

VI. Streszczenie w języku angielskim

Silver nanoparticles (AgNPs) are among the most commercialized nanomaterials. Their versatile properties enable their applications in a wide range of fields, from electronics, through the textile and cosmetic industries, to biomedicine. The antimicrobial activity of AgNPs, recognized as the strongest among nanomaterials investigated to date, constitutes their primary attribute of interest for practical applications.

The growing demand for silver nanoparticles is associated with the need to develop synthesis methods that are not only economically viable but also simple, rapid, and environmentally sustainable. Biological synthesis meets these criteria and stands out against conventional methods, which typically require high energy input or involve toxic reagents. Filamentous fungi are particularly attractive candidates for AgNP biosynthesis due to their ease of cultivation, rapid growth, efficient biomass production, ability to generate large quantities of secondary metabolites, and resilience to mechanical stress and metal exposure. Crucially, both the fungal species employed, and the metabolites produced can influence the characteristics of the resulting nanoparticles, and consequently – their potential applications.

The potential cytotoxicity of silver nanoparticles toward cells raises concerns about the safety of their use. Additionally, silver nanoparticles released into the natural environment may pose a threat to organisms at different trophic levels. Therefore, it is necessary to conduct comprehensive analyses of the toxic potential of newly synthesized silver nanoparticles, as well as to search for methods to reduce their effective doses, thereby limiting their consumption.

The objective of this doctoral dissertation was the microbiological synthesis of silver nanoparticles with the participation of the brown-rot wood fungus *Gloeophyllum striatum* DSM 9592 under various process conditions, as well as a broad evaluation of their biological activity, including antimicrobial, cytotoxic, ecotoxic potential, and synergistic activity with commonly used antibiotics.

Obtained results demonstrated that the brown-rot wood fungus *G. striatum* can be used for the efficient biosynthesis of silver nanoparticles. It was also proven that the conditions of the synthesis process, such as temperature or shaking, may determine the physicochemical and biological properties of the obtained nanomaterials, as well as the efficiency of their synthesis.

Analysis of the antimicrobial potential showed that the synthesized silver nanoparticles were active against the tested microorganisms, and their effectiveness

depended on the synthesis conditions and the target species. No clear tendency was observed for one type of silver nanoparticle to show stronger activity against all tested microbial strains. Among the tested microorganisms, fungi were more sensitive to the action of silver nanoparticles compared to bacteria. The most sensitive organisms among the fungal strains were the yeasts *Malassezia furfur* DSM 6170, while among the bacterial strains the most sensitive were the gram-negative bacteria *Pseudomonas aeruginosa* ATCC 27853.

Evaluation of the toxic potential of silver nanoparticles demonstrated that the obtained nanomaterials exhibited varying cytotoxic or ecotoxic effects on the tested models. It was shown that the cytotoxic effect on the human fibroblast cell line induced by the nanoparticles was stronger than their hemolytic activity and was determined by the applied biosynthesis conditions. The lowest cytotoxic activity among the tested nanomaterials was exhibited by nanoparticles synthesized at 4°C, even at concentrations active against the most sensitive strains. The study of the ecotoxic potential of silver nanoparticles revealed that the tested soil and aquatic bacterial strains, freshwater and marine crustacean species, as well as aquatic plants, all showed sensitivity to the presence of nanoparticles in the environment. The nanoparticles were most toxic to the freshwater crustacean species *Daphnia magna*, while the weakest toxic effect was observed in the case of the cultivated plants *Sorgho saccharatum*, *Lepidium sativum*, and *Sinapis alba*.

Based on the research results, it was found that silver nanoparticles synthesized at 4°C without shaking (4ns AgNPs) were the most promising in terms of antimicrobial activity and toxic potential. At concentrations active against *P. aeruginosa*, *C. albicans* ATCC 10231, and *M. furfur*, they did not cause hemolytic effects, exhibited the lowest cytotoxic activity and minor ecotoxic potential. Furthermore, 4ns AgNPs showed synergistic activity with antibiotics against the tested pathogenic bacteria, making it possible to reduce the dose of nanoparticles effective against microorganisms and minimize their toxic potential.

The obtained results demonstrated that by optimizing the conditions of the biosynthesis process of silver nanoparticles using filamentous fungi, it is possible to modify the properties of the produced nanomaterials, which may lead to obtaining a product with high antimicrobial activity while maintaining low toxic potential.