

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

Project title: Food packaging materials based on biopolymers and their derivatives modified with new plasticizers, including deep eutectic solvents.

1.1. Project goals

- obtain novel materials based on chosen biopolymers;
- evaluation of physicochemical and biological properties of obtained materials;
- the improvement of mechanical properties of obtained materials using novel classes of plasticizers;
- the formation of materials with a potential application as biomaterials and 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 polysaccharides (starch, cellulose, chitin). Most of polysaccharide materials suffer poor mechanical resistance and lack of elasticity. Crosslinking and plasticization are the most frequently applied among different modification methods of biopolymer-based materials.

Mixing two different biopolymers of various mechanical resistance or their derivatives coupled with doping with plasticizers, especially those regarded as “green” ones, can result in the preparation of valuable but biodegradable materials with unique features that favor their application in food packaging and the medical sector.

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 chosen biopolymers and their doping with different plasticizers.

Task 2: Physicochemical characterization of prepared materials by different methods, e.g., ATR-FTIR, mechanical testing, contact angle measurement, AFM, swelling/degradation tests, thermal properties (by TG, DSC), aging tests, 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

De Matos Fonseca et al “An Overview of Biopolymers in Food Packaging Systems” in “Nanotechnology-Enhanced Food Packaging” (Eds. Jyotishkumar Parameswaranpillai, Radhakrishnan Edayileveetil Krishnankutty, Aswathy Jayakumar, Sanjay Mavinkere Rangappa, Suchart Siengchin), 2021, WILEY-VCH GmbH

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

Gierszewska M. et al. "Chitin and chitosan" *Encyclopedia of polymer science and technology* Seidel Arza (red.), 2021 John Wiley & Sons

Ostrowska-Czubenko J. et al. "Modyfikacja chitozonu: krótki przegląd" *Wiadomości Chemiczne* 70(9-10) (2016) 657-679

Jakubowska E. et al. "The role of a deep eutectic solvent in changes of physicochemical and antioxidative properties of chitosan-based films" *Carbohydrate Polymers* 25 (2021) 117527

Jakubowska E. et al. "Physicochemical and storage properties of chitosan-based films plasticized with deep eutectic solvent" *Food Hydrocolloids* 108 (2020) 106007

Jakubowska E et al. "Development and characterization of active packaging films based on chitosan, plasticizer, and quercetin for rapeseed oil storage" *Food Chemistry* 399 (2023) 133934

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