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Mechanical Characteristics and Antibacterial Properties of Ag-Poly(Vinyl Alcohol)/ws-Chitosan Hydrogel Nanocomposites Synthesized by γ-Irradiation Combined with Freeze/Thaw Cycles

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Hydrogels have been used successfully in many biomedical applications including scaffolds for wound healing applications or soft tissue implants. A problem for the biomedical application of hydrogels is that microorganisms may grow in hydrogels due to their natural biocompatible properties. Improvement in application of hydrogels is often achieved by the addition of natural polysaccharide or non-specific antimicrobial species such as Ag nanoparticles. The antibacterial bio-synthetic hydrogel nanocomposites consist of blends between water soluble derivatives of radiation processed chitosan (ws-chitosan) and poly(vinyl alcohol) cross-linked by γ-irradiation (via ^{60}Co source) and radiation in situ incorporated Ag nanoparticles (AgNPs). Chitosan is a copolymer composed of glucosamine and N-acetyglucosamine sugars, linked by 1–4 glucosidic bonds, both of which are constituents of mammalian tissues. Chitosan degradation by ionizing radiation gives structural diversity which contributes to its wide application in biomedicine. The radiation technology platform allows synthesis by environmentally friendly and biocompatible radiolytic products of water. The postirradiation hydrogel freeze-thaw procedure was performed to enhance mechanical properties and to prevent liking of un-grafted ws-chitosan during AgNPs synthesis. The thus obtained ws-chitosan, poly(vinyl alcohol)/ws-chitosan polymer matrix and nanocomposites were subjected to molecular weight determination (by Zetasizer), FT-IR, NMR, SEM, elemental analysis and mechanical characterization by thermomechanical analysis, in static stress/strain and dynamic mode. The antibacterial properties against *Escherichia coli* and *Staphylococcus aureus* were assessed by using the agar diffusion test.
Results revealed the partial formation of Maillard reaction products during radiation degradation of chitosan. The non-linear stress-strain data from unconfined compression test were fit by the Kennedy equation and by an elastic model (Rige and Wright). The results indicated changes in matrix mechanical resistance upon incorporation of ws-chitosan. In contrast, AgNP incorporation decreased the polymer matrix elasticity while increasing the cross-linking density of polymer network and provides more rigidity to

the structure which increases the values of storage modules (obtained in dynamic mode) and, as a consequence, causes a better mechanical stiffness of the network. The antibacterial activity of Ag-poly(vinyl alcohol)/ws-chitosan hydrogels show enhanced antibacterial potential in comparing with poly(vinyl alcohol)/ws-chitosan hydrogel matrix only. For investigated hybrid hydrogel, zone of inhibition is greater against *Staphylococcus aureus* than for *Escherichia coli*. This is important for the treatment of wound infections in diabetic patients which are dominantly caused by aerobic Gram-positive cocci. These promising results give possibility for development and optimization of synthesized antibacterial Ag-hydrogel nanosystems.

Country/Organization invited to participate

Serbia

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