Optimization of the extraction techniques using Deep Eutectic Solvents for the recovery of biomolecules from food industry by-products

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STATE OF THE ART

The agri-food industry generates a large amount of by-products, which represent a major issue of global interest. This is principally due to the presence of vast amounts of organic moieties such as proteins, lipids, carbohydrates, that can have negative effects on the environment and human health (Ezejiofor and Uchechi, 2014). The by-product composition may also include valuable bioactive compounds, as reported by several studies (Ben-Othman et al. 2020; Chaouch and Benvenuti, 2020; Skendi et al., 2020). In the last years, the importance of these substances and their benefic effects on the human health is gaining particular attention, due to the spread of diet-related diseases and the increasing consumers' interest in a healthy lifestyle. In this context, the transition from a linear to a circular economy in the agri-food sector can be promoted implementing models aimed at the extraction and recovery of valuable molecules from the available by-product, before their utilization as an energy source or a mere disposal (Donner et al., 2020).

Due to the increasing environmental concerns, in the last years there has been a growing interest in the development of green extraction technologies to be applied also in the food industry. According to the Green Chemistry principles, reduction or elimination of toxic organic solvents represents one of the major issue. Within this frame a growing number of research papers have been published in the last 20 years about the potential use of deep eutectic solvents (DESs), with the paper of Abbott et al. (2003) being a milestone in this research area. However, DESs and their application for the extraction of bioactive compounds from food matrices still presents unresolved issues. This is true especially in relation to the sub-category of hydrophobic DESs, for which many applications in the food sector have not been explored and still exist many limitations. Based on these assumptions, it is evident that DESs scale-up application in industry needs further contributions from the scientific community.

PHD THESIS OBJECTIVES AND MILESTONES

This PhD thesis project will be aimed at **investigating the potential use of NaDESs**, both hydrophilic and hydrophobic, **for the recovery** of several **compounds of interest** for the food and cosmetic industries, such as phenolic compounds, tocols and pigments, naturally found in agri-food byproducts.

Table 1. *Gantt Diagram*

	Activity \ Months	2	4	6	8	10	12	14	16	18	20	22	24
A1)	***NaDESs characterization***												
	1) Experimental trials (physicochemical properties and behavior)												
	2) Extracts characterization												
A2)	***Extraction process Optimization***												
	1) Individuation of the best operating conditions												
A3)	***Extracts concentration and DESs recovery***												
	1) Extract concentration trials												
	2) DESs recovery												
A4)	***Thesis and Papers Preparation***												

The PhD project can be scheduled into the following activities (also reported in Table 1):

A1) NaDESs characterization, to select the ones best suited to achieve the goals of the project**.**

The main physicochemical properties - pH, density, viscosity, melting point, polarity - of various DESs, with a focus also on HDESs, will be considered and the biofunctional properties of the extracts will be investigated.

A2) Extraction process optimization, through the use of the Response Surface Methodology in order to explore and identify the best extraction conditions.

A3) Extracts concentration and DESs recovery, so to develop a purification methodology having low costs and respecting the environmental sustainability objective of the project.

The potential use of the extracts, as such or concentrated, in food formulation will be studied as well as the procedure for DESs recovery and recycling.

A4) Writing and editing of the PhD thesis, preparation of scientific papers, participation to scientific meeting presenting oral and/or poster communications.

Throughout the planned activities, the pertinent scientific literature will be constantly monitored and updated.

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