MECHANISMS AND KINETICS OF SILVER NANOPARTICLE RELEASE FROM POLYVINYL ALCOHOL/KERATIN/CHITOSAN ELECTROSPUN NANOFIBROUS SCAFFOLD

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ABSTRACT

Silver nanoparticles (AgNPs), an excellent antimicrobial agent, has received great attention in antimicrobial wound dressing and tissue engineering. Understanding the release and migration behaviour of AgNPs from products containing them is critical. The aim of this study was to assess and understand the release mechanisms of AgNPs from electrospun nanofibrous polymeric system with 3D geometry and establish the best-fitted kinetic model. A 3-dimensional electrospun nanofibrous scaffold (3DENS) incorporating AgNPs was prepared via emulsion electrospinning using Poly(vinyl alcohol) (PVA), keratin, and chitosan polymer solution. A colloidal solution of AgNPs was added to the polymer solution as the antimicrobial agent at concentrations of 8 ppm, 80 ppm, and 400 ppm. The release mechanisms and kinetics of incorporated AgNPs were evaluated in an aqueous medium at different time intervals (1 h, 3h, 6 h, 12 h, 24 h, 48 h, 96 h, and 192 h) was determined by spectrometry using inductively coupled plasma- optical emission spectrometer conjugated with an auto sampler. All measurements were done in triplicate for each 3DENS. Approximately half of the total AgNPs released from the samples occurredduring the first 6 hr after immersion in the releasing medium, thereafter, a gradual increase in the release was observed before reaching an equilibrium. The maximum release of AgNPs was between 25% and 30% for all samples, which took place after 24 hours. After that, no further release was observed. AgNPs release data were fitted to zero order, first order, Higuchi, Hixson, Kopcha, and Korsmeyer-Peppas models to evaluate release mechanisms and kinetics. Release kinetics from scaffolds of the three concentrations were better fitted on the Korsmeyer-Peppas model with adjusted regression coefficients of 0.986, 0.989 and 0.981, respectively. The Korsmeyer-Peppas release exponent (n) indicates that the AgNPs release mechanism was following a non-Fickian diffusion. Therefore, the results of this study could be useful in predicting the AgNPs release rate and understanding the mechanism of release from nanofibrous polymeric products in biomedical application.