

## PHD PROJECT DESCRIPTION

(4000 characters max., including the aims and work plan to be published online)

### **Project title: Development of Sustainable Extraction Strategies for Bioactive Compounds from Plant Materials**

#### **1.1. Project goals**

The project will focus on the development of sustainable extraction strategies for the recovery of bioactive compounds from selected plant materials. Particular attention will be paid to phenolic compounds and other natural antioxidants, which are important for functional food, nutraceutical, cosmetic and biomedical applications. The research will combine modern green extraction techniques with environmentally acceptable solvents in order to obtain extracts characterized by high biological activity, improved selectivity and reduced environmental impact.

The proposed study will compare conventional and advanced extraction approaches, including ultrasound-assisted extraction, microwave-assisted extraction, pressurized liquid extraction and subcritical water extraction. The use of green solvents, such as ethanol-based systems, bio-based solvents and natural deep eutectic solvents, will be evaluated in terms of extraction efficiency, selectivity, safety and compatibility with analytical procedures.

#### **1.2. Outline**

The project will result in the development of sustainable extraction protocols for obtaining bioactive compounds from selected plant materials. The candidate will identify the most effective green solvents and extraction techniques, including subcritical water extraction, and determine their influence on extract composition and biological activity.

The results are expected to provide new knowledge on the relationship between extraction conditions, selectivity and functionality of plant extracts, supporting their potential use in food, nutraceutical, cosmetic and biomedical applications.

#### **1.3. Work plan**

Months 1-12: literature review, selection and characterization of plant matrices, preparation of reference extracts, implementation of analytical assays and preliminary extraction screening.

Months 13-24: optimization of UAE, MAE and bio-based solvent systems using experimental design; comparison of extraction yield, phenolic recovery and antioxidant activity.

Months 25-36: development of subcritical water and pressurized extraction protocols; LC-MS/MALDI-MS profiling; evaluation of extract selectivity and matrix effects.

Months 37-48: stability and functional tests, cytocompatibility and cell-migration screening where justified, green-metric assessment, preparation of doctoral dissertation.

#### **1.4. Literature (max. 7 listed as a suggestion for a PhD candidate preliminary study)**

1. Kaczkowska, H.; Pestriakova, M.; Wólkiewicz, J.; Krakowska-Sieprawska, A.; Fijałkowski, P.; Rafiński, Z.; Pomastowski, P.; Walczak-Skierska, J.; Rafińska, K. *Foods* 2025, 14, 2448.
2. Silva, S.S. et al. *Separation and Purification Technology* 2023, 304, 122344.
3. Chemat, F. et al. *Ultrasonics Sonochemistry* 2017, 34, 540–560.

4. Zhang, J. et al. Trends in Food Science & Technology 2020, 95, 183–195.
5. Herrero, M. Analytical and Bioanalytical Chemistry 2024, 416, 2039–2047.
6. Usman, M.; Nakagawa, M.; Cheng, S. Processes 2023, 11, 3444.
7. Kerkel, F. et al. Green Chemistry 2021, 23, 2962–2973.

### **1.5. Required initial knowledge and skills of the PhD candidate**

The candidate should hold a Master's degree in Chemistry and have practical laboratory experience, including sample preparation, extraction of plant materials and basic spectrophotometric analyses. They should be able to plan and perform chemical analyses, interpret data, and document results. Good organizational skills, independence, and willingness to work in an interdisciplinary team are essential.

### **1.6. Expected development of the PhD candidate's knowledge and skills**

During the project, the PhD candidate will gain advanced knowledge of green chemistry, sustainable extraction techniques and analytical methods used for the characterization of plant-derived bioactive compounds.

The project will strengthen the candidate's ability to design experiments, critically analyze results, prepare scientific publications, present research at conferences and conduct independent research in the field of natural products and sustainable technologies.