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ABSTRACT OF THE DOCTORAL THESIS

"Investigation of biological properties of electrospun PL-b-CL/PVP nanofibers modified with nanoparticles and antibacterial proteins – evaluation of cytotoxic effect as well as *in vitro* antibacterial and anticancer activities"

Nanomedicine, currently one of the fastest developing fields of nanotechnology, offers new possibilities for effective methods of treating many diseases, including cancer or infections caused by highly antibiotic-resistant bacteria. It is a new therapeutic alternative to the often difficult diagnostics or not fully effective treatment methods. Nanomaterials are favored by their unique physicochemical and biological properties, mainly resulting from their small nanometric size. However, on the other hand, the wide spectrum of action and not fully understood toxicity mechanisms constitute a barrier to the medical use of nanomaterials, and therefore indicate the direction of many future studies. Therefore, electrospun polymer nanofibers, as innovative nanomaterials with great scientific and application potential, are currently the focus of many researchers from various fields, including tissue engineering, regenerative medicine, and controlled drug delivery systems.

The main aim of this doctoral thesis was to develop new nanomaterials based on electrospun PL-b-CL/PVP nanofibers modified with nanoparticles and antibacterial proteins as well as assessment of their physicochemical and biological properties.

The doctoral thesis consists of three original research papers published in the journals *Nanomaterials*, *Macromolecular Bioscience* and *Nanotechnology, Science and Applications*. All nanofibers were produced from a biocompatible and biodegradable copolymer PL-b-CL and PVP, and then modified with previously synthesized nanoparticles (CdSe QDs, AuNPs, Dend-AgNPs) and/or proteins (endolysin). The research used a wide range of physicochemical and biological methods, as well as various approaches and methods of nanofiber modification, which allowed for a comprehensive characterization of the developed nanomaterials and an assessment of their application potential.

Publication I (*Nanomaterials*, 2023) presents a procedure for the synthesis of hybrid PL-b-CL/PVP nanofibers modified with cadmium selenide quantum dots (CdSe QDs) with antibacterial properties against drug-resistant *Pseudomonas aeruginosa* PAO1. What is particularly important, the developed PL-b-CL/PVP-CdSe QDs nanofibers reduced the viability of cancer cells to ~20%, which makes them very promising anticancer materials for topical use

In Publication II (*Macromolecular Bioscience*, 2024), electrospun PL-b-CL/PVP nanofibers functionalized with gold nanoparticles (AuNPs) were evaluated, which showed clear antibacterial activity against *P. aeruginosa* PAO1, low cellular toxicity against fibroblasts, and slightly increased immunoreactivity, which creates possibilities for their use as a new class of wound dressings. The obtained PL-b-CL/PVP-AuNPs nanofibers also proved to be platforms for the transport of antibacterial agents, in this case dendronized silver nanoparticles (Dend-AgNPs), which additionally enhanced the antibacterial activity of the entire nanoscaffold.

In the latest Publication III (*Nanotechnology, Science and Applications*, 2025), the role of PL-b-CL/PVP nanofibers as efficient carriers for therapeutic substances with antibacterial properties, i.e. Dend-AgNPs and bacteriophage-derived proteins (endolysins) was confirmed. PL-b-CL/PVP nanofibers, which were surface-decorated with Dend-AgNPs and endolysin, showed satisfactory antibacterial activity against the Gram-negative pathogen *P. aeruginosa* PAO1, and this effect was associated with Dend-AgNPs, which, by increasing the permeability of the outer bacterial membrane, enable endolysin to digest bacterial peptidoglycan. Moreover, the incorporation of the Dend-AgNPs/endolysin complex into nanofibers significantly reduced its cytotoxicity towards human fibroblasts. The obtained results clearly indicate the potential of the produced nanofibers as innovative materials with antibacterial properties.

Thanks to precisely selected electrospinning parameters, cylindrical nanofibers with significant porosity and good thermal and mechanical stability were obtained, which was confirmed by the performed physicochemical analyses. In addition, the applied NF modifications allowed to broaden their spectrum of action and to produce multifunctional nanomaterials that can be used as effective solutions in antibacterial and anticancer therapies, which opens up new possibilities in the field of nanomedicine and biomaterial applications.

Keywords: electrospinning, nanofibers, nanoparticles, endolysin, antibacterial activity, anticancer properties

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