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Enzymatic synthesis and characterization of metallic nanoparticles for targeted application on antimicrobial biodegradable polymers

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Statement of the Problem: Limited natural resources and the exponential growth of the population lead to dramatic changes in production, consumption, transportation and storage of food. The application of nanoparticles in packaging affects its antibacterial, mechanical, thermal and barrier properties, but also increases the safety of food and shelf life of the product. This work therefore, presents the methodology of synthesis, characterization and application of metallic nanoparticles as antimicrobial components for application on biodegradable polymers foreseen as the future packaging materials.

Methodology & Theoretical Orientation: We apply enzymes to synthesize metallic nanoparticles, reveal the kinetics and mechanism of reactions, and characterize nanoparticles by classical (SEMEDX, FTIR, ICPOES, GFAAS) and beyond-state-of-the-art (GEMMA, PDMA, MALDI-TOF-MS/MS) instrumental methods. After synthesis and characterization, the antimicrobial activity of nanoparticles was tested against model microorganisms (*Staphylococcus aureus, Escherichia coli, Candida albicans*) using statistical method design of experiment. Antimicrobial mixtures of nanoparticles were further applied with dip-coating on polymers by sol-gel process using 3-glycidyloxypropyltrimethoxysilane (GLYMO) precursor.

Findings: We produced metallic nanoparticles, optimized their antimicrobial activity and characterized polymers with antimicrobial layers. Enzymatic synthesis of nanoparticles at moderate temperatures ensured mild production conditions and enabled lower energy consumption. In our future work, we plan to produce a prototype of antibacterial biodegradable packaging using additive technology (3D-printing).

Conclusion & Significance: This multidisciplinary research work is significant for different scientific, industrial and technological applications: Enzymatic synthesis of nanoparticles is economically and ecologically favorable approach; usage of biodegradable polymers with metallic nanoparticles is the priority of food and packaging industry; optimization of highest antimicrobial activity of NPs mixture using design of experiment offers an innovation in formulation and; prototyping by 3D printing enables wide variety of additional applications. Therefore, we expect a significant outcome of this project and strengthening further collaboration with our industrial and academic partners.

Biography

Iva Rezić is the Head of Department of Applied Chemistry at University of Zagreb where she leads the group for synthesis and characterization of metallic nanoparticles. She has two PhDs and expertise in Material Science and Characterization, Nanotechnology, Chemical Trace Elements Analysis and Statistical Modeling of Complex Mixtures. She is an Editor-in-Chief of *TEDI* journal, Editor of four and Reviewer of 33 journals. She actively participates as a member of various associations, commissions and committees.

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