Preparation and characterization of smart magnetic hydrogels and its use for drug release

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ABSTRACT

In this work it was synthesized magnetic hydrogels based on chitosan that were successfully fabricated by chemically cross-linking of glutaraldehyde and $MnFe_2O_4$ nanoparticles (ca. 10–50 nm) to be used in biotechnology applications (drug release).
Those hydrogels were cured by two sources of energy γ-radiation (cobalt source with 3, 5, 10 KGy and 60 Watts UV-radiation lamp). For characterization, the hydrogels were dried until constant weight and analyzed by infrared spectra (IR), thermal analyses and UV absorption spectra The IR spectra of dried materials showed characteristic bands of chitosan, attributed to ν_{OH}= and ν_{NH} centered at 3446 cm^{-1}, Amide I band corresponding to $\nu_{C=O}$ vibration (1650 cm^{-1}) of acetyl groups in chitosan. The band Amide III at 1332 cm^{-1}, due to combination of NH deformation and the ν_{CN} stretching vibration and the band due to ν_{C-O} at 1089 cm^{-1}.The magnetic particles showed bands at ca. 600 and 400 cm^{-1} attributed to the stretching ν1 and ν2 from octahedral and tetrahedral sites of crystalline structure respectively. Thermal analyses (TGA/DTGA) showed three events of loss. Molecular absorption spectra in UV-vis showed large bands in visible line of spectra. All swelling behavior is plotted on the average of three trials. The cross-sectional SEM observation demonstrates that the $MnFe_2O_4$ nanoparticles were fairly uniformly distributed in the gel matrix.
The swelling kinetics and time dependent-swelling behaviors of chitosan/glutaraldehyde/ $MnFe_2O_4$ hydrogels was obtained in deionised water (pH 7) and serum solution.
Moreover, in vitro release data reveal that drug release profile of the resulting hydrogels is controllable by switching on or off mode of a given magnetic field. While applying magnetic fields to the magnetic hydrogels, the release rate of vitamin A of the hydrogels was considerably decreased as compared with those when the field was turned off, suggesting a close configuration of the hydrogels as a result of the aggregation of $MnFe_2O_4$ nanoparticles. Based on this on-&-off mechanism, the smart magnetic hydrogels based on the hydrogels ferrite hybrid composites can be potentially developed for application in novel drug delivery systems.

Keywords: Hydrogel; Radiation processing; chitosan; glutharaldehyde, magnetic nanoparticles, drug release