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Plectranthus monostachyus: Pharmacological Studies, Isolated Compounds and Future Prospects

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Abstract

Plectranthus monostachyus, a member of the Lamiaceae family, is widely used in traditional medicine across West and Central Africa for ailments such as infections, inflammation, diabetes, and gastrointestinal disorders. Despite its ethnomedicinal importance, it remains understudied compared to other species in the *Plectranthus* genus. This review aimed to evaluate the pharmacological activities as well as isolated bioactive compounds of *P. monostachyus* by synthesizing existing research, elucidating its therapeutic potential, and highlighting directions for future drug discovery and modern pharmacotherapy. A comprehensive literature search was conducted using SciFinder, Google Scholar, PubMed, and ScienceDirect for English-language articles published up to May 2024. Studies reporting on the ethnopharmacological, morphological, phytochemical, and pharmacological properties of *P. monostachyus* were included, with emphasis on bioactive compounds and their documented therapeutic effects. The species contains diverse phytochemicals, including flavonoids, tannins, saponins, alkaloids, and essential oils, which are associated with antioxidant, anti-inflammatory, antimicrobial, antidiabetic, hepatoprotective, nephroprotective, and anti-sickling activities. Studies confirmed the plant's pharmacological properties, validating several ethnomedicinal claims. However, research is limited, with many studies being published several years ago, or lacking detailed mechanistic analyses. Taxonomic ambiguities and the scarcity of clinical studies further restrict the full understanding of its therapeutic potential. Future investigations should focus on comprehensive phytochemical profiling, mechanistic studies, clinical evaluations, and standardization of extracts to fully exploit the species as a potential source of novel therapeutic agents.

Keywords: *Plectranthus monostrachyus*, pharmacological activities, therapeutic potentials, bioactive compounds

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Introduction

Human civilizations have long relied on plants for therapeutic purposes (Jima and Megersa, 2018), with over 80,000 of the 250,000 known flowering plant species utilized in traditional medicine (Chen *et al.*, 2016). Beyond serving as food and genetic resources, plants are a reservoir of bioactive compounds with potential medical applications, especially those sourced from tropical rainforests (Butler, 2012; Vattakaven *et al.*, 2016). Fossil evidence indicates that humans have used plants medicinally since at least the Middle Palaeolithic, approximately 60,000 years ago, and current estimates suggest that up to 80% of the global population still depends on plant-based traditional medicine (Hu *et al.*, 2020). Tropical rainforest plants are particularly valuable because of their chemical diversity, which has evolved as defense mechanisms against pests, pathogens, and environmental stressors (Jadid *et al.*, 2020). These ecosystems are considered a "world's largest pharmacy," harboring compounds that have led to over 70% of modern drugs, including twelve of the top 25 pharmaceutical agents worldwide (Alves *et al.*, 2018; Paton *et al.*, 2019; Atanasov *et al.*, 2021; Rashid *et al.*, 2024). Nigeria's rainforests, which cover approximately 95,372 km² of its land area, contribute significantly to this biodiversity and present untapped potential for drug discovery (Adeyekun *et al.*, 2025; Onyekwelu *et al.*, 2026,).

Among rainforest plants, several have been recognized for their immunomodulatory and therapeutic properties, including *Morinda citrifolia*, *Echinacea purpurea*, *and Phyllanthus niruri* (Kim *et al.*, 2022; Susilawati *et al.*, 2023; Marhaeny *et al.*, 2023). In this context, *Plectranthus monostachyus (P. monostachyus)*, indigenous to tropical Africa, emerges as a promising candidate for pharmacological investigation due to its documented anti-inflammatory, antimicrobial, and antioxidant activities (Barbosa *et al.*, 2023).

The genus *Plectranthus* (Lamiaceae) comprises approximately 300 species distributed across tropical Africa, Asia, and Australia, many of which have ethnobotanical and medicinal applications (Ribeiro *et al.*, 2017). The genus is taxonomically complex, with frequent reclassification among closely related genera such as *Coleus* and *Solenostemon* (Paton *et al.*, 2018; Paton *et al.*, 2019). *P. monostachyus*—recently recognized as *Coleus monostachyus*—is widely distributed across ruderal habitats in Africa and holds ecological and economic importance (Kiew, 2016; Kiew and Kamin, 2021).

Species in the *Plectranthus* genus demonstrate diverse pharmacological activities, including antibacterial, antifungal, antiviral, anti-inflammatory, antioxidant, and analgesic effects (Mesquita *et al.*, 2020; Cerqueira *et al.*, 2020; Kumar *et al.*, 2020). The leaves are the most frequently used part in traditional preparations, offering both therapeutic efficacy and sustainability by preventing whole-plant harvesting (Farias *et al.*, 2016). For instance, *P. amboinicus* and *P. barbatus* have shown activity against pain, inflammation, and various infectious agents, largely attributed to secondary metabolites such as rosmarinic acid and thymoquinone (Kapewangolo *et al.*, 2013; Kumar *et al.*, 2020; Duraisamy *et al.*, 2021).

Despite these advances, *P. monostachyus* remains one of the least studied species in the genus. Preliminary studies (Okokon *et al., 2016*) indicate antimicrobial, antioxidant, anti-inflammatory, antidiabetic, hepatoprotective, nephroprotective, and antilipidemic properties, but systematic documentation of its pharmacological activities, bioactive compounds, and mechanisms of action is lacking.

Although *P. monostachyus* is widely used in traditional medicine, few studies (Enin *et al.,* 2021; Ahamed *et al.,* 2023; Odion *et al.,* 2024) have comprehensively reviewed its pharmacological properties, isolated phytochemicals, and therapeutic potential. Existing reports primarily focused on other well-studied *Plectranthus* species, leaving a significant knowledge gap regarding *P. monostachyus*. Without a systematic synthesis of available data, opportunities for drug discovery and clinical translation remain underexplored.

This review aimed to evaluate the pharmacological properties and bioactive compounds of *P. monostachyus*, synthesizing existing research to elucidate its therapeutic potential. It also seeks to highlight future research directions and assess the species' potential for modern drug development. Investigating *P. monostachyus* has broad scientific, social, and medical significance. It may uncover novel bioactive compounds that could lead to innovative treatments for diseases such as diabetes, cancer, cardiovascular, neurodegenerative diseases, and inflammatory disorders. Moreover, validating its traditional uses can strengthen confidence in herbal medicine, promote sustainable drug development, and support equitable access to effective therapies, particularly in resource-limited settings.

Materials and Methods

Search Strategy

A systematic literature search was conducted to harmonize data on the ethnopharmacology, morphology, phytochemistry, and pharmacology of *P. monostachyus*. Electronic databases including SciFinder, PubMed, Google Scholar, and Elsevier Science Direct were searched for relevant articles published in English from 1924 to May 2024. The articles were collected from PubMed (Central: PMC-National Library of Medicine National Institutes of Health), ScienceDirect (Elsevier), SciVerse Scopus, and Web of Science (Main Collection—Clarivate Analytics) from December 2000 to May 2024. Keywords used included "*Plectranthus monostachyus*," "*Coleus monostachyus*," "*Solenostemon monostachyus*," "ethnobotany," "traditional uses," "phytochemistry," "bioactive compounds," and "pharmacological activities." Boolean operators (AND, OR) were applied to refine the search.

Eligibility criteria

Articles reporting traditional uses, pharmacological activities, isolation and characterization of bioactive compounds, or potential therapeutic applications of the species were included. Studies were excluded if they were not published in English, lacked primary data, focused on unrelated plant species, or were review articles without original experimental findings.

Screening and selection

A total of 278 articles were initially retrieved. Following title and abstract screening, 183 articles were excluded for irrelevance, duplication, or failure to meet inclusion criteria. Full-text assessment of the remaining 95 articles led to the exclusion of 80 additional papers due to incomplete data or methodological limitations. Ultimately, 15 articles were included in this review for detailed analysis of ethnobotanical uses, phytochemical composition, pharmacological activities, and potential therapeutic applications of *P. monostachyus*.
Data extraction focused on the plant parts studied, experimental models, isolated compounds, and reported pharmacological effects. Information was compiled and synthesized to provide a comprehensive overview of the species' pharmacological potential and research gaps.

Results

Taxonomy

Plectranthus monostachyus (P. Beauv) belongs to the Lamiaceae (mint) family. The genus *Plectranthus* is paleotropical, oil-rich, and part of the Nepetoideae subfamily, encompassing about 300 species of annual or perennial herbs or subshrubs, many succulent (Thaniarasu *et al.*, 2015; Cretton *et al.*, 2018). Several species are economically and medicinally important. Among them, *P. monostachyus*, notable for its aromatic leaves, is a significant medicinal succulent (Chijindu *et al.*, 2025). It resembles Indian Borage (*Coleus amboinicus*) but differs in stem morphology: *P. monostachyus* stems are quadrangular, whereas Indian Borage stems are round. Nodules may appear on mature plant roots. Unlike Indian Borage, *P. monostachyus* blooms continuously in sunny conditions. The species has undergone taxonomic revisions, with *Coleus monostachyus* now the commonly accepted name (Pollard and Paton, 2001; Paton *et al.*, 2019;).

Morphological Features and Distribution

P. monostachyus is an erect, branched annual herb growing up to 1 m, with succulent, aromatic, quadrangular stems and short hairs along the angles (Meerts and Paton, 2024). Internodes measure 5–7 cm in length and 2–4 mm in width, and adventitious roots range from 5–17 cm. Leaves are opposite, simple, slightly fleshy, with petioles 2–9.5 cm long; laminae measure 2.4–13 × 1.8–10.5 cm, glabrous on top and puberulous below with gland dots. Inflorescences are terminal false spikes, up to 40 cm, with sessile dichasia or verticillasters. Flowers are bluish-purple with a white base, bisexual, and zygomorphic, 7.5–9 mm long (Prasad et al., 2022) (Figure 1).
P. monostachyus is native to West and Central Africa, including Burkina Faso, Cameroon, Chad, Congo, Ghana, Guinea, Nigeria, Senegal, Sudan, and Togo. The plant is valued for its essential oils and medicinal potential (Thaniarasu *et al*., 2015).

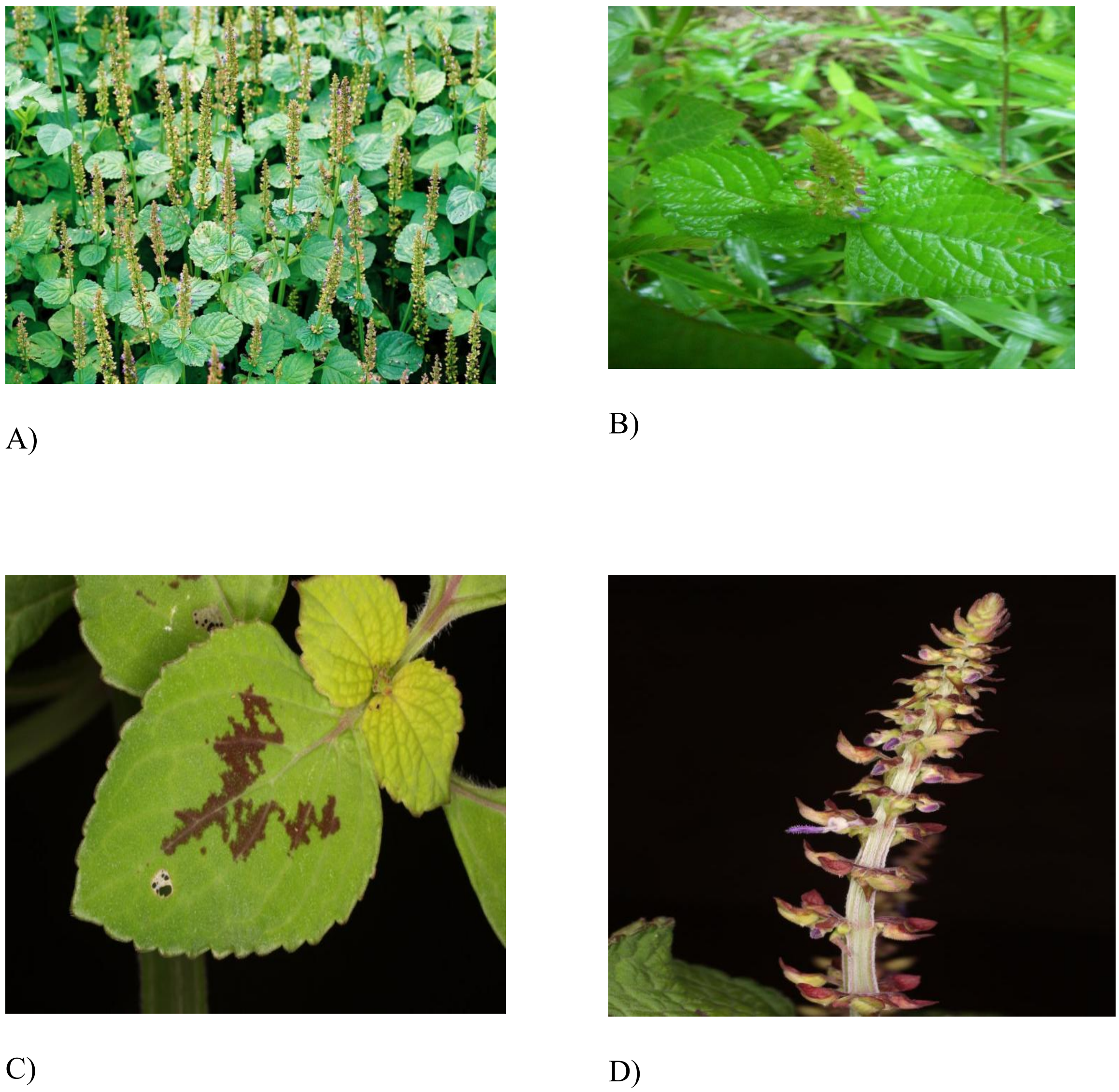


Figure 1. (A) Flowering plant of *P. monostachyus* (B) Flowering spike of *P. monostachyus* (C) Variegated leaves of *P. monostachyus* (D) Flowering stem of *P. monostachyus*

Microscopy

Titus et al. (2024) reported irregular epidermal cells with non-striated periclinal walls and undulating anticlinal walls. Cells ranged 45–135 µm in length (mean 98.4 ± 1.86 µm) and 49.3 ± 0.56 µm in width. Stomata were diacytic, oval, 31.5 ± 0.21 × 20.35 ± 0.27 µm, with a stomatal index of 20%. Trichomes were mostly unicellular; starch grains were present. Vein architecture was pinnate with well-developed polygonal to rectangular areoles.

Ethnomedicinal Uses

Compiling information on the ethnobotanical uses of *P. monostachyus* has proven challenging due to taxonomic inconsistencies, which have resulted in different names being used for the same species in studies. This has led to fragmented documentation and difficulty in synthesizing traditional knowledge.

According to Lukhoba *et al.* (2006), species within the *Plectranthus* genus are widely used in folk medicine for the treatment of gastrointestinal disorders, respiratory conditions, thirst, skin diseases, and musculoskeletal problems. They are also reported to stimulate breast milk production. In West and Central Africa, *P. monostachyus* is used for a wide range of therapeutic purposes, including the treatment of poisoning and various disease conditions (Oguamanama *et al.*, 2017).

Traditionally, the leaves are prepared in different decoctions and are commonly used to manage microbial infections, particularly those affecting the feet (Okoko and Ere, 2012).

They are also administered internally for cough and colic and are believed to possess sedative properties while enhancing digestion (Ekundayo and Ezeogu, 2006). Additionally, the leaves have been used in the management of rheumatism, snakebites, female infertility, dysmenorrhea, and hematuria (Koffi *et al.*, 2009).

Among the Ibibio people of the Niger Delta, Nigeria, the aerial parts are used to treat inflammatory conditions such as hemorrhoids, fever/malaria, and stomach ulcers (Adebayo and Krettli, 2011). The plant is also used as a diuretic, for hypertension, and in diabetes management (Olabanji *et al.*, 2008; Koffi *et al.*, 2009; Djama *et al.*, 2012).

Despite these widespread uses, not all claims have been scientifically validated, highlighting the need for further pharmacological and clinical studies (Kiew and Kamin, 2021).

Isolated Compounds of Pharmacological Importance from Plectranthus monostachyus

Plants have long been crucial to humans and animals for food, shelter, and medicine, with their therapeutic effects largely attributed to bioactive secondary metabolites (Iniaghe *et al.*, 2009). *P. monostachyus*, an oil-rich member of the Nepetoideae subfamily, has been extensively screened for phytochemicals. Its leaves, stems, and whole plant contain alkaloids, tannins, anthraquinones, saponins, terpenes, steroids, phlobatannins, coumarins, polyphenols, monoterpenes, diterpenoids, sesquiterpenes, and flavonoids (Datte *et al*., 2010; N'Guessan *et al.*, 2011; Amazu *et al.*, 2015: Okokon *et al.*, 2015). The leaf essential oil is particularly rich in β-pinene, oct-1-en-3-ol, β-caryophyllene, octan-3-ol, and (E,E)-α-farnesene. Other constituents include water, proteins, lipids, glucids, calcium, phosphate, and essential oils (Djama *et al.*, 2012). High concentrations of polyphenols, bioflavonoids, saponins, tannins, alkaloids, and phytate likely underlie its pharmacological benefits (Lukhoba *et al.*, 2006). A summary of these pharmacological and phytochemical profiles is provided in Table 1, highlighting the compounds responsible for the plant's antioxidant, anti-inflammatory, and antimicrobial activities.

Pharmacological Activities

Antimicrobial and Antibacterial Activity

Studies have shown that *P. monostachyus* leaf extracts possess notable antimicrobial properties (Ekundayo and Ezeogu, 2006). Okoko and Ere (2012) further evaluated the antimicrobial and antioxidant activities of the plant.

Further antibacterial evidence was provided by Ohwofasa and Okwena (2018), who investigated the antibacterial activity of *Solenostemon monostachyus* (a synonym of *P. monostachyus*) in combination with *Vernonia amygdalina* against *Salmonella typhi*, *Escherichia coli*, and *Enterobacter aerogenes*. The study showed that higher concentrations of the extracts produced larger zones of inhibition, with the combined extracts exhibiting greater sensitivity, suggesting possible synergistic effects.

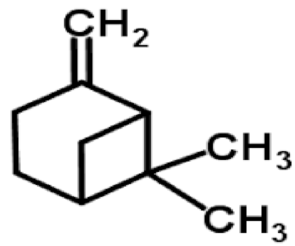
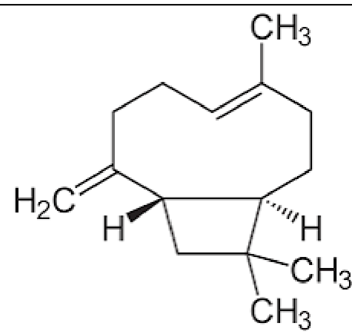
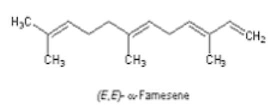
These findings further support the antibacterial potential of *Plectranthus monostachyus* and highlight its promise as a source of bioactive compounds for developing therapies against resistant bacterial strains.

Anti-Sickle Cell Activity

To manage sickle cell disease (SCD), Afolabi *et al*. (2012) investigated the effects of methanol extract of selected plants, including *Solenostemon monostachyus* (*Plectranthus monostachyus*), *Ipomoea involucrata*, and *Carica papaya* seed oil. Their study demonstrated that the aqueous methanol extracts significantly reduced the proportion of sickled cells in untreated patient blood (26.85 ± 3.12%) to 1.03 ± 0.16 for *C. papaya* oil, 1.90 ± 0.43 for *P. monostachyus*, and 4.04 ± 0.71 for *I. involucrata*. Although sickling was not completely reversed, treated samples showed higher levels of normal red blood cells compared to untreated controls, indicating meaningful anti-sickling activity.

Importantly, *P. monostachyus* exhibited a notable ability to inhibit hemoglobin polymerization, a key target in SCD management (Nwaoguikpe and Ejele, 2010). In some cases, it performed better than *V. amygdalina* in improving hemoglobin levels. These findings highlight the promising antisickling potential of *P. monostachyus* and suggest that combining these plant extracts may offer synergistic benefits in SCD management (Afolabi *et al.*, 2012).

Table 1. Summary of the pharmacological and phytochemical profiles of *P. monostachyus*

Phytochemical constituents	Structure	Pharmacological action
B-pinene		Antioxidant, hepato protective, nephroprotective (Oguamana *et al*.,2017). Analgesicic (Liapi *et al*., 2007) Anti-inflammatory, antidiabetic, antilipidemic (Tandon, 2005)
β-caryophyllene,		Analgesic and anti-inflammatory (Datta *et al*., 2004; Chavan *et al*., 2012) Antidiabetic, antilipidemic (Tandon, 2005)
(E, E)-α-farnesene		Analgesic and anti-inflammatory (Datta et al., 2004; Chavan *et al*., 2012) Antidiabetic, antilipidemic (Tandon, 2005)
Alkaloids		Antimicrobial (Okoko & Ere, 2012), antidiabetic, antilipidemic (Tandon, 2005).
Phenolics		Antimicrobial (Okoko & Ere, 2012), anti-inflammatory (Gurgel *et al*., 2009)
Tannins		Antibacterial and Antilipidemic (Tandon, 2005)

Anti-Ulcerogenic Activity

Studies have demonstrated the antiulcerogenic properties of *P. monostachyus* leaf extracts (Amazu *et al.*, 2015). Its traditional use as an ulcer remedy led to experimental evaluation using models induced by histamine, ethanol, indomethacin, and reserpine. Indomethacin induces gastric injury by inhibiting prostaglandin synthesis through the cyclooxygenase pathway, thereby reducing mucosal protection (Datte *et al.*, 2010; Arumugam *et al.*, 2016). Prostaglandins play a key role in maintaining mucosal integrity via mucus and bicarbonate secretion, their suppression increases susceptibility to ulceration (Hiruma-Lima et al., 2006). The observed reduction in mucosal damage suggests that the extract may enhance prostaglandin-mediated protection.

Ethanol-induced ulcers are linked to oxidative stress, mucosal damage, and disruption of gastric secretions (Abdel-Mogib *et al.*, 2002). The extract mitigated ethanol-induced ulcers, likely due to its antioxidant and cytoprotective effects (Amaechi *et al*., 2015).

Phytochemical studies have identified sesquiterpenes such as β-pinene and β-caryophyllene, which may contribute to antiulcer activity by enhancing glutathione and prostaglandin (PGE2) synthesis (Ekundayo and Ezeogu, 2006). Additional mechanisms may include inhibition of lipoxygenase activity and histamine-induced gastric secretion (Kramoh *et al.*, 2012; Kapewangolo *et al.*, 2013).

Antioxidant Activity

P. monostachyus showed strong antioxidant activity via DPPH radical scavenging and enhanced enzymatic antioxidant defenses (Datte *et al.*, 2010; Oguamana *et al.*, 2017; Olawole *et al.*, 2019). High bioflavonoid and polyphenol contents may contribute to its capacity to neutralize free radicals, suggesting potential for preventing oxidative damage in hepatocytes and erythrocytes.

Antidiabetic and Antilipidemic Activities

Several secondary metabolites present in *P. monostachyus* including polysaccharides, terpenes, tannins, steroids, and alkaloids, have been linked to antidiabetic activity. Okokon *et al.* (2015) reported a significant reduction in blood glucose levels (BGL) in diabetic rats treated with the extracts and fractions of the plant's aerial parts over a 2-week period. Similarly, Amaechi *et al.* (2015) observed that a single dose of the leaf extract significantly lowered BGL in streptozotocin-induced diabetic rats. These findings tend to confirm the ethnomedicinal claims regarding the plant's antidiabetic properties.

In addition to its hypoglycemic effects, *P. monostachyus* exhibited notable antilipidemic activity. Okokon *et al.* (2015) demonstrated that two weeks of treatment with the extract significantly lowered total cholesterol (TC), triglycerides (TG), LDL, and VLDL, while elevating HDL in diabetic rats. ElHazmi and Warsy (2001) suggested that these effects may be due to increased lipoprotein lipase activity, enhancing plasma triglyceride uptake by skeletal muscle and adipose tissue. Adaramoye *et al.* (2005) also reported reversal of hyperlipidemia markers in rats treated with *P. monostachyus*. The suppression of lipid oxidation and the elevation of HDL-c further indicate a potential anti-atherogenic effect (Amaechi *et al.*, 2015).

Analgesic and Anti-Inflammatory Activity

Some of the isolated compounds in *P. monostachyus* such as monoterpene β-pinene have been shown to possess analgesic and anti-inflammatory effects (Liapi *et al.*, 2007), while sesquiterpenes such as β-caryophyllene and (E,E)-α-farnesene also contribute to these activities (Datta *et al.*, 2004, Chavan *et al.*, 2012). Flavonoids, well-known for their anti-inflammatory properties, inhibit phospholipase A2 and C, cyclooxygenase, and lipoxygenase pathways, and some act via opioid receptor activation to induce antinociception (Middleton *et al.*, 2000; Rajendran *et al.*, 2000).

In vivo studies (Okokon *et al.* 2016) demonstrated that *P. monostachyus* leaf extract significantly reduced early-stage carrageenan-induced oedema, likely by modulating histamine, serotonin, and kinins (Monago *et al.*, 2015). Inhibition of prostaglandin synthesis may account for reduced oedema (Fidele *et al.*, 2012). The extract also significantly reduced xylene-induced ear oedema suggesting inhibition of phospholipase A2 (Jantan *et al.*, 2015). The extract also inhibited acetic acid-induced writhing, indicating antinociceptive effects potentially linked to the blockade of arachidonic acid metabolism (Okokon *et al.*, 2016).

Antihypertensive Activity

P. monostachyus leaf extracts have been reported to exhibit significant antihypertensive effects (Fidele *et al.*, 2012). In normotensive rabbits, hydroethanolic extracts lowered blood pressure dose-dependently, likely through cholinergic and non-cholinomimetic mechanisms (Abrogoua *et al.*, 2012). The extract demonstrated vasorelaxation by inhibiting KCl- and noradrenaline-induced contractions, suggesting blockade of L-type voltage-operated and receptor-operated Ca^{2+} channels (Shah and Gilani, 2011). Endothelium-dependent pathways involving NO/cGMP and prostacyclin (PGI_2) also contributed to vasorelaxation. Antioxidant compounds such as flavonoids and terpenes may further support blood pressure reduction by scavenging free radicals (Datte *et al.*, 2010; Okoko and Ere, 2012).

Hepatoprotective and Nephroprotective Activity

Pretreatment with *P. monostachyus* leaf extract was reported to mitigate paracetamol-induced liver intoxication (Oguamana *et al.*, 2017). This effect may be linked to the extract's antioxidant constituents, which protect liver tissue from free radical damage (Oguamana *et al.*, 2017).

Similarly, *P. monostachyus* exhibited nephroprotective activity in paracetamol-induced nephrotoxicity. Kidney function markers—urea, creatinine, electrolytes, tissue GSH, SOD, CAT, and MDA—were normalized following extract pretreatment, accompanied by reduced histological damage such as tubular necrosis, glomerular congestion, and inflammatory infiltration (Mugford and Tarloff, 1997; Oguamana *et al*., 2017).

Discussion

Numerous studies have been conducted on the genus *Plectranthus*, revealing a wide range of pharmacological potential across its species. Few studies have focused on this species, which has resulted in limited identification of its phytoconstituents and persistent uncertainty in correlating its traditional uses with scientifically validated pharmacological effects. Folk medicine attributes significant therapeutic properties to *P. monostachyus*, including anti-inflammatory, antibacterial, antiulcerogenic, and antioxidant effects. These pharmacological activities are likely linked to the plant's rich and diverse phytochemical composition.

The primary goal of this review was to consolidate the available literature on *P. monostachyus*, identifying the bioactive compounds responsible for its pharmacological actions. By doing so, the review aimed to provide a foundation for future studies that could scientifically validate the ethnomedicinal uses of this species and explore its potential as a source of new drug candidates.

Taxonomic uncertainty remains a challenge for this species due to the lack of clear morphological standards for differentiating closely related species. According to Paton *et al.* (2019), the genera *Coleus* and *Plectranthus* are now recognized as distinct, and *Coleus monostachyus* (P. Beauv.) A.J. Paton is the current accepted name, replacing the former *P. monostachyus*. Despite the taxonomic reclassification, numerous synonyms and historical references exist, including *Solenostemon monostachyus*, *Plectranthus palisotii*, and others (Kiew, 2016). This taxonomic complexity highlights the need for standardization in future research to ensure clarity and reproducibility.

Research on the genus *Plectranthus* generally shows significant medicinal and commercial potential. However, *P. monostachyus* remains one of the least studied species within the Lamiaceae family. Very few studies (Ahamed *et al.,* 2023; Barbosa *et al.,* 2023) have investigated its pharmacological properties and phytochemical composition, and none have undertaken a systematic review until now. Despite its broad ethnomedicinal applications, ranging from antimicrobial and antioxidant to antidiabetic, hepatoprotective, nephroprotective, and antilipidemic effects, the species has received limited scientific attention, with researchers focusing instead on better-characterized relatives in the genus such as *P. ambionicus*.

This review highlights the relevance of *P. monostachyus* in contemporary pharmacotherapy by synthesizing scattered data on its ethnomedicinal, morphological, phytochemical, and pharmacological characteristics. Folk medicine reports the use of various *Plectranthus* species for gastrointestinal disorders, respiratory illnesses, skin diseases, musculoskeletal abnormalities, and even lactation enhancement (Lukhoba *et al.*, 2006). Specifically, *P. monostachyus* is employed in West and Central Africa to treat diverse ailments, including poisonings (Oguamanama *et al.*, 2017). Its leaves are reported to have calming properties, aiding colic, cough, and digestion (Ekundayo *et al.*, 2006), while also being used for hematuria, female infertility, rheumatism, and snakebites (Koffi *et al.*, 2009).

Experimental studies support some of these ethnomedicinal claims. Okoko and Ere (2012) demonstrated antioxidant and antibacterial activities in leaf extracts, suggesting that diverse bioactive compounds contributed to these effects. Similarly, Ikpesu and Pondei (2018) reported significant antibacterial efficacy of *Solenostemon monostachyus* extracts against Gram-negative bacteria. Afolabi *et al.* (2012) highlighted its anti-sickling potential in the management of sickle cell anemia, while Amazu *et al.* (2015) provided evidence for antiulcer activity. Leaf extracts also showed antidiabetic effects in streptozotocin-induced diabetic mice (Amaechi *et al.*, 2015), further validating traditional claims. Additional pharmacological actions include nephroprotective, analgesic, hepatoprotective, anti-inflammatory, and antihypertensive effects.

Phytochemical analyses have revealed compounds that likely underpin these pharmacological properties. The essential oil of *P. monostachyus* leaves contains sesquiterpenes such as β-pinene, oct-1-en-3-ol, β-caryophyllene, octan-3-ol, and (E,E)-α-farnesene (Okokon *et al.,* 2016; Essien *et al.,* 2017). Other studies (Afolabi *et al.,* 2016; Afolabi *et al.,* 2021; Enin *et al.,* 2021) have identified tannins, oxalates, saponins, alkaloids, phytate, and bioflavonoids, as contributory to its health-promoting effects. The plant also has a high total polyphenol content, which is closely linked to antioxidant activity (Heim *et al.*, 2002).

Beyond pharmacology, the nutritional composition of *P. monostachyus* leaves further supports their medicinal value. Leaves contain approximately 10.1% protein, sufficient to meet a portion of the Recommended Dietary Allowance (RDA) for children, pregnant women, nursing mothers, and adults (Adinortey et al., 2012; Obichi et al., 2015). Crude fiber content (5.2%) contributes to gastrointestinal health, while moisture, ash, crude fat, and carbohydrate contents support overall dietary energy and nutrient intake (Abolaji et al., 2007; Fagbohun et al., 2012). Essential minerals such as potassium, calcium, magnesium, manganese, and iron play critical roles in metabolic, neuromuscular, and enzymatic functions (Enechi and Odonwodo, 2003; Ujowundu et al., 2010; Khare et al., 2011: Lambrechts et al., 2022), while vitamins A, C, and E contribute to antioxidant defenses, immune function, vision, and red blood cell production (Achikanu et al., 2013).

The scarcity of focused study on *P. monostachyus* has limited comprehensive analyses of its phytochemistry, pharmacology, and potential as a source of lead compounds. Nevertheless, this review underscores the plant's significant pharmacological potential and highlights the need for further studies. Future research should prioritize comprehensive phytochemical profiling, mechanism-of-action studies, and clinical trials to validate safety and efficacy. Standardization of extracts, exploration of additional pharmacological activities such as anticancer and neuroprotective effects, and application of biotechnological approaches like tissue culture and genetic engineering could enhance the production of bioactive compounds and expand therapeutic applications.

P. monostachyus holds immense promise as a source of novel therapeutic molecules. While traditional claims and preliminary studies provide a foundation for its pharmacological relevance, further rigorous research is essential to fully understand its potential.

Limitations of the Study

Despite providing a comprehensive overview of *P. monostachyus*, this review faced several limitations. First, the available literature on the species is limited, with many studies being published several years ago, resulting in gaps in current knowledge on certain phytochemicals, their mechanisms of action, and dose-dependent pharmacological effects. Second, inconsistencies in taxonomy and nomenclature across studies created challenges in accurately synthesizing information, as the species has been referred to by multiple synonyms over time. Third, most studies are preliminary, with few in vivo or clinical investigations, limiting the ability to fully validate ethnomedicinal claims.

Conclusion

This review examined the morphological, phytochemical, and pharmacological characteristics of the *Plectranthus* genus, with particular emphasis on *P. monostachyus*,a species that has historically received limited scientific attention. Its morphology, pharmacological activities that have been scientifically evaluated, and the phytochemicals isolated from it were documented. This review provides a framework for researchers interested in exploring the phytochemical and pharmacological profiles of *P. monostachyus*. The findings indicate that, compared to other well-studied species in the genus, *P. monostachyus* remains largely understudied, underscoring the need for further investigation of its pharmacological and phytochemical properties. Further research should focus on comprehensive phytochemical profiling, mechanistic pharmacological studies, and clinical evaluations to validate traditional uses. Biotechnological approaches, such as tissue culture and genetic engineering, may enhance bioactive compound production, while standardization of extracts could optimize therapeutic applications. Such efforts will help unlock the full medicinal potential of *P. monostachyus* and may lead to the discovery of novel therapeutic agents.

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