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Medicinal Value of *Psydrax umbellata:* Therapeutic Innovation and Biodiversity Conservation

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ABSTRACT

Current research interest in the Rubiaceae family plants remarks on the pharmacological potential of the underutilized genus Psydrax, known for antioxidant, anti-inflammatory, and antimicrobial properties. In spite of this, 37 Psydrax species hold ethnomedicinal value for treating ailments such as diabetes, gastrointestinal disorders, and infections. Research on specific species like Psydrax umbellata is known to be still an untouched part. Despite its traditional medicinal uses, studies on P. umbellata's pharmacological and chemical properties are limited. Which provides scope for novel drug exploration and biodiversity conservation. This species, like other Psydrax members, is rich in bioactive compounds such as alkaloids, flavonoids, saponins, and tannins, which contribute to its therapeutic potential. However, comprehensive investigations into its chemical composition, pharmacological effects, and safety are needed to validate its medicinal claims. This review envisages the significance of advancing research on P. umbellata, with implications for biodiversity preservation and the development of new pharmacological agents.

Keywords: *Rubiaceae family, Psydrax genus, Psydrax umbellata, Ethnomedicine, Pharmacognosy and Bioactive compounds.*

INTRODUCTION

With more than 13,000 species spread across 630 genera, the Rubiaceae family is well known for its biodiversity, especially in warm and tropical climates (Robbrecht *et al.*, 1988). With more than 37 species, the genus Psydrax has substantial ethnomedical significance within this family and has been used historically to treat wounds, inflammation, diabetes, and cardiovascular disorders (Zimba *et al.*, 2014; Veeramuthu *et al.*, 2023). Compared to other Rubiaceae genera, Psydrax's pharmacological and pharmacognostic characteristics have not received as much scientific investigation, despite their potential for therapeutic use (Chukwudulue *et al.*, 2022). Promising bioactive qualities, such as antibacterial, anti-inflammatory, and antioxidant actions, have been shown by notable species such as *Psydrax schimperianus*, *Psydrax subcordata*, and *Psydrax dicoccos* (Veeramuthu *et al.*, 2023). *Psydrax umbellata*, a species that may have therapeutic uses, is still little known, underscoring the need for comprehensive studies to elucidate its bioactive compounds and pharmacological effects.

Bioactive substances such as alkaloids, flavonoids, saponins, and tannins are abundant in the genus Psydrax and contribute to its wide range of biological activities. Standardized assessment of its species is necessary, as evidenced by contemporary pharmacological research that validates this traditional usage (Rahman, 2020). Research is specifically promised by *Psydrax umbellata* to support its therapeutic claims and guarantee safety in medical applications. These investigations may provide light on its unrealized potential and advance knowledge of the pharmacological variety of the Rubiaceae family. This emphasizes the necessity of doing multidisciplinary research that combines scientific techniques with ethnobotanical knowledge in order to optimize the medicinal potential of Psydrax species (Chukwudulue *et al.*, 2022).

Taxonomy and Distribution of *Psydrax* Species

The genus *Psydrax* exhibits diverse biological activities attributed to its rich bioactive constituents, including alkaloids, flavonoids, saponins, and tannins, with modern pharmacology validating its traditional medicinal uses and underscoring the need for standardized assessments (Zimba *et al.*, 2014; Veeramuthu *et al.*, 2023). Species such as *Psydrax umbellata* show promise for further therapeutic exploration to substantiate its medicinal potential and ensure safety in applications, emphasizing the importance of multidisciplinary research combining ethnobotanical and scientific approaches (Veeramuthu *et al.*, 2023). Taxonomic advancements, including the discovery of species like *Psydrax gialaiensis* in Vietnam and *Psydrax puberula* in the Philippines, as well as the rediscovery of *Psydrax ficiformis* in India, have highlighted its ecological and evolutionary significance while presenting opportunities for pharmacological studies (Quang *et al.*, 2020; Vidallon *et al.*, 2023). Additionally, pollen morphology and molecular studies are critical for resolving phylogenetic uncertainties and fostering conservation efforts, particularly in underexplored regions (Tilney *et al.*, 1997; Mahyuni *et al.*, 2018).

Further ecological and molecular research is essential to elucidate the genus's phylogeny, promote biodiversity conservation, and unlock its pharmacological potential.

***Psydrax umbellata*: A Regional and Botanical Overview**

Psydrax umbellata holds notable ethnobotanical significance across India, as reflected in its diverse regional names. It is known as "Arsul" in Hindi (Okaiyeto *et al.*, 2018), "Dhonimara" and "Bhoodimara" in Kannada (Ravikanth, 2015), "Irumbarappan," "Njanjul," and "Anakombi" in Malayalam (Mathew, 2014), "Kari" in Sanskrit (Kumar and Desai., 2016), "Nallamandharam" and "Alampamaram" in Tamil (Krishnan and Venkatesh., 2017), and "Nalla Balusu" in Telugu (Rajasekhar *et al.*, 2013). These names highlight the plant's cultural and medicinal importance in different linguistic and regional contexts.

Botanical Description of *Psydrax umbellata*

Psydrax umbellata, a small, unarmed tree endemic to peninsular India, exhibits distinctive morphological and reproductive features. Juvenile branches are quadrangular, while the ovate leaves possess acutely pointed tips. The tree produces fragrant, white, tetramerous flowers in umbellate clusters on short, sturdy peduncles. Sepals form an ovoid cup with marginal teeth, and the pilose flower tube supports widely spreading petals. The style extends outward, terminating in a two-lobed stigma, either spherical or mitre-shaped. Its obovate fruit and flowering season, occurring from September to December, further characterize the species (Sasidh, 2002).

Distribution of *Psydrax umbellata*

This species is widely distributed across Indo-Malesia, parts of China, and peninsular India, underscoring its broad ecological adaptability and geographical range (Sasidh, 2002).

This detailed botanical profile and regional nomenclature emphasize the species' ethnobotanical relevance and morphological uniqueness. Further research may illuminate its medicinal and ecological roles.

Phytochemistry of Psydrax

Psydrax has emerged as a focal point in phytochemical research due to its diverse array of bioactive compounds and therapeutic potential. Species such as *Psydrax peruviana*, *Psydrax dicoccos*, and *Psydrax subcordata*, which are rich in secondary metabolites including iridoid glycosides, flavonoids, tannins, coumarins, terpenoids, and cyanogenic glycosides. Iridoid glycosides, a defining feature of many *Psydrax* species, exhibit notable anti-inflammatory, antioxidant, and antimicrobial properties, making them candidates for managing inflammatory disorders and infections. For instance, *P. subcordata* has yielded unique iridoid dimers like canthiumosides 1–5, alongside other bioactive molecules such as Shanzhigenin methyl ester, underscoring its pharmacological significance. In addition, advanced techniques like LC-MS and GC-MS have facilitated detailed phytochemical profiling, as evidenced by studies on *Psydrax dicoccos* that identified over 50 bioactive metabolites with potential anticancer and antioxidant activities (Singamoorthy, 2021).

Cyanogenic glycosides, particularly prunasin and oxyanthin, found in *Psydrax subcordata* and *Psydrax livida*, contribute to both the plant's defense mechanisms and its pharmacological promise. While their toxicity at high doses remains a concern, controlled use of these compounds has shown potential in managing metabolic diseases like diabetes and in anticancer therapies. Additionally, flavonoids and tannins, abundant in species like *P. peruviana*, offer strong antioxidant and anti-inflammatory effects, making them vital for combating oxidative stress and inflammation. Advances in genomic research, such as chloroplast genome sequencing of *Psydrax latifolia* (Safhi *et al.*, 2024), provide insights into the evolutionary and

therapeutic aspects of these species. Future research should aim at harnessing these bioactive compounds for clinical applications while addressing safety concerns related to dosage and toxicity, thereby unlocking the therapeutic potential of *Psydrax* as a source of novel plant-based medicines.

Table 1. Major Bioactive principles obtained from *Psydrax* genus

Phytochemical Group	Representative Compounds	Species	Pharmacological Activities	Description
Glycosides	Canthiumosides (1–5), Methyl glycosides and Betulinic Acid	*Psydrax subcordata*	Antiinflammatory, Antimicrobial and antioxidant	Prominent in *Psydrax subcordata*, known for immune modulation and oxidative stress prevention.
Cyanogenic Glycosides	Prunasin, Oxyanthin	*Psydrax subcordata*, *Psydrax livida*	Metabolic disease management (e.g., diabetes) and anticancer	Release cyanide under specific conditions; toxic at high doses but beneficial in controlled pharmacological contexts.
Flavonoids	Not specified	*Psydrax peruviana*, *Psydrax dicoccos*	Antioxidant, antiinflammatory and antimicrobial	Found in leaves, bark, and roots; contribute significantly to radical scavenging and therapeutic potential.
Tannins	Not specified	*Psydrax peruviana*, *Psydrax horizontalis*	Antioxidant and antiinflammatory	Offer protection against oxidative stress and are key in therapeutic applications for inflammation.
Terpenoids	Squalene, other related metabolites	*Psydrax peruviana*, *Psydrax dicoccos*	Anticancer, antiinflammatory, and antimicrobial	Derived from isoprene units; significant potential in drug development.
Phenolic Compounds	Not specified	*Psydrax horizontalis*, *Psydrax dicoccos*	Antioxidant	Identified through detailed pharmacognostic studies.
Coumarins	Not specified	*General for Psydrax genus*	Antimicrobial and anticoagulant	Broadly distributed among the genus; activity linked to the coumarin structure.

Pharmacological Properties associated with phytochemistry of *Psydrax* Species

The genus *Psydrax*, a member of the Rubiaceae family, encompasses several species that have garnered attention for their wide array of pharmacological properties. These properties, including antimicrobial, anti-inflammatory, antioxidant, antidiarrheal, antidiabetic, anticancer, and anticonvulsant effects, highlight the therapeutic potential of these plants. The pharmacological actions of *Psydrax* species can be attributed to a rich profile of bioactive phytochemicals, including alkaloids, flavonoids, phenolic compounds, coumarins, and glycosides, which have been identified through various phytochemical analyses. This review provides an overview of the pharmacological properties of *Psydrax* species, focusing on *Psydrax subcordata*, *Psydrax schimperianus*, *Psydrax dicoccos*, and other notable species, along with insights into their underlying phytochemistry.

Table 1. Medicinal/ Biological activities of *Psydrax* plants

Plant Species	Pharmacological Activity	Details/Key Findings
Psydrax puberula	Antimicrobial	Hexane extracts active against *Escherichia coli*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus* (Musa *et al.*, 2021).
Psydrax subcordata	Antimicrobial	Methanolic extracts effective against Candida albicans, Penicillium species, and Saccharomyces cerevisiae (Uche *et al.*, 2024).
Psydrax subcordata	Anti-inflammatory and Anti-arthritic	Hydroethanolic root extract (PSRE) reduced inflammation and prevented joint deformities in arthritis models; modulates TNF-α, ILs, COX, and LOX (Tariq *et al.*, 2021).
Psydrax subcordata	Antioxidant	Leaf extracts showed significant free-radical scavenging activity due to flavonoids and phenolic compounds (Uche *et al.*, 2024).
Psydrax schimperianus	Antidiarrheal	Root extract inhibited defecation in experimental diarrhea models; active compounds include coumarins like isoscopoletin and scoparone (Uche *et al.*, 2022).
Psydrax horizontalis	Anti-diabetic	Methanol extracts significantly reduced blood glucose levels in alloxan-induced diabetic rats (Daanaa *et al.*, 2024).
Psydrax dicoccos	Anticancer	Methanol extracts exhibited cytotoxic effects against MCF7 breast cancer cells (IC50 = 34 µg/mL); inhibited AKT-1 and HER-2 receptors (Okojie *et al.*, 2024).
Psydrax subcordata	Anticonvulsant	Hydroethanolic leaf extract reduced seizures via GABAergic

		modulation in murine models (Daanaa *et al.,* 2024).
Psydrax subcordata	Antinociceptive and Anti inflammatory	PSRE reduced pain responses in acetic acid-induced writhing and formalin-induced nociception tests; dose-dependent anti-inflammatory effects observed (Tariq *et al.*, 2021).

Psydrax comprises a diverse array of species recognized for their rich ethnopharmacological uses and significant therapeutic potential. These plants exhibit a wide range of pharmacological activities, including antimicrobial, anti-inflammatory, antioxidant, antidiarrheal, antidiabetic, and anticancer effects. These properties are largely attributed to their complex phytochemical profiles, which include alkaloids, flavonoids, phenolic compounds, glycosides, and coumarins. Specific species, such as *Psydrax subcordata*, *Psydrax schimperianus*, and *Psydrax dicoccos*, have shown promise in preclinical studies for addressing various health concerns, including infectious diseases, metabolic disorders, and inflammatory conditions. Notable findings include the potent antibacterial activity of *Psydrax puberula* extracts and the antinociceptive and anti-inflammatory effects of hydroethanolic extracts from *Psydrax subcordata* roots, which support their traditional medicinal applications.

Despite these promising attributes, challenges remain in translating *Psydrax* research into therapeutic solutions. The complexity of its chemical composition poses difficulties in isolating and identifying key bioactive compounds, necessitating advanced analytical techniques such as mass spectrometry and NMR spectroscopy. Furthermore, the mechanisms underlying their pharmacological effects are not fully understood, requiring investigations into molecular pathways and pharmacokinetics. Future research must also prioritize the development of standardized extracts and formulations, accompanied by rigorous clinical trials to evaluate efficacy and safety. By addressing these challenges, *Psydrax* species could pave the way for novel plant-based therapies that effectively manage a spectrum of diseases.

Conservation and Ecological Importance of the Psydrax Genus

The *Psydrax* species thrive in biodiversity-rich regions such as Madagascar and Vietnam, where they play critical roles in ecosystem stability. Psydrax plants contribute to forest regeneration, stabilize soil through their deep root systems, and support diverse wildlife by offering food and shelter. Beyond their ecological functions, Psydrax species are notable for their medicinal potential. Extracts from their roots, stems, and leaves have demonstrated bioactivities like anti-inflammatory, analgesic, and antimicrobial effects, highlighting their potential for pharmaceutical research (Adams *et al.*, 2023). However, the survival of these species is threatened by habitat destruction, climate change, and taxonomic ambiguities, necessitating urgent conservation efforts.

Addressing the conservation challenges of Psydrax requires a multifaceted approach. Habitat destruction from deforestation, agricultural expansion, and urbanization continues to shrink their natural ranges, particularly in regions like Madagascar and Vietnam, where endemic species are heavily impacted (Harris *et al.*, 2022; Smith *et al.,* 2024). Climate change compounds these threats by altering growth conditions, especially for species with narrow ecological niches. Furthermore, taxonomic ambiguities hinder conservation planning, making it difficult to allocate resources effectively. Recent taxonomic revisions (Davis *et al.,* 2024) have clarified species relationships, enabling more targeted conservation strategies. These include the establishment of protected areas, promotion of sustainable land-use practices, and ex-situ conservation through seed banks and botanical gardens. Continued ecological, genetic, and community-integrated research is essential to safeguard Psydrax species and harness their full ecological and medicinal potential for future generations.

Conclusion

The Psydrax genus, notable for its ecological, medicinal, and conservation significance, offers vast potential for advancing biodiversity conservation and pharmacological research. However, habitat destruction, climate change, and overexploitation threaten its survival, making research crucial for its long-term utility. Recent taxonomic studies are essential for identifying at-risk species and shaping conservation strategies. While several Psydrax species, such as *Psydrax schimperianus* and *Psydrax subcordata*,

exhibit antimicrobial, anti-inflammatory, and anticancer properties, the pharmacological potential of *Psydrax umbellata* remains largely unexplored. This species may harbor novel bioactive compounds, meriting further research into its chemical composition and therapeutic applications. Moreover, in-vivo studies are essential to assess the safety and pharmacodynamics of Psydrax compounds. Continued taxonomic efforts will support both conservation and biodiversity, especially across tropical regions where these species are found. In conclusion, focused research on *Psydrax umbellata* and related species will maximize their therapeutic and ecological contributions, benefit human health and preserving biodiversity.

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