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MULTIFUNCTIONAL SURFACES LOADED WITH ANTIMICROBIAL NANOPARTICLES AND STRONTIUM-DOPED HYDROXYAPATITE AS COATINGS OF MEDICAL DEVICES

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Riassunto

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Introduction: Bioactive coatings containing antibacterial and osteoinductive molecules are gaining increasing attention (1), aiming at avoiding bacterial adhesion and surface colonization, and facilitating the integration of the host tissues. For this purpose, the aim of this work was the design and development of antimicrobial NPs-loaded films, doped with Sr^{2+} enriched Hydroxyapatite (SrHA) as bioactive coatings of orthopaedic implants.
Methods: Polylactic acid (PLA) nanoparticles loaded with thymol were manufactured by means of microfluidics and purified by dialysis. Several processes parameters as flow rate ratio (FRR) and total flow rate (TFR) were tested, and their impact was evaluated (PDI, size and zeta potential). In addition, SrHA salts were synthesized by a coprecipitation method (2), and their structure was confirmed by X-ray analysis. Finally, zein films containing NPs-loaded thymol and SrHA were produced by solvent casting techniques. The zein films and their components were characterized by physico-chemical and preclinical properties.
Results: A pre-formulative study on NPs production was carried out using different concentrations of PLA (0.5 – 0.75 and 1% w/v) and for each concentration different FRR was tested (ranging from 1-1 to 8-1). The preliminary results suggested that the best concentration of PLA was 0.75% w/v. Therefore, NPs were produced with a concentration of PLA of 0.75% and loaded with thymol. NPs production showed that the process parameters variation had a significant impact on the particles size and smaller nanoparticles were obtained by increasing the FRR with a zeta potential of -30 mV for all the FRR tested. In addition, encapsulation efficacy (%) of thymol was evaluated showing an encapsulation around the 77% for the ratio 8 – 1 (aqueous to organic). Subsequently, the XRPD and EDS analysis carried out on the SrHA salts confirmed the crystallinity and the presence of the Sr^{2+}. Therefore, SrHA salts (2% w/w) and NPs (10% w/w) were loaded into the zein film and characterized by a multidisciplinary approach. The presence of the SrHA salts seems to improve mechanical properties of the films (compared to unloaded film) and the in vitro characterization suggested that the final systems were biocompatible towards fibroblasts cell and capable to promote cell proliferation.
Conclusions: Zein based films loaded with PLA-thymol NPs and SrHA were successfully developed as coating materials for implants. Further studies are ongoing to assess the antimicrobial and biological properties on mesenchymal cells.

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References:

1) D Pavithra and Mukesh Doble 2008 Biomed. Mater. 3 034003
2) 2) X. Ding et al. ACS Biomater. Sci. Eng. 2019, 5, 4574−4586

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