ELECTROPHORETIC DEPOSITION OF MULTICOMPONENT COATINGS INCORPORATING BIOPOLYMERS, PHYTOTHERAPEUTICS AND BIOACTIVE GLASS FOR BIOMEDICAL APPLICATIONS

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The long-term application of metallic implants is still challenged due to their poor osseointegration capability and susceptibility to bacterial infections. Electrophoretic deposition (EPD) offers the possibility to functionalize the surface of metallic implants by creating composite coatings composed of bioactive materials, biopolymers and herbal drug molecules [1,2]. Thus, the aim of the current work was to develop novel multicomponent coatings with tailored bioactivity and antibacterial activity on titanium by EPD. The natural polymer zein was utilized to encapsulate phytotherapeutic drugs by in-situ antisolvent precipitation method, while the biopolymers sodium carboxymethyl cellulose and chondroitin sulphate were compared in their ability to form biocompatible and biodegradable coating matrix. In order to endow bioactivity and to enhance the antibacterial properties of the coatings copper-doped bioactive glass (CuBG) particles were incorporated. A Taguchi design of experiment (DoE) with an orthogonal array of L_{27} (3^4) type was used to optimize the key suspension and process parameters, including the ethanol content in the suspension, the CuBG concentration, the applied voltage and deposition time, aiming to achieve high deposition yield (DY), low standard deviation (SD) of DY and high signal-to-noise ratio of DY and SD. The deposition mechanisms were explained by zeta potential measurements and current density observations. The morphology, chemical composition, wettability, drug release behavior, roughness, bioactivity and adhesion strength of the coatings were analyzed. Additionally, cytocompatibility tests with osteosarcoma MG-63 and preosteoblast MC3T3-E1 cells, as well as antibacterial assays against Gram-positive *S. aureus* and Gram-negative *E. coli* after 1 and 3 days of incubation were performed. The results showed that the ethanol amount in the EPD suspension and the applied voltage had the highest influence on the deposition mass and the coating homogeneity. The suitable adjustment of the EPD parameters allowed to limit the water hydrolysis and polymer precipitation during processing. Additionally, the CuBG particles were homogeneously embedded in the polymeric matrix, while apatite-like formations could be detected on all composite coatings after immersion in simulated body fluid (SBF), according to FTIR, SEM and EDX analyses. Moreover, the outcomes confirmed that the selection of appropriate polymer matrix can be used to adjust the key physical and biological characteristics of the final coatings. The obtained results prove that the prepared coatings can be promising candidates to facilitate bone tissue integration and to prevent infections around orthopaedic and dental implants.

References:

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