CHEMICAL ENGINEERING

Valorization of agrifood waste via crystallization

Funded By	Dipartimento DISAT
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Context of the research activity	The aim of this PhD project is to valorize agri-food waste by using its extracts (e.g., polyphenols, triglycerides, waxes, polysaccharides) for the development of novel, sustainable products for the food, nutraceutical/pharmaceuticals and agrochemical sectors.
Objectives	Developing formulations with enhanced dissolution rate and bioavailability is critical for many industrial sectors including pharma, food and agrochemicals. Multiphase systems (e.g., emulsions, foams, creams) are a convenient and effective encapsulation and delivery strategy, particularly for oral and topical formulations. Currently, synthetic excipients, surfactants and specialty polymers are used to create formulations with enhanced properties. These materials are very affective but not sustainable as they are derived from non-renewable resources through some of the most greenhouse gas-intensive manufacturing processes. It is clearly necessary to move away from polymer-based formulations and find more sustainable and safer alternatives. This project proposes a unique approach whereby synthetic additives will be replaced with natural crystalline particles specifically engineered. Micro and nano-sized solid particles are excellent interfacial stabilizers; they adsorb more strongly than traditional surfactants at interfaces (Pickering effect), providing longer shelf life to the final products. In particular, using crystals of small organic molecules, such as triglycerides and polyphenols, presents many advantages compared to other food grade Pickering systems. These compounds are biocompatible, non-toxic and, in some cases, they provide health benefits. They can be extracted from waste materials from the agri-food industry such as fruits, vegetables/seeds and coffee grounds. The extraction processes do not use polluting chemicals and, more importantly, the main particle properties of these crystals (size, shape and polymorphism) can be easily modified by controlling the conditions in which they are nucleated and grown. The prospective student will first study the crystalline properties of selected natural small molecules using a variety of solid state characterization techniques such as X-ray diffraction, optical and electron microscopy, and differential scanning calorimetry. After such preliminary study the ability of the studied crystalline particles to stabilize complex multiphase formulations will be evaluated. This task will involve also the use of advanced imaging techniques such as

	confocal Raman microscopy, X-ray tomography and scanning electron microscopy. The studentship is related to the project CryForm (https://cordis.europa.eu/project/id/949229) funded by the European Research Council H2020 and led by Dr Elena Simone (https://www.disat.polito.it/it/personale/scheda/(nominativo)/elena.simone). The prospective student will join a multi-disciplinary and international team, and they will work closely with molecular modelers, chemists, crystallographers and engineers.

Skills and competencies for the development of the activity	A master degree (or equivalent) in Chemistry, Chemical Engineering, Pharmacy of Physics (Physical Chemistry) is an essential requirement. Some basic knowledge of computational chemistry and crystallization might be desirable.