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RESEARCH

Salvia lanigera Poiret Extracts: Study of the Phytochemical Profiling via GC–MS and HPLC–DAD and Bioactivity with ADME Analysis

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Abstract
This investigation evaluated the chemical composition and the biological activities of the ethanol and petroleum ether extracts of *Salvia lanigera* Poiret from the M'sila region, Algeria. Phytochemical analysis identified 17 compounds in the ethanol extract (HPLC–DAD), with cynarin, ellagic acid, and rutin as major components. Petroleum ether extract (GC–MS) revealed 16 compounds, predominantly palmitic acid and stearic acid. Antioxidant activity was assessed using four assays: the ethanol extract showed significant activity in the phenanthroline assay (1.94 ± 0.18 µg/mL), and SNP assay (124.78 ± 0.59 µg/mL), compared to the BHA standard. Both extracts demonstrated antibacterial and antifungal effects, with inhibition zones of 10–13 mm and MIC values ranging from 0.78 to 3.125 mg/mL against tested strains. Enzymatic assays revealed α-glucosidase inhibition by the ethanol extract (IC_{50} = 27.07 ± 0.78 µg/mL), while α-amylase inhibition was lower (ethanol: 429.85 ± 1.43 µg/mL; petroleum ether: 520.31 ± 1.63 µg/mL). Acetylcholinesterase (AChE) and butyrylcholinesterase (BChE) inhibition were minimal (IC_{50} > 200 µg/mL for AChE; ethanol: 365.84 ± 5.48 µg/mL, petroleum ether: 636.13 ± 4.49 µg/mL for BChE). Urease inhibition was notable for the ethanol extract (54.88%) and comparable for the petroleum ether extract (52.00%). These findings highlight the potential of *S. lanigera* extracts as sources of bioactive compounds with antioxidant, antimicrobial, and enzymatic inhibitory properties, warranting further exploration for therapeutic applications.

Keywords *Salvia lanigera* Poiret · HPLC–DAD · GC–MS · Antibacterial activity · Antifungal activity · Antioxidant activity · Enzymatic inhibitory activity

Introduction

The *Salvia* genus, recognized as one of the largest within the *Lamiaceae* family, comprises nearly one thousand formally identified species renowned for their ornamental, medicinal, and hallucinogenic attributes (Lu 2019; Ortiz-Mendoza et al. 2022). Medicinal plants have constituted a cornerstone of global healthcare systems, serving as the foundation for both traditional medicine and modern pharmacotherapy (Abdallah 2011; Aouzal et al. 2024; Lamari et al. 2025; Paşayeva et al. 2025). Among these, Salvia species hold particular pharmacological significance due to their well-documented therapeutic applications across diverse medical traditions.

A distinguishing feature of the genus is the unique modification of its stamens, which form a lever-like apparatus. This morphological feature, in conjunction with the distinct morphology of the calyx and corolla, has been crucial for the taxonomic differentiation of *Salvia* from other genera (Shahraki et al. 2024). Geographically, the genus demonstrates the greatest diversity in Europe, its primary area of distribution, with notable additional concentrations in the Old World, where approximately 350 species have been documented (Karalija et al. 2022). Furthermore, North Africa represents a significant region of *Salvia* diversity, with 27 taxa recorded across Morocco, Algeria, Tunisia, Libya, and Egypt (Euro-Med Checklist 2024).

A notable species within the *Salvia* genus is *Salvia lanigera Poiret* (also referenced as *Salvia verbenaca subsp. clandestina* (L.) Pugsley; *Salvia controversa* Ten), classified under the section *Pleiosphace.* This species is prevalent in Algeria, primarily thriving in desert or dry shrubland ecosystems. *Salvia lanigera* is easily identified by its distinctive morphology, characterized by pinnatipartite leaves with linear segments and dark purple flowers, complemented by a calyx adorned with sparse, visible green hairs (Quezel and Santa 1963; POWO 2024).

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