

## A comparison of different green extraction techniques for recovering polyphenols from Tropea red onions by-product using Natural Deep Eutectic Solvent (NADES).

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The onion (*Allium cepa* L.) is one of the oldest cultivated plants, used for both food and medicinal purposes. The red onion of Tropea is a typical Italian variety grown in specific areas of Calabria. Distinguished by its intense red skin, sweetness and crunchiness, it has been awarded IGP certification since 2008 [1]. During post-harvest processing, the peel is removed, generating large amounts of waste that is difficult to dispose of due to the presence of sulphur compounds responsible for unpleasant odours [2]. In recent years, several studies have highlighted the potential of onion peels as a source of bioactive compounds, particularly phenols with antioxidant properties, which could be used as ingredients in the nutraceutical, cosmetic or pharmaceutical industries [3].

In this context, the following study aimed to enhance the value of Tropea onion peel by-product as a source of phenolic compounds through sustainable extraction. To this aim, Natural Deep Eutectic Solvents (NADES), which are recognised for their safety and sustainability, were used. First, a preliminary study was conducted to determine the most effective NADES mixture for polyphenol extraction. Spectrophotometric assays were used to test the antioxidant activity (DPPH) and total phenolic content (IPT) of the extracts, identifying the ChCl:citric acid (2:1) solution as the most efficient for polyphenol recovery from red onion peel. Subsequently, the combined effectiveness of NADES and green extraction techniques was evaluated by comparing three different extraction techniques: ultrasound-assisted extraction (UAE), pressurised liquid extraction (PLE) and solid-phase dispersion of the matrix (MSPD). The results were then compared with those obtained using standard extraction solvents (water and 70% ethanol), which highlighted the high effectiveness of NADES, particularly when combined with ultrasound. Finally, the chemical profile and variation of individual phenolic compounds under different extraction conditions were evaluated by high-performance liquid chromatography coupled with quadrupole time-of-flight mass spectrometry analysis (HPLC-QTOF-MS). The most abundant compounds identified were quercetin, quercetin 3-glucoside and protocatechuic acid.

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