NATURAL DEEP EUTECTIC SOLVENTS (NADES) AS A GREEN STRATEGY FOR THE EXTRACTION OF ROSMARINIC ACID FROM SOME LAMIACEAE SPECIES

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Abstract

The plants from Lamiaceae family are widely distributed and used in food, cosmetics, and as therapeutics in medicine. Many phenolic compounds known for their broad spectrum of biological activities are found in Lamiaceae species, particularly rosmarinic acid (RA). Growing interest in novel green solvents for extracting bioactives from plants is driven by a shift towards minimizing harmful organic solvents. Natural deep eutectic solvents (NADES) are a promising option, composed of naturally occurring substances that form a transparent liquid when combined at specific molar ratios.

The aim of this study was to explore the effectiveness of choline chloride-based natural deep eutectic solvents (NADES) for the extraction of RA from *Melissa officinalis* and *Thymus serpyllum*, followed by HPLC-PDA analysis for quantification and assessing antioxidant activity through DPPH, FRAP, and ORAC methods. Comparisons were made with conventional (70% ethanol) extracts.

Four NADES were prepared via microwave irradiation, combining choline chloride with citric acid, 1,2-propanediol, urea, or fructose at a 1:1 molar ratio, with the addition of 20% water (w/w). The extraction process involved sonication of plant material (solid-liquid ratio 1:10 (g/mL)) for two hours at 40 °C.

HPLC-PDA analysis revealed that RA was the main compound in all extracts. Overall, NADES yield similar or greater amounts of RA than 70% ethanol ($p \leq 0.05$; Tukey test). Specifically, NADES extracted nearly 25% more RA from *M. officinalis* than ethanol. For *T. serpyllum*, 50% higher RA yields were achieved using NADES containing citric acid and 1,2-propanediol. Additionally, NADES extracts demonstrated superior antioxidant activity in reducing ferric ions and neutralizing DPPH radicals compared to ethanol ($p \leq 0.05$), except in the ORAC assay. Our results confirm the potential of NADES as effective green solvents for the extraction of bioactive compounds from plants. Future work will focus on optimizing the extraction process to maximize RA yield from other Lamiaceae species.

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