

# 1. PHD PROJECT DESCRIPTION (4000 characters max., including the aims and work plan, all in English)

**Project title:** Designing and analysis of novel emulsion food products

## 1.1. Project goals:

The main goals of the project are:

- Development of novel reduced-fat emulsions enriched with bioactive compounds from agro-food byproducts and natural materials.
- Application of various emulsification methods in the production of food emulsions.
- Investigation of the effect of natural emulsifiers and bioactive compounds on food emulsions stability and quality.
- Determination of antioxidant, antimicrobial, rheological, structural, textural, and sensory properties of novel food emulsions.

**1.2. Outline:** Currently, as consumers become more concerned about their health, there is a need to develop healthy, nutritionally balanced emulsion products containing bioactive natural ingredients with all of the sensory properties. Lipid oxidation is a serious problem in food production, due to generation of rancid odours and flavours, changes in texture and colour, and decrease of shelf life and nutritional value. Among food products, emulsions are example of a food that can rapidly degrade by lipid oxidation reactions. Interestingly, the phenomenon that the overall oxidation rate is generally faster in emulsions than in bulk oil may be attributable to the large interfacial area in emulsions compared with the relatively small interface between air and oil in bulk oils. More robust food emulsions can be created by adding appropriate stabilizers into the formulation, such as emulsifiers, antioxidants, ripening inhibitors, texture modifiers, and weighting agents. In order to reduce and control lipid oxidation, antioxidants are added to food emulsions. However, antioxidant efficacy in multiphase systems depends on many factors, but particularly the partitioning of the antioxidant into the different phases seems to be an important factor. Especially, agro-food residuals are a rich source of natural antioxidants and other active components that can improve the nutritional, performance and functional properties of emulsions and provide protection against undesirable oxidative reactions. In addition, some proteins present in waste and their hydrolysates acting as emulsifiers, have a strong antioxidant activity. The location of proteins in emulsions also plays a key role in determining their oxidation susceptibility. For this reason, it is possible to develop healthy emulsions compensate sensorial impacts of reduced fat content by its replacing by low energy, active compounds extracted from agro-food byproducts.

In the course of the project, the ability of active compounds from agro-food waste to prevent both lipid and protein from oxidation in model food emulsions will be estimated. Moreover, the possibilities of using agro-food residuals in reduced-fat emulsions as natural stabilizers and fat replacers will be studied. The novel food emulsions containing edible oil droplets coated by waste protein will be prepared and analyzed using a range of

complementary analytical methods.

The present investigations can be the platform for efficient and economic enrichment way for food emulsions, and they contribute to the value-added utilisation of plant residual materials.

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

- Preparation of novel pro-health food emulsions loaded with bioactive compounds from agro-food residuals.
- Development of novel techniques for extraction of bioactive compounds from by-products of agro-food industries.
- Applications and effects of different emulsification techniques in the production of food emulsions.
- Determination of physicochemical, antioxidant, and antimicrobial properties of the obtained extracts and novel food emulsions by modern instrumental techniques.
- Investigation of the effect of concentration and type of emulsifiers such as surfactants and proteins on emulsions stability.
- Evaluation of a link between the chemical and physical stabilities of the emulsions.
- Sensory evaluation and consumer acceptability of new food emulsions.
- Application of statistical and chemometric tools to data analysis and optimize the storage conditions of food emulsions to prolong their shelf life.

### **1.4. Literature:**

1. Muijlwijk K., Berton-Carabin C., Schroën K.. Cross-flow microfluidic emulsification from a food perspective. *Trends Food Sci. Technol.* 2016, *49*, 51-63.
2. Yashini M., Sunil C.K., Sahana S., Hemanth S.D., Chidanand D.V., Rawson A. Protein-based fat replacers – A review of recent advances. *Food Rev. Int.* 2021, *37*, 197-223.
3. Zhou L., Zhang J., Xing L., Zhang W.. Applications and effects of ultrasound assisted emulsification in the production of food emulsions: A review. *Trends Food Sci. Technol.* 2021, *110*, 493–512.
4. Lu Z., Zhou S., Ye F., Zhou G., Gao R., Qin D., Zhao G. A novel cholesterol-free mayonnaise made from Pickering emulsion stabilized by apple pomace particles. *Food Chem.* 2021, *353*, 129418.
5. Velderrain-Rodríguez G.R., Salvia-Trujillo L., González-Aguilar G.A., Martín-Belloso O. Interfacial activity of phenolic-rich extracts from avocado fruit waste: Influence on the colloidal and oxidative stability of emulsions and nanoemulsions. *Innov. Food Sci. Emerg. Technol.* 2021, *69*, 102665.

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

- Basic knowledge in the field of analytical, food and colloids chemistry.
- Basic knowledge in the instrumental techniques used for characterization of food emulsions and waste extracts.
- The ability to interpret and describe experimental results and draw conclusions.
- Knowledge of speaking and writing English.

- Commitment to scientific work, permanent self-education and ability to cooperate in a team.

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

- The ability to practical skills:
  - (1) methodology for extraction of active components from agro-food residuals,
  - (2) preparation of the novel food emulsions,
  - (3) application of new techniques and instrumentations for qualitative and quantitative analysis of food emulsions.
- The ability to write scientific publications, scientific projects (grant applications) and presentation of results at international conferences, workshops and tutorials.
- Preparation for hard work, formulation and solving the scientific problems related to trends in food science and technology.