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

Project title: Innovative biodegradable dressing and packaging materials containing biocidal substances.

1.1. Project goals

The objective of the proposed research project is:
(a) Synthesis or selection of substances of biocidal nature.
(b) To produce materials that are composites or blends of a biocidal substance with a polymeric matrix.
(c) Targeting of materials for dressing and packaging purposes.
(d) Analysis of physical, chemical, biological: molecular, microbiological and genetic nature.

1.2. Outline

The overarching aim of the project is to synthesise or select biocidal substances suitable for incorporation into a biodegradable polymer matrix to produce materials of: 1) dressing and 2) packaging. The prepared materials will be subjected to a series of utilitarian/utility and biological tests.

Human health and environmental aspects will be taken into account at each stage of the project.

1.3. Work plan

First year

- Synthesis or selection of substances with antibacterial (bactericidal and/or fungicidal) properties.

- Determination of the minimum inhibitory concentration (MIC) of potentially biocidal substances against selected micro-organisms.

- Determination of the minimum biocidal concentration (MBC) of potentially biocidal substances against selected micro-organisms.

- Preparation of test material in the form of composite dressing and packaging materials based on biodegradable polymers.

- Determination of utilitarian properties, e.g.: biocidal properties (bactericidal, fungicidal), cytotoxicity, mutagenicity, antioxidant properties of films.

- Preparation of a grant to NCN or/and a project to IDUB-UMK.

2nd year

- Quantification of the biodegradability of composite materials in different environments (e.g. sea water, lake water, river water, soil) and using pure strains.

- Isolation and identification of selected microorganisms from degraded materials.

- Preparation of a biopreparation/'microbial vaccine' to improve the biodegradability of the materials produced.

- Preparation of a scientific publication with IF.

- Drafting of a patent application.

3rd year

- Evaluation of the effect of biopreparations on soil biological activity.

- Preparation of scientific publication with IF.

- Participation in a scientific conference.

4th year

- Conducting missing, supplementary and complementary analyses, requiring repetition or extension of given research options.

- Preparation of a scientific publication with IF.

- Active participation in national and international scientific conferences to present the results obtained.

- Preparation of a dissertation dossier, based on published scientific papers.

- Public defence of the dissertation.

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

1)Gierszewska M., Jakubowska E., Richert A. The adenine-modified edible chitosan films containing cholinę chloride and citric acid mixture. Scientific Reports, 2023, 13, 12629. https://doi.org/10.1038/s41598-023-39870-4. IF 4.6, 140 MNiSW

2)Richert A., Kalwasińska A., Felföldi T., Szabó A., Fehére D., Dembińska K., Swiontek Brzezinska M. Characterization of bacterial biofilms developed on the biodegradable polylactide and polycaprolactone polymers containing birch tar in an aquatic environment, Marine Pollution Bulletin, 2024, 199 (2024) 115922. IF 5.8, 140 MNiSW

3)Kowalonek J. , Stachowiak–Trojanowska N., Cieciurska Z., Richert A. Zinc oxide nanoparticles and sage (Salvia officinalis) essential oil as active components of alginate films for food packaging, Polymer Degradation and Stability, 2025, 237, 111328. IF 6.3, 140 MNiSW

4)Richert A., Kalwasińska A., Jankiewicz J., Swiontek Brzezinska M. Effect of birch tar embedded in polylactide on its biodegradation. International Journal of Biological Macromolecules, 2023, 239(1), 124226. https://doi.org/10.1016/j.ijbiomac.2023.124226. IF 8.2, 140 MNiSW

5) Swiontek Brzezinska, M., Walczak, M., Kalwasińska, A., Richert, A., Świątczak, J., Deja Sikora, E., & Burkowska-But, A. (2020). Biofilm formation during biodegradation of polylactide, poly (3, 4 hydroxybutyrate) and poly (ε-caprolactone) in activated sludge. International Journal of Biological Macromolecules, 159, 539-546.

6) Swiontek-Brzezinska, M., Pałubicka, K., Latos, M., Janik, A., Tarnawska, P., Krajnik, K., &

Kalwasińska, K. (2022). Natural compounds derived from Brassicaceae plants as an alternative to synthetic fungicides and their influence on soil fungus diversity.
7) Kaczmarek-Szczepańska, B., Sionkowska, M. M., Mazur, O., Świątczak, J., & Swiontek Brzezinska, M. (2021). The role of microorganisms in biodegradation of chitosan/tannic acid materials. International Journal of Biological Macromolecules, 184, 584-592.

1.5. Required initial knowledge and skills of the PhD candidate

1. A completed master's degree in biological sciences: biology, forensic biology, biotechnology, molecular diagnostics.
2. Significant knowledge of microbiology and genetics.
3. Experience working in a microbiology or genetics laboratory.
4. Ability to write research funding applications.
5. Ability to edit simple scientific texts.
6. Communication skills in English.
7. Positive interpersonal skills.
8. Ability to speak freely.
9. Openness to national and international cooperation.
10. Organisational skills.

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

Knowledge development

- To improve knowledge of genetic and microbiological analyses (theoretical and practical).
- To increase knowledge of the practical use of biocidal substances, which may vary in nature in terms of their derivation or form.
- To implement and adapt the most up-to-date research techniques having a genetic, molecular, microbiological or biochemical character.

Skills

- Ability to prepare, apply and obtain projects/grants in internal (University competitions, e.g. IDUB, CPATT UMK) and external (e.g. NCN) competitions, as well as their conduct and implementation.
- Selection of the obtained research results to the nature of a reputable journal.
- Familiarity with the editorial path of publication (from manuscript submission, through post-review revisions, to publication of results in a reputable foreign journal with IF.
- Skills in team and individual activities, including teaching students.
- Preparation of occasional workshops at UMK, e.g. 'Fascinating Plant Day' and/or and/or 'Biologists' Night' And representing the university at popularisation events, e.g. "Festival of Science and Arts".
- Presenting results at national and international scientific conferences.
- Co-ordinating work aimed at the proper execution of the doctoral thesis.