therapeutic

Table 2 Part of Plant, Ethnobotanical Uses, Secondary Metabolites, Potential Activity of Genus *Poikilospermum*

Species	Part of Plant Used	Ethnobotanical Uses	Secondary Metabolites	Main Pharmacological Activities	Ref
P. suaveolens	Leaves, Bark, Roots	Fever reduction, wound healing, digestive issues	Flavonoids, Tannins, Terpenoids, Alkaloids	Anticancer, Antioxidant, Anti-inflammatory	[3,16,41]
P. amboniense	Leaves, Stem	Treatment of skin disorders, respiratory ailments	Tannins, Flavonoids, Terpenoids	Antimicrobial, Anti-inflammatory, Wound healing	[9,10]
P. lanceolatum	Bark, Roots	Antimicrobial agent, gastrointestinal disorders	Alkaloids, Tannins	Analgesic, Antimicrobial	[42,43]
P. cordifolium	Leaves, Roots	Treatment of fever, anti-inflammatory	Alkaloids, Saponins, Terpenoids	Anticancer, Anti-inflammatory	[44,45]
P. scaberrimum	Leaves, Bark	Skin conditions, fever relief	Saponins, Flavonoids, Terpenoids	Antioxidant, Anti-inflammatory	[3]
P. macracanthum	Leaves, Bark	Antimicrobial, digestive health	Alkaloids, Flavonoids, Phenolics	Antimicrobial, Antidiabetic	[46,47]
P. giganteum	Leaves, Bark	Wound healing, fever relief	Flavonoids, Alkaloids	Antimicrobial, Antipyretic	[10,48,49]
P. mollissimum	Leaves, Bark, Root	Respiratory health, anti-inflammatory, Gastrointestinal disorders, skin ailments	Tannins, Terpenoids, Saponins, Alkaloids, Phenolic acids	Anti-inflammatory, Antimicrobial, Antioxidant	[9,44]
P. grandiflorum	Leaves, Stem	Digestive issues, anti-inflammatory	Flavonoids, Alkaloids, Terpenoids	Antioxidant, Antidiabetic	[43]
P. japonicum	Leaves, Bark	Antimicrobial agent, anti-inflammatory	Saponins, Alkaloids, Tannins	Antimicrobial, Anti-inflammatory	[10,46]
P. pubescens	Leaves, Stem	Traditional medicine for skin infections	Flavonoids, Saponins, Terpenoids	Antimicrobial, Antioxidant	[9,50,51]
P. curvigoni	Leaves, Bark, Roots	Digestive health	Tannins, Flavonoids, Alkaloids	Antioxidant, Antimicrobial	[46]
P. merrillii	Bark, Roots	Antimicrobial agent, fever relief	Saponins, Tannins, Alkaloids	Antimicrobial, Anti-inflammatory	[12,47]
P. kurzii	Leaves, Bark, Roots	Fever reduction, gastrointestinal disorders	Flavonoids, Saponins	Antipyretic, Antimicrobial	[31,46]
P. borneense	Roots, Leaves	Skin ailments, anti-inflammatory	Terpenoids, Phenolics	Antimicrobial, Anti-inflammatory	[9,52,53]
P. verrucosum	Bark, Leaves	Digestive issues, wound healing	Alkaloids, Flavonoids	Antimicrobial, Anti-inflammatory	[12,31,46,54]
P. macrophyllum	Leaves, Roots	Respiratory ailments, wound healing	Flavonoids, Saponins	Antioxidant, Antimicrobial	[43,55,56]

Table 3 Native Source, Part of Plant, and Traditional Uses of *P. suaveolens*

Native	Plant Part Used	Use	Preparation/Mode of Use	Ref
Batu kapur, Maros, Indonesia	Leaves	Antimicrobial,	Topical application, decoction	[11]
Lore Lindu National Park, Sigi Regency, Central Sulawesi	Stem (Bark and Wood)	Antioxidant,	Topical application, decoction	[46]
Salenrang Village, Bontoa District, Maros Regency, South Sulawesi.	Stem	Wound Healing	Topical, paste or decoction	[57]
Gala and Guimad villages in Ozamis City	Leaves	Breast tumor and cancer, Kidney,	Herbal drink/decoction	[58]
Local communities, Borneo/Kalimantan	Leaves, roots	Fever reduction, maternal/ postnatal care	Bath soak, oral decoction	[37,38]
Mandailing, Sumatra	Leaves	Skin disease, fatigue	Decoction, topical	[5]

spectrum and deep-rooted integration into indigenous knowledge systems.[4,11] Collectively, the cultural practices and formulations demonstrated the multifaceted role of *P. suaveolens* as a medicinal and cultural resource. The profound association between traditional healing, maternal care, and craftsmanship affirms the relevance of ethnobotanical heritage to contemporary scientific exploration. These uses indicate cultural/empirical relevance but do not constitute evidence of efficacy; alignment with pharmacology is discussed only where experimental data exist.

P. suaveolens: A Pharmacologically Promising Species

P. suaveolens was the most extensively observed species within *Poikilospermum* genus, with 186 recorded field observations.[15] Commonly known as "Mentawan" in Indonesia, *P. suaveolens* is a climbing or epiphytic plant belonging to the Urticaceae family. The plant predominantly inhabits humid tropical rainforest ecosystems, favoring low to mid altitude limestone regions in Maros, South Sulawesi, Indonesia. Morphologically, *P. suaveolens* is characterized by broad, rough-textured, hairy leaves, small greenish flowers, and clustered, dark-colored, berry-like fruits. These stems are woody and have been traditionally incorporated into herbal remedies. Local communities extensively use leaves to treat wounds, ulcers, skin infections, and inflammation because of their antimicrobial and anti-inflammatory properties.[1] Ethnopharmacological research has further reported the application of various plant parts, including leaves, stems, and fruits, for managing conditions such as eye infections, fever, malaria, diarrhea, postpartum recovery, and certain cancer types.[11]

Phytochemical investigations support these traditional uses, showing the presence of diverse bioactive compounds, including flavonoids, alkaloids, triterpenoids, tannins, and cardiac glycosides across different plant parts. Its widespread medicinal use is consistent with its rich phytochemical composition, which reinforces its value as a promising candidate for drug discovery and pharmaceutical development. *P. suaveolens* primarily thrives in humid lowland regions near riverbanks and forest edges and is distributed across southern China, Myanmar, Vietnam, and the Philippines.[3,59] Pharmacological relevance, particularly antimicrobial, anti-inflammatory, and wound healing properties, is significant in traditional medicine and modern pharmacological research.[11]

Gas chromatography-mass spectrometry (GC-MS) analysis of *P. suaveolens* extracts identified over 50 compounds, including lupan-3-yl acetate and beta-sitosterol, that exhibit anti-inflammatory and anticancer activities.[31] These results demonstrate the considerable therapeutic potential of *P. suaveolens* in contemporary medicine and emphasize the importance of further research on its bioactive constituents (Table 4). Collectively, these varied pharmacological effects affirm the significance of traditional healing systems and their promising role as novel therapeutic agents.

Table 4 Active Compound, Bioactivity and Pharmacological Properties of *P. suaveolens*

Active Compound	Concentration (%)	Bioactivity	Ref
Lupan-3-Yl Acetate	12.77	Anticancer, Anti-inflammatory	[31]
1,3,4,5-Tetrahydroxy-Cyclohexanecarboxylic Acid	8.25	Antioxidant	[31]
Dl-Threitol	7.88	Metabolic regulation	[31]
Beta-sitosterol	nd	Cholesterol-lowering, Anticancer	[3]
Sitostenone	nd	Cytotoxic activity	[3]
Gamma-sitosterol	nd	Anti-inflammatory, Anticancer	[1,3,31]
6-Octadecenoic Acid, (Z)-	6.16	Antioxidant, Anti-inflammatory	[60,61]
L-(+)-Ascorbic Acid 2,6-Dihexadecanoate	5.5	Antioxidant	[62,63]
5-Hydroxy-7-Methoxy-2-Pentylchromone	5.49	Antioxidant, Anticancer	[31]
Vitamin E	5.21	Antioxidant, Anti-inflammatory	[64]
3-Methoxy-5-Methylphenol	4.74	Antioxidant	[65]
4,6-Dioxatricyclo [3.3.1.02.7] Nonane, 1,3,3- Trimethyl-, (1s)-	4.11	Anti-inflammatory	[31]
Tetraethylammonium chloride	4.08	Antimicrobial	[31]
Lupeol	2.71	Anticancer, Antioxidant	[66,67]
10,12-Hexadecadien-1-Ol	2.28	Antioxidant, Anti-inflammatory	[31]
4,4,5,8-Tetramethylchroman-2-Ol	2.21	Antioxidant	[68]

Bioactivities and Mechanistic Insights of P. suaveolens in the Context of Ethnomedicine

The pharmacological attributes of *Poikilospermum* have been increasingly explored in recent years, with a broad spectrum of biological activities, including antibacterial, anti-inflammatory, antioxidant, and anticancer effects. These therapeutic benefits are largely attributed to the phytochemical diversity of the genus, particularly the presence of flavonoids, tannins, alkaloids, and saponins in the various plant parts. The convergence between traditional ethnobotanical uses and contemporary pharmacological evidence strongly supports the medicinal relevance of *Poikilospermum* species. The traditional use of leaves for pain relief and inflammation management has been corroborated by pharmacological research that has reported substantial analgesic and anti-inflammatory effects. These outcomes are primarily associated with flavonoids and tannins, which are known to modulate inflammatory pathways and nociceptive responses.[69] This concordance between ancestral practices and scientific validation enhances the credibility of ethnopharmacological knowledge and reports the therapeutic potential of *Poikilospermum* for pain and inflammation control.

The use of *Poikilospermum* roots in the treatment of gastrointestinal diseases and diarrhea is consistent with the results showing that the roots possess anti-diarrheal and digestive supportive activities. These effects are associated with the presence of tannins and saponins, which have gastrointestinal protective and regulatory properties.[70] The traditional application of bark for wound healing and dermatological conditions is supported by pharmacological data showing significant antimicrobial and wound-healing effects.[19,71,72] These effects are largely attributed to flavonoids and essential oils in the bark, which exhibit antibacterial and regenerative activities.[11,19] In ethnomedical practice, Poikilospermum stems of *Poikilospermum* have been traditionally used to manage respiratory ailments. This is supported by pharmacological research reporting expectorant and anti-inflammatory properties traced to the presence of bioactive metabolites with bronchodilatory and anti-inflammatory effects. These results reinforce the scientific basis for the use of *Poikilospermum* in respiratory care.

Comprehensive pharmacological analyses of different plant parts have revealed multiple therapeutic properties in preclinical models, including strong anti-inflammatory, antioxidant, and antimicrobial activities.[73,74] These observations substantiate long-standing ethnobotanical practices across indigenous communities and show the clinical potential of *Poikilospermum* as a multifunctional medicinal resource. Further investigations of this genus have reported additional pharmacological effects. *Poikilospermum* species exhibit anthelmintic properties, suggesting their potential use in managing parasitic infections with antimicrobial effects that inhibit microbial proliferation. Its anti-inflammatory and analgesic properties support its use in the treatment of inflammation-related diseases and relieving pain.[75] Moreover,

immunomodulatory activities show potential for immune regulation, whereas hepatoprotective effects suggest liver-protecting capabilities.[76] In general, the integration of ethnobotanical traditions with modern pharmacological results contributes to a more comprehensive understanding of their therapeutic relevance. Interdisciplinary research, including drug development initiatives based on diverse bioactivities, is essential to fully unlock the potential of modern medicine (Table 2).

Antimicrobial Activity

Indonesia's rich biodiversity presents an array of plant species that have potential as alternative therapeutic agents. *P. suaveolens* contains a variety of phytochemicals, including flavonoids, steroids, terpenoids, alkaloids, saponins, tannins, and essential oils, with antibacterial and antimicrobial properties.[77] Antimicrobial agents function by inhibiting or eliminating the growth of pathogenic microorganisms, such as bacteria, fungi, viruses, and protozoa. These agents are widely used in clinical medicine, public health, sanitation, and agriculture to prevent and control infections. Research on *P. suaveolens* has shown that extracts from its outer shell possess potent antimicrobial activity against *Staphylococcus aureus* (*S. aureus), Escherichia coli* (*E. coli*), and *Candida albicans* (*C. albicans*). The efficacy of the extracts was confirmed by agar diffusion assays. Distinct zones of inhibition were observed around the treatment wells in contrast to the DMSO-treated negative control without inhibitory activity. The extract produced inhibition zones measuring between 16.17 and 18.17 mm against *S. aureus*, showing strong antibacterial potency.[16,31] Statistical analyses confirmed a concentration-dependent response, and the activity was attributed to bioactive constituents such as alkaloids, tannins, saponins, and steroids.

Similar inhibitory effects were observed against *E. coli*, with the suppression of bacterial proliferation recorded at increasing concentrations of 25%, 50%, 75%, and 100%.[31] Furthermore, the extract exhibited strong antifungal activity against *C. albicans*, thereby emphasizing its broad-spectrum antimicrobial potential. GC-MS analysis of *P. suaveolens* reported over 50 phytochemical constituents, including lupan-3-yl acetate, 1,3,4,5-tetrahydroxycyclohexanecarboxylic acid, DL-threitol, and vitamin E, which are known for their antimicrobial activity by disrupting microbial growth and metabolism.[46] These compounds are summarized in Table 4, which supports their potential use as natural antimicrobial agents. The antimicrobial activity *of P. suaveolens* is mediated by a complex array of bioactive compounds. These constituents act synergistically to disrupt the bacterial membrane integrity, increase membrane permeability, and induce cell lysis. Additionally, many compounds interfere with bacterial protein biosynthesis. For example, flavonoids can bind to bacterial enzymes and structural proteins, impairing critical cellular functions, and inhibiting proliferation. Alkaloids exert their effects by targeting ribosomal subunits and inhibiting translation of essential proteins. The dual-action membrane disruption and inhibition of protein synthesis are shown in Figure 3 and collectively show the pharmacological relevance of *P. suaveolens* as an antimicrobial agent. These results reinforce the traditional use of *P. suaveolens* in treating infections, and suggest a strong potential for the development of natural antimicrobial therapy in the management of bacterial and fungal diseases.

From a molecular perspective, flavonoids, such as quercetin, disrupt bacterial cell membranes and inhibit essential enzymes, such as DNA gyrase and topoisomerase IV, thereby impeding DNA replication and bacterial proliferation.[78,79] Quercetin and kaempferol are known to inhibit bacterial ribosomal functions and interfere with protein synthesis. Alkaloids act via DNA intercalation or ribosomal subunit disruption, leading to translational arrest and microbial cell death.[80–82] These mechanisms corroborate the experimental results where *P. suaveolens* extracts showed substantial inhibitory activity against *S. aureus, E. coli*, and *C. albicans*, confirming their use in traditional infection control.

Anti-Inflammatory Activity

Inflammation is an essential biological response to injury or irritation that serves to protect and initiate the healing of damaged tissues. This process involves a complex interaction between blood cells, signaling proteins, and inflammatory mediators. These responses can be categorized as acute or chronic. Acute inflammation is immediate, localized, and typically resolves during tissue repair. Chronic inflammation is a prolonged condition that leads to tissue degradation and contributes to the progression of various diseases when left unmanaged.[83–86]

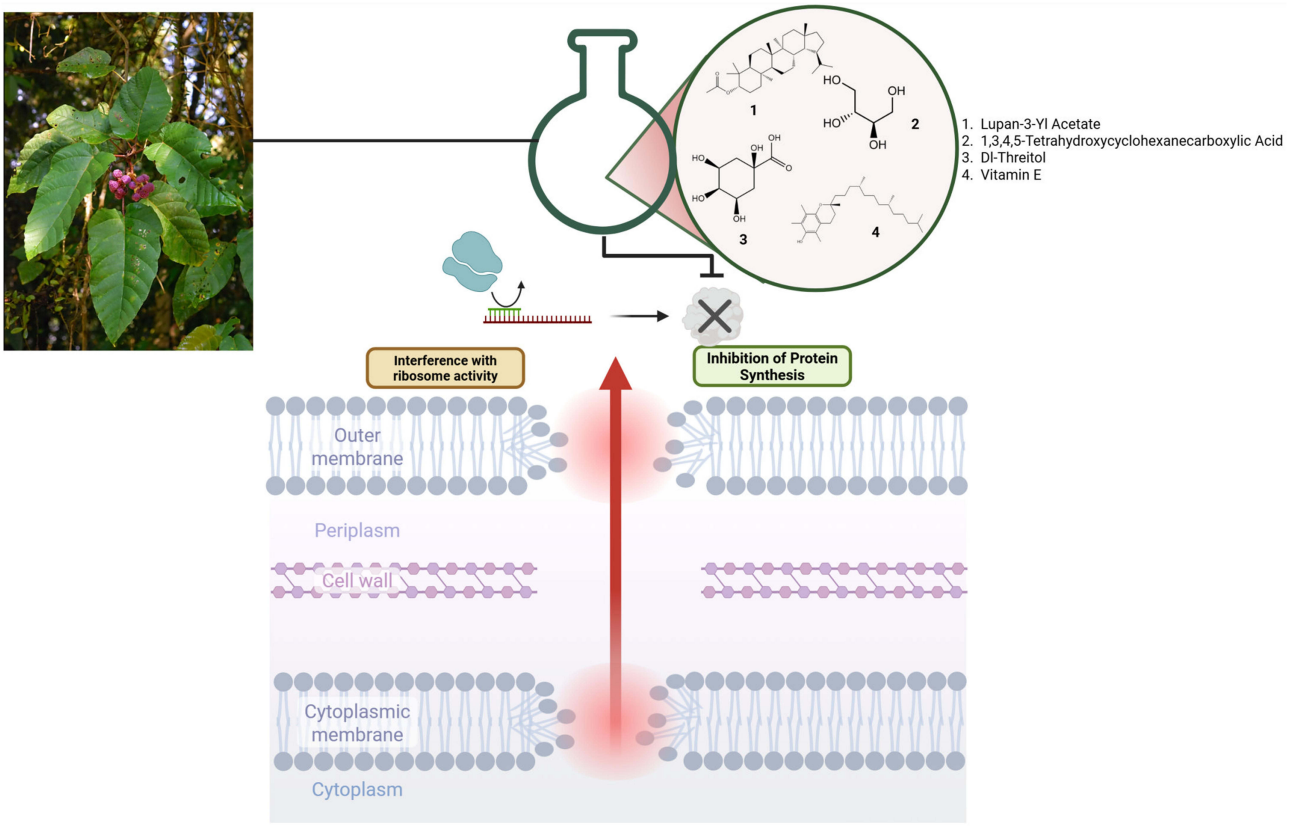


Figure 3 Proposed antibacterial mechanisms associated with bioactive constituents reported for *P. suaveolens*: disruption of microbial membranes, inhibition of key enzymes/proteins, interference with nucleic acids and quorum sensing, oxidative-stress modulation, and biofilm attenuation. Conceptual schematic; not to scale. Created in BioRender. Mrdiana, L. (2025) https://BioRender.com/pya67rr.

The anti-inflammatory activity of *P. suaveolens* has been reported in preclinical models, who used excisional wound models in Wistar albino rats to evaluate wound-healing efficacy.[11,16] Topical ointments formulated with ethyl acetate (EA) and ethanol (ET) extracts at concentrations of 10 and 15% significantly enhanced the wound healing process. Complete wound closure was achieved by day 15 in the group treated with 10% EA extract, outperforming the positive (5% povidone-iodine) and base ointment negative controls. These results are consistent with previous reports emphasizing the potential of plant-derived bioactive compounds to accelerate tissue regeneration and promote inflammation resolution.[87] At the molecular level, the anti-inflammatory effects of *P. suaveolens* are mediated through the inhibition of the nuclear factor kappa B (NF-κB) signaling pathway,[88,89] as reported in (Figure 4). NF-κB is a transcription factor that regulates the expression of inflammatory cytokines and immune-related genes.[90,91] Under inflammatory stimuli, NF-κB is activated through the toll-like receptor (TLR) pathways, leading to the phosphorylation and degradation of the inhibitor IκB. This process enables the NF-κB complex (p50/p65) to translocate into the nucleus and promote the transcription of pro-inflammatory genes such as TNF-α, IL-1β, and IL-6.[92–95]

Bioactive compounds in *P. suaveolens*, particularly flavonoids, have been shown to suppress this pathway by preventing the phosphorylation and degradation of IκB, inhibiting the nuclear translocation of NF-κB, and reducing the expression of downstream inflammatory mediators (Figure 4).[96,97] This mechanism leads to a reduction in cytokine production and attenuation of inflammatory responses.[98] This combined biochemical and physiological evidence reinforces the role of *P. suaveolens* as a natural anti-inflammatory agent, capable of mitigating excessive inflammation and promoting tissue repair.

The anti-inflammatory effects of *P. suaveolens* are primarily driven by the suppression of the NF-κB signaling pathway. Quercetin impedes the phosphorylation and proteasomal degradation of IκBα,[99,100] retaining the NF-κB complex in the cytoplasm and suppressing its nuclear translocation. This results in the downregulation of pro-

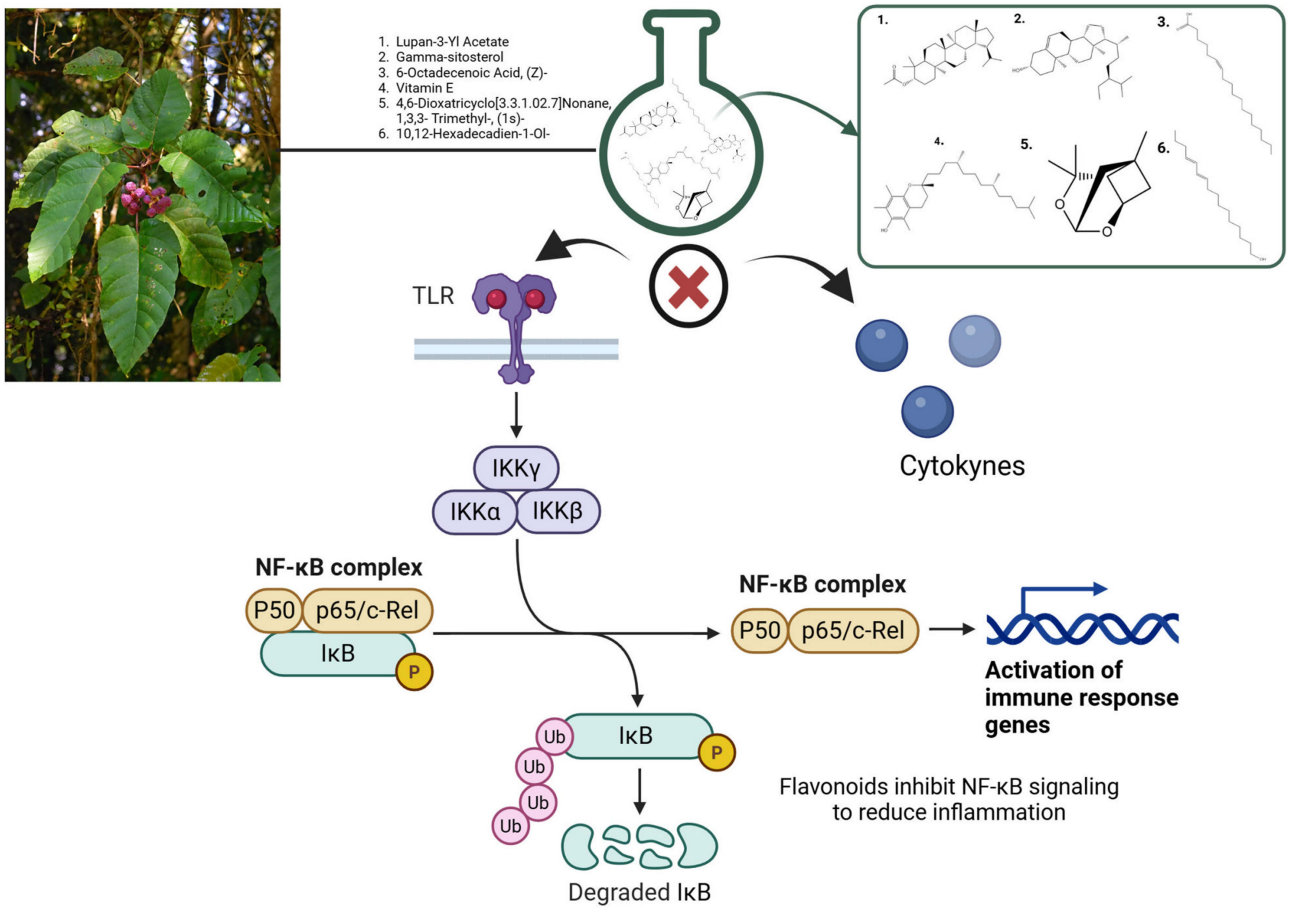


Figure 4 Anti-inflammatory actions linked to flavonoids reported in *P. suaveolens* and related literature: attenuation of NF-κB activation (via IκBα stabilization), down-regulation of COX-2/iNOS and pro-inflammatory cytokines (TNF-α, IL-1β, IL-6), and modulation of MAPK signaling, alongside activation of the Nrf2/ARE antioxidant response. Conceptual schematic. Created in BioRender. Mrdiana, L. (2025) https://BioRender.com/pya67rr.

inflammatory cytokines, including TNF-α, IL-1β, and IL-6. Additionally, terpenoids downregulate COX-2 and PGE2, providing complementary anti-inflammatory modulation.[101,102] This mechanistic balance supports the traditional applications of the plant in wound healing, fever reduction, and the treatment of inflammatory skin conditions.

Antioxidant Activity

Among the three known species, *P. suaveolens* has been reported to exhibit potential antioxidant activity, primarily because of its high concentration of flavonoids and tannins.[103,104] These polyphenolic compounds function as free radical scavengers, directly neutralizing reactive oxygen species (ROS) and protecting cells from oxidative damage. Figure 5 shows that the antioxidant system plays a central role in the prevention of oxidative stress-related diseases, including cardiovascular diseases, neurodegenerative conditions, and certain cancers. The antioxidant action of *P. suaveolens* operates through two primary mechanisms: (1) direct scavenging of free radicals, and (2) enhancement of endogenous antioxidant defense systems.[105–107] The enzymatic antioxidant mechanism includes superoxide dismutase (SOD), which catalyzes the dismutation of superoxide radicals (O_2^-•) into hydrogen peroxide (H_2O_2) and molecular oxygen (O_2), thereby reducing the cellular oxidative burden.

$$O_2^- \bullet + 2H^+ \rightarrow [SOD] \rightarrow H_2O_2 + O_2 \quad (1)$$

Flavonoids play a central role in non-enzymatic antioxidant defenses by donating hydrogen atoms to neutralize reactive free radicals (R•). This reaction stabilizes the radicals and prevents the propagation of the oxidative chain reactions.

https://doi.org/10.2147/DDDT.S533657

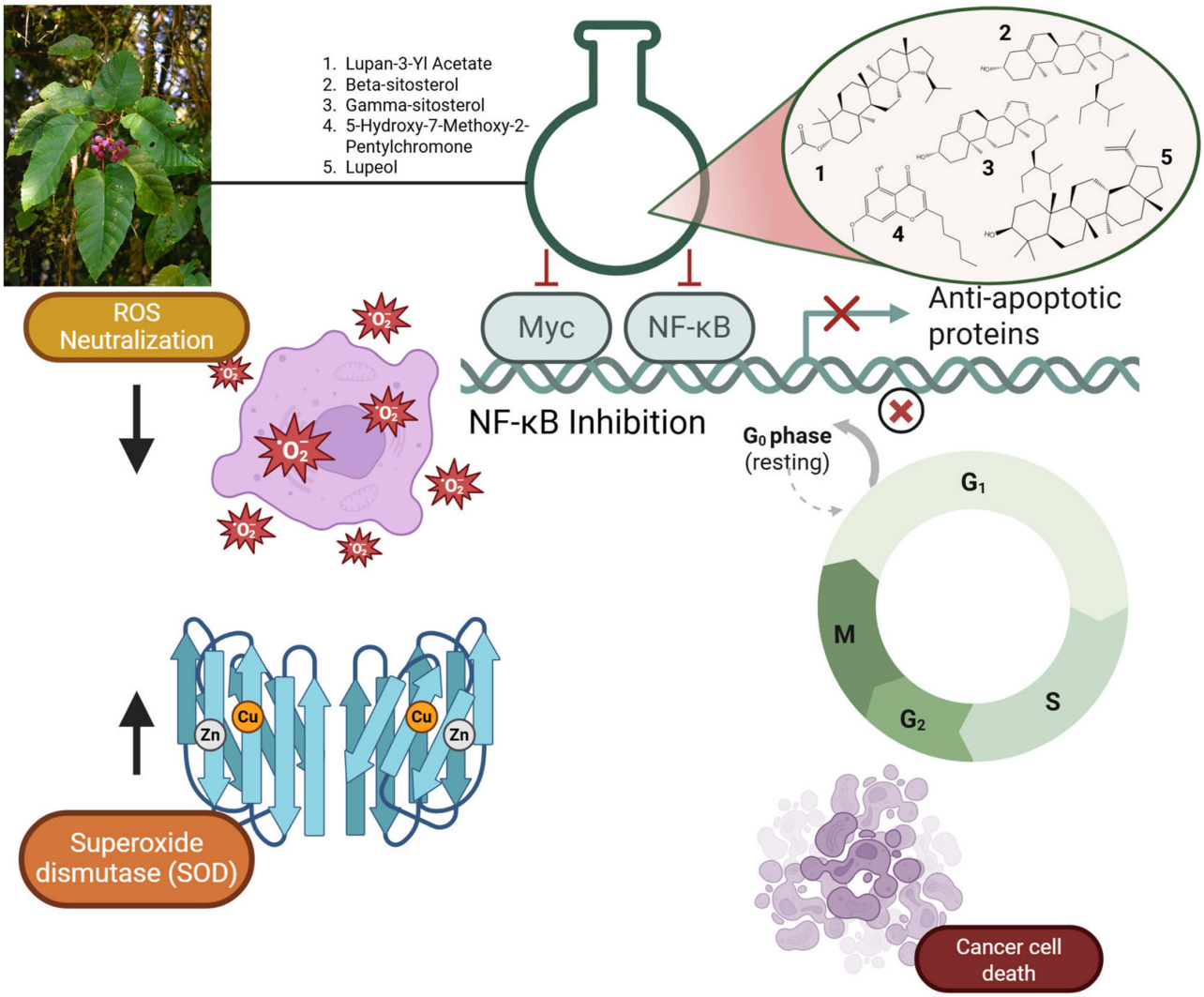


Figure 5 Antioxidant and cytotoxic/antiproliferative mechanisms reported preclinically for *P. suaveolens* constituents: ROS scavenging and redox homeostasis support; mitochondrial pathway involvement (Bax↑/Bcl-2↓, caspase-9/-7 activation); and cell-cycle modulation (eg, Cyclin D1/CDK1). Created in BioRender. Mrdiana, L. (2025) https://BioRender.com/pya67rr.

$$Flavonoid(OH) + R\bullet \rightarrow Flavonoid(O\bullet) + RH \quad (2)$$

The underlying molecular mechanism includes the formation of resonance-stabilized flavonoid radicals. The resulting flavonoid radical obtained from the donation of hydrogen atoms is delocalized across the aromatic ring system, minimizing the reactivity and stabilizing compound.[108,109] This antioxidant buffering prevents the further propagation of oxidative reactions in biological membranes and cellular components. In addition to direct radical scavenging, *P. suaveolens* has been shown to modulate the activities of endogenous antioxidant enzymes. The extracts enhanced the expression and activity of SOD and catalase (CAT) enzymes, which are responsible for converting superoxide radicals to hydrogen peroxide, water, and oxygen.[110,111] This enzymatic defense mechanism reduces the ROS burden and preserves cellular redox homeostasis. Moreover, the tannins present in *P. suaveolens* may chelate transition metals such as Fe^{2}+ and Cu^{2}+, reducing the Fenton reaction and producing highly reactive hydroxyl radicals from hydrogen peroxide. Tannins contribute an additional layer of antioxidant protection owing to metal-catalyzed radical formation. Collectively, these biochemical and molecular processes support the strong antioxidant capacity of *P. suaveolens* and substantiate its traditional use in the prevention and treatment of oxidative stress-related ailments. The dual function of scavenging free

radicals and enhancing enzymatic defenses positions *P. suaveolens* as a promising natural antioxidant candidate in phytopharmaceutical development.

P. suaveolens exhibits potent antioxidant effects through direct radical scavenging and enhancement of endogenous defence systems. Polyphenolic compounds, such as flavonoids and tannins, donate hydrogen atoms to neutralize ROS such as superoxide anions (O_2^-•) and hydroxyl radicals.[106,107,112] These actions are potentiated by the upregulation of antioxidant enzymes such as SOD, CAT, and glutathione peroxidase. Quercetin activates the Nrf2 pathway and stimulates the transcription of antioxidant response elements (ARE).[113,114] This dual mechanism of action reinforces the role of *P. suaveolens* in combating oxidative stress due to associated conditions such as cardiovascular disease, neurodegeneration, and carcinogenesis.

Anticancer Activity

Research on *P. suaveolens* shown promising anticancer activity, which is attributed to its rich phytochemical profile, including flavonoids (quercetin and kaempferol), terpenoids, and alkaloids. These compounds synergistically enhanced the antioxidant, anti-inflammatory, and cytotoxic capacities of, making *P. suaveolens* them viable candidates for advanced anticancer interventions. The methanol fraction reported strong cytotoxic potential in the brine shrimp lethality test (BSLT), with LC_{50} values ranging from 4.87 to 85.54 μg/mL, showing potent bioactivity.[1] Fetalvero et al reported an IC_{50} of 26.58 μg/mL against A549 non-small cell lung carcinoma cells, confirming dose-dependent cytotoxicity accompanied by morphological signs of apoptosis.[115] Mechanistically, *P. suaveolens* induced cancer cell death through multiple pathways. Flavonoids neutralize ROS, minimize DNA damage, and halt tumor progression.[116,117] This is achieved through direct radical scavenging and upregulation of endogenous antioxidant enzymes such as SOD. Additionally, flavonoids donate electrons to stabilize free radicals (R•), forming less-reactive compounds. In parallel, bioactive compounds from *P. suaveolens* inhibit the NF-κB signaling cascade, a critical regulator of inflammation and cell survival.[118,119] This suppression decreases the transcription of anti-apoptotic genes, promoting apoptosis and arresting the cell cycle at the G_0/G_1 phase.[120,121] ROS neutralization, NF-κB inhibition, and apoptosis induction *P. suaveolens* show substantial anticancer potential through these mechanisms.

Despite these results, the safety profile of this compound must be assessed. BSLT-based toxicity evaluations of the methanol stem extract obtained LC_{50} values between 4.87 and 114.49 μg/mL, with fractions A, B, D, E, and G considered highly toxic (LC_{50} < 100 μg/mL).[1] These results necessitate cautious interpretation, because high in vitro cytotoxicity does not inherently imply selectivity for malignant cells. To ensure safe therapeutic application, further research must include in vivo toxicity profiling in mammalian systems, including histopathological and organ-specific evaluations as well as determination of the therapeutic index. These integrated pharmacological and toxicological assessments are important for translating the anticancer potential of *P. suaveolens* into clinically viable phytomedicine.

Comparisons Within Urticaceae

Beyond Southeast Asia, several Urticaceae genera show pharmacological themes that mirror those reported for *Poikilospermum*. Urtica spp. are widely associated with anti-inflammatory and antioxidant effects; Boehmeria and Debregeasia contribute antimicrobial and wound-care evidence; Girardinia, Laportea, and Pilea add reports of cytotoxicity in cell models. Across these taxa, flavonoids (eg, flavonols, flavones) and phenolic acids (eg, caffeic/ferulic derivatives) recur as dominant classes, with triterpenoids and lignans appearing in several species. This chemotaxonomic pattern is broadly consistent with redox-modulatory and inflammation-linked pathways often discussed for *P. suaveolens*. However, evidence levels and study quality vary markedly. Much of the cross-genus literature remains in vitro, with limited in vivo corroboration and sparse clinical data. Direct cross-species efficacy inference is therefore unwarranted. Where overlaps exist (eg, antioxidant and anti-inflammatory activities), extract standardization, dose-response characterization, appropriate positive controls, and selectivity against non-target cells are inconsistently reported, limiting translational interpretation.

Notably, regional studies indicate that *P. suaveolens* may present distinct chemoprofiles—for instance a flavonoid/triterpenoid-leaning signature-aligned with antibacterial and wound-care ethnomedicine. Whether these profiles confer functional advantages over better-studied genera (eg, *Urtica dioica*) remains an open question that warrants head-to-head

comparisons under harmonized analytical (LC–HRMS/MS) and bioassay conditions. Standardized cross-genus panels (same extraction protocol, matched dosing, identical readouts) would allow quantitative ranking of effect sizes and reproducibility, thereby clarifying the position of *P. suaveolens* within the broader Urticaceae pharmacology landscape.

Synergistic Interactions and Polypharmacology

The co-occurrence of multiple bioactive compounds within *P. suaveolens* enhances its therapeutic efficacy through synergistic interactions. Flavonoid-mediated ROS scavenging can reduce oxidative stress–induced NF-κB activation and potentiate anti-inflammatory activity. Tannins can stabilize epithelial barriers, inhibit microbial adherence, and complement the bactericidal effects of alkaloids and flavonoids. This integrative pharmacological behavior supports reduced dosing, enhanced safety profiles, and efficacy in complex pathologies such as cancer, chronic inflammation, and polymicrobial infections. Collectively, the multi-target pharmacological framework of *P. suaveolens* shows potential as a source of therapeutic agents for diseases that require holistic intervention. Understanding the interaction networks and mechanistic underpinnings of the constituent compounds is important for the rational development of standardized phytopharmaceutical formulations and future clinical translation.

Research Gaps

The traditional knowledge of the ethnobotanical applications of *Poikilospermum* has significantly influenced modern scientific research. Insights from different generations regarding the therapeutic properties of plants have established a basis for substantiating and investigating their applications in a scientific context. The amalgamation of historical methodologies and contemporary research has fostered comprehensive drug development strategies in natural medicine. Recognizing the cultural importance of medicinal plants, researchers can substantiate conventional assertions while discovering novel therapeutic potentials. This methodology facilitates the advancement of herbal medicines, nutritional supplements, and pharmaceutical formulations that correspond to contemporary healthcare requirements, while safeguarding cultural heritage. *Poikilospermum* demonstrates significant pharmacological properties, including antibacterial, anti-inflammatory, and antioxidant activities, indicating its potential for use in the treatment of infections, inflammation, and illnesses associated with oxidative stress. Subsequent investigations could examine its bioactive components for applications in pharmaceutical formulations aimed at treating particular diseases. Translating these insights into practical applications requires stringent clinical studies and standardized preparation procedures to guarantee safety, efficacy, and consistency.

Notwithstanding the promising outcomes, the constraints in the existing research require attention. Research characterized by limited sample sizes, insufficient controls, and methodological discrepancies, such as differences in extraction techniques and dosing, impedes the comparability of results. Moreover, variations in pharmacological action among plant sections, shaped by the phytochemical composition and environmental conditions, further hinder reproducibility. Future research should implement standardized methodologies and sourcing practices to minimize variability and enhance reliability.

The pharmacological potential of *P. suaveolens* is considerable, particularly in terms of its bioactive components and modes of action, which show promise in the fight against cancer and other chronic diseases. The expansive genus *Poikilospermum* has not been sufficiently studied, and presents prospects for the identification of novel bioactive chemicals. Enhancing research via interdisciplinary cooperation in ethnobotany, pharmacology, and biotechnology is essential for realizing the complete therapeutic potential of this genus. As natural compounds continue to influence drug discovery, *P. suaveolens* and its relatives may provide a sustainable supply of novel therapeutics.

Conclusion

In summary, this review provides a comprehensive synthesis of the phytochemical diversity and pharmacological potential of *P. suaveolens*, with emphasis on its traditional uses, bioactive constituents, and therapeutic activities. As one of the most prominent species within the genus Poikilospermum, *P. suaveolens* exhibits a broad spectrum of biological effects, including antibacterial, anti-inflammatory, antioxidant, and anticancer properties, largely attributed to its rich content of flavonoids, alkaloids, tannins, and terpenoids. These bioactive compounds have been shown to

interact with key molecular targets such as bacterial ribosomes and the NF-κB signaling pathways, suggesting their potential roles in managing infections, inflammation, and cancer. The traditional ethnomedicinal applications of *P. suaveolens*, supported by emerging pharmacological evidence, highlight its value as a prospective candidate for natural product-based drug development. By bridging ethnobotanical knowledge with scientific validation, this review highlights the significance of *P. suaveolens* in modern pharmaceutical research and lays the groundwork for future translational research. In the broader Urticaceae context, *P. suaveolens* shares the core antioxidant/anti-inflammatory themes seen in genera such as Urtica and Boehmeria, yet emerging chemoprofiles suggest potentially distinct leads. Standardized cross-genus LC–HRMS/MS and head-to-head bioassays, including selectivity and in vivo confirmation, are needed to quantify any advantage and to prioritize candidates for translation.

Future Perspectives

Several critical and practical research directions must be pursued to realize the full therapeutic potential of *P. suaveolens*. First, comprehensive in vivo studies using disease-specific animal models, including antibacterial, anti-inflammatory, antioxidant, and anticancer studies, should be conducted to validate the pharmacological effects observed in vitro. These studies should evaluate the appropriate dosage ranges, therapeutic indices, and potential toxicological profiles of specific bioactive compounds such as quercetin, kaempferol, and key alkaloids. Second, clinical trials, starting with Phase I safety assessments, are urgently needed to determine human pharmacokinetics, tolerability, and efficacy, particularly in wound healing, infectious diseases, or inflammation-related disorders where *P. suaveolens* has traditional applications.

Third, isolation and characterization of individual bioactive compounds should be prioritized through advanced techniques such as HPLC-MS/MS, NMR, and LC-QTOF to support structure–activity relationship (SAR) studies. These investigations will enable the development of standardized phytopharmaceutical preparations with predictable therapeutic outcomes. Fourth, addressing formulation challenges is crucial given the potential solubility and stability limitations of polyphenols and terpenoids. The application of modern drug delivery platforms, such as phytosomes, nanoemulsions, solid lipid nanoparticles, and amorphous solid dispersions (ASDs), can significantly improve the bioavailability and controlled release of these compounds, enabling better clinical translation.

Moreover, future studies should explore the synergistic effects of multiple phytochemicals in plants through combination index analysis and network pharmacology, thereby validating its holistic therapeutic potential, as seen in traditional use. Finally, expanding research to include other lesser-studied Poikilospermum species, particularly *P. acuminatum* and *P. lanceolatum*, through comparative phytochemical and pharmacological studies may yield new therapeutic candidates and contribute to a broader understanding of the genus. Taken together, these multidisciplinary strategies will establish a stronger evidence base and pave the way for transforming *P. suaveolens* into a scientifically validated, clinically effective, and pharmaceutically optimized herbal medicine.

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