Equilibrium Swelling and Kinetic Studies of Highly Swollen Chitosan Film

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Abstract

The synthesis, characterization and swelling equilibrium of chitosan film in water-solvent mixtures were investigated. Chitosan film was prepared by reacting chitosan with 2% v/v glacial acetic acid. The film was characterized by Fourier transform Infra-red spectroscopy (FT-IR), X-ray diffractometry (XRD) and scanning electron microscopy (SEM) to determine its structure and morphology. The swelling behavior of this chitosan film was further investigated in water-solvent (methanol, ethanol, butanol and acetone) mixtures gravimetrically at different temperatures and pH. The equilibrium and dynamic swelling properties were studied to investigate the pH-sensitive behavior of the gels. The hydrogel demonstrated critical swelling behavior as the pH approached 6.8. The dynamic swelling was performed and the results were analyzed using a second-order model to calculate the time constant of the swelling. The values of percentage equilibrium swelling of chitosan film in water were higher than the values in organic solvents. The values range from 105.23% ± 0.28% to 131.83% ± 0.41% in water but in organic solvents it ranges from 48.68% ± 0.38% to 96.11% ± 0.02%. The results of the swelling measurement in organic solvent were compared with the prediction of the Flory-Rehner theory of swelling equilibrium. It was shown that the theory correctly predicted the swelling behavior of the hydrogel up to 60% solvent concentration. Diffusion behavior was also investigated. The calculated diffusion exponent is greater than 0.5 indicating that the diffusion of solvent into the film was non-Fickian and could be described as anomalous. Generally, the sorption process was found to be endothermic, feasible and spontaneous.

Key words: Chitosan, hydrogel swelling, organic solvents, diffusion, equilibrium.