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International Conference on

Materials Science and Materials Chemistry

August 20-21, 2018 | Paris, France

Antimicrobial activity of Vancomycin loaded in biomimetic hydroxyapatite and poly (Lactic acid) microcapsules

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Any orthopaedic surgical procedure carries possible bone infection risks, which might be prevented by using bone cement based on combining pure hydroxyapatite, HAP or biomimetic hydroxyapatite, bHAP, poly (lactic acid), PLA, and antibiotic drugs, like vancomycin, VCM, for local drug delivery, and thus overcoming the disadvantages of systemic antibiotic therapy. The goal of the current study was to determine the vancomycin antimicrobial ability by using hydroxyapatites, HAPs, and PLA microcapsules that are biocompatible and nontoxic. Our results show that the initial burst release and total release of active VCM agent can be controlled by using VCM/HAP/PLA or VCM/bHAP/PLA composites in aqueous dispersions. Among bone cement, the biomimetic hydroxyapatite, like multi-substituted hydroxyapatite with Mg, Zn, Sr and Si, HAP-Mg-Zn-Sr-Si, has attracted increased interest due to its osteoconductivity in vivo, thus opening the new opportunities for orthopaedic surgical procedures. In the current investigation, both pure HAP and HAP-Mg-Zn-Sr-Si were prepared by wet chemical methods, without surfactants or template molecules and characterized by XRD, FTIR, TEM, SEM-EDX and AFM. The PLA microcapsules were synthesized and morphologically characterized, by TEM, SEM and AFM. Then, HAPs mixed with vancomycin loaded in PLA microcapsules were synthesized and structurally characterized by XRD, FTIR, TEM, SEM-EDX and AFM. Further, the vancomycin release into the water dissolution medium was quantitatively measured by UV-Vis spectrum, which is characteristic for vancomycin. The vancomycin was released into the dissolution medium from composite microcapsules, within of 4 weeks, compared to vancomycin loaded in pure HAP, where drug release was observed for only about 2 weeks. The release of vancomycin is dependent of the microcapsules (i.e. solid) and dissolution liquid ratio and can be controlled with precision. The antibacterial activities of aqueous dispersions of VCM/HAP/PLA or VCM/bHAP/PLA composites were determined using the inhibition zone assay. High level of inhibition zone was obtained for the aqueous dispersions of both VCM/HAP/PLA and VCM/bHAP/PLA composites, used individually, against four pathogenic species: Staphylococcus aureus, Salmonella typhimurium, Bacillus cereus and Micrococcus luteus. Additionally, a distinct inhibition zone was clearly formed in methicillin-resistant Staphylococcus aureus media for up to 3 weeks incubation, for these composites. This approach can be used for further development of controlled delivery systems of therapeutic vancomycin molecules, for biomedical applications as the coating of metallic implants and as bone grafts in orthopaedic surgery.

Speaker Biography

Gertrud-Alexandra Paltinean graduated from the Faculty of Chemistry and Chemical Engineering of Babes-Bolyai University (bachelor degree, master degree and doctorate). Her activities are focused on the preparation and characterization of nanomaterials based on multisubstituted hydroxyapatite and air pollution, using advanced technologies (UV-Vis, lyophilizer, AFM, STM) from the Physical Chemistry Center where she is a member.

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