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

Project title: Dissolution of active compounds in a polymer matrix using various surfactants - a case study of new food storage packaging

1.1. Project goals

- obtain novel materials based on chosen biodegradable polymers;
- evaluation of physicochemical and biological properties of obtained materials;
- the improvement of dissolution of active compounds in polymeric matrixes using novel various surfactants;
- the formation of materials with a potential application as active packaging.

1.2. Outline

Non-biodegradable plastics applied in different areas of human life constitute a significant environmental problem. One of the new approaches suggests the exchange of non-biodegradable plastic with biodegradable ones composed of substrates from renewable resources, like polylactide and cellulose derivatives.

In order to extend the possibilities of food storage, packaging modifications are carried out. One of the modification methods is the introduction of active compounds into the polymer matrix that can limit the development of undesirable pathogens. However, the solubility of active compounds in the polymeric matrix is a problem that needs to be solved.

The answer to the mentioned problem seems to be the application of non-ionic surfactants. The molecule of a non-ionic surfactant consists of two asymmetrically arranged groups with opposite properties: one has hydrophobic properties while the other is hydrophilic.

In the case of surfactants one of the most significant features is the balance between the hydrophilic and hydrophobic parts, known as the hydrophilic-lipophilic balance (HLB). The HLB value allows to determine the ability of a substance to disperse in water or in a lipophilic system. In addition, this factor becomes useful during the formulation of stable emulsions. It is well known, that the HLB values and the structures of the used surfactants affect the properties of the systems and determine their application.

Considering the problems concerning the dissolution of active compounds based on the preliminary study incorporation of different non-ionic surfactants into the polymeric system can result in the preparation of valuable biodegradable materials with unique features that favor their application in food packaging.

1.3. Work plan

The main goal will be achieved through the implementation of working elements as follows:

Task 1: Formation of films based on biodegradable polymers with an addition of active compounds and non-ionic surfactants.

Task 2: Physicochemical characterization of prepared materials by different methods, e.g., FTIR, mechanical testing, contact angle measurement, AFM, degradation tests, thermal properties, antioxidative properties, migration of components, water vapor transport properties.

Task 3: Evaluation of application potential in the laboratory conditions simulating the usage of materials in the food packaging sector.

1.4. Literature *(max. 10 listed, as a suggestion for a PhD candidate)*

Siracusa V et al. “Biodegradable polymers for food packaging: a review” Trends in Food Science & Technology 19(12) (2008) 634-643

Abbot, V., & Sharma, P. Thermodynamic and acoustic studies of quercetin with sodium dodecyl sulfate in hydro-ethanolic solvent systems: A flavonoid-surfactant interaction study. Chemical Physics, 538(June), (2020) 110921.

Bhagawan, W. S. et al. Formulation and characterization of quercetin niosome with concentration variations of span 20 surfactant. Journal of Pharmaceutical Sciences and Community, 18(2), (2021) 84–94.

Brandelero, R. P. H. et al. The effect of surfactant Tween 80 on the hydrophilicity, water vapor permeation, and the mechanical properties of cassava starch and poly(butylene adipate-co-terephthalate) (PBAT) blend films. Carbohydrate Polymers, 82(4), (2010) 1102–1109.

Olewnik-Kruszkowska E. et. al. “Polylactide-Based Films Incorporated with Berberine—Physicochemical and Antibacterial Properties”, Foods 12 (2023) 91

Olewnik-Kruszkowska E. et.al. “Polylactide-Based Films with the Addition of Poly(ethylene glycol) and Extract of Propolis—Physico-Chemical and Storage Properties”, Foods 11 (2022) 1488

Chu, Y., et al. Evaluations of physicochemical and biological properties of pullulan-based films incorporated with cinnamon essential oil and Tween 80. International Journal of Biological Macromolecules, 122, (2019) 388–394.

Facchi, D. P et al. Composite filter with antimicrobial and anti-adhesive properties based on electrospun poly(butylene adipate-co-terephthalate)/poly(acid lactic)/Tween 20 fibers associated with silver nanoparticles. Journal of Membrane Science, 650, (2020) 120426.

1.5. Required initial knowledge and skills of the PhD candidate

- Analytical thinking
- Eager to learn
- Knowledge about polymers
- Knowledge about materials characterization
- Basic knowledge about polymers modification

1.6. Expected development of the PhD candidate’s knowledge and skills

Acquiring advanced skills in analyzing materials
- Learning advanced instrumental techniques
- Learning techniques of the laboratory work
- Learning biological research techniques
- Development of analytical thinking
- Personal development as a young scientist