

GREEN AND SUSTAINABLE EXTRACTION OF MULTIFUNCTIONAL BIOACTIVE INGREDIENTS USING NATURAL DEEP EUTECTIC SOLVENTS FOR PHARMACEUTICAL APPLICATIONS

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Growing interest in green solvents for the recovery of bio-actives from natural sources is a result of the growing need for environmentally friendly and sustainable extraction processes. This study applied the green and sustainable extraction of multifunctional bioactive ingredients using, natural deep eutectic solvents (NADES) as an attractive alternatives of traditional organic solvents. Four NADES namely, Choline Chloride: Lactic Acid (ChCl:LA), Choline Chloride: Acetic Acid (ChCl:AA), Choline Chloride: Citric Acid (ChCl:CA), and Choline Chloride: Propylene Glycol (ChCl:PG), along with propylene glycol (PG) were selected for the extraction of antioxidant-rich fractions from *Paeonia officinalis* and *Paeonia anomala* leaves and roots. Ultrasound-assisted probe extraction (5 min, 35% amplitude) with NADES was used for the extraction of phenolic rich fractions and NADES were removed using solid-phase extraction (SPE). Pressurized Liquid Extraction (PLE) with conventional solvent 75% ethanol was used as a reference method. All the extracts were analyzed for total phenolic content (TPC), total flavonoid content (TFC), and antioxidant activity using ABTS and ORAC assays. In most of the samples the highest TPC was expressed by ChCl:PG other than *P. officinalis* leaves. TFC results indicated ChCl:AA as the most effective solvent. ChCl:PG also showed superior ABTS radical scavenging activity across all tested leaves and roots samples than other NADES, whereas ORAC trends varied by species. UHPLC-ESI-QTOF-MS/MS analysis revealed that NADES extracts were richer in phenolics than PLE extracts with conventional solvents. Overall, ChCl:PG provided the most selective antioxidant-rich extracts, demonstrating the potential of polyol-based NADES as sustainable, selective alternatives to conventional solvents and advanced extraction techniques such as PLE.



Fig. 1. NADES prepared in the laboratory for the extraction of phytochemicals

Keywords: *Paeonia officinalis*, *Paeonia anomala*, antioxidant activity, NADES, PLE, UAE.