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Characteristics of Bio-hybrid Hydrogel Materials with Prolonged Release of the Model Active Substance as Potential Wound Dressings

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Abstract : In recent years, biocompatible hydrogels have been used more and more in medical applications, especially as modern dressings and drug delivery systems. The main goal of this research was the characteristics of bio-hybrid hydrogel materials incorporated with the nanocarrier-drug system, which enable the release in a gradual and prolonged manner, up to 7 days. Therefore, the use of such a combination will provide protection against mechanical damage and adequate hydration. The proposed bio-hybrid hydrogels are characterized by: transparency, biocompatibility, good mechanical strength, and the dual release system, which allows for gradual delivery of the active substance, even up to 7 days. Bio-hybrid hydrogels based on sodium alginate (SA), poly(vinyl alcohol) (PVA), glycerine, and Aloe vera solution (AV) were obtained through the chemical crosslinking method using poly(ethylene glycol) diacrylate as a crosslinking agent. Additionally, a nanocarrier-drug system was incorporated into SA/PVA/AV hydrogel matrix. Here, studies were focused on the release profiles of active substances from bio-hybrid hydrogels using the USP4 method (DZF II Flow-Through System, Erweka GmbH, Langen, Germany). The equipment incorporated seven in-line flow-through diffusion cells. The membrane was placed over support with an orifice of 1,5 cm in diameter (diffusional area, 1.766 cm^2). All the cells were placed in a cell warmer connected with the Erweka heater DH 2000i and the Erweka piston pump HKP 720. The piston pump transports the receptor fluid via seven channels to the flow-through cells and automatically adapts the setting of the flow rate. All volumes were measured by gravimetric methods by filling the chambers with Milli-Q water and assuming a density of 1 g/ml. All the determinations were made in triplicate for each cell. The release study of the model active substance was carried out using a regenerated cellulose membrane Spectra/Por®Dialysis Membrane MWCO 6-8,000 Carl Roth® Company. These tests were conducted in buffer solutions – PBS at pH 7.4. A flow rate of receptor fluid of about 4 ml /1 min was selected. The experiments were carried out for 7 days at a temperature of 37°C. The released concentration of the model drug in the receptor solution was analyzed using UV-Vis spectroscopy (Perkin Elmer Company). Additionally, the following properties of the modified materials were studied: physicochemical, structural (FT-IR analysis), morphological (SEM analysis). Finally, the cytotoxicity tests using in vitro method were conducted. The obtained results exhibited that the dual release system allows for the gradual and prolonged delivery of the active substances, even up to 7 days.

Keywords : wound dressings, SA/PVA hydrogels, nanocarrier-drug system, USP4 method
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