HYALURONAN/CHITOSAN HYDROGELS FOR LOCAL DELIVERY OF DOXORUBICIN

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Relevance. Cancer is a leading cause of death worldwide, and conventional treatments like chemotherapy often cause significant systemic toxicity. Targeted drug delivery systems are therefore essential. Hydrogels, with high fluid retention and balanced structure, provide an ideal platform for local, controlled delivery. This study focuses on hyaluronan–chitosan hydrogels for localized doxorubicin delivery. Hyaluronan, a natural polysaccharide, offers biocompatibility and degradability, while chitosan enables high drug loading and promotes cell adhesion. Together, they encapsulate doxorubicin for controlled release at the target site. The inclusion of sodium alginate and polyvinyl alcohol optimizes hydrogel structure and properties, aiming to increase local drug concentration, reduce side effects, and improve treatment outcomes. The study investigates hydrogel preparation, characterization, and performance, highlighting their potential in enhancing cancer therapy and advancing innovative drug delivery strategies.

In this study, we developed a sodium hyaluronate (HA) injectable hydrogel conjugated with doxorubicin (DOX) and cross-linked with low molecular weight chitosan (HA-OCS-DOX), and analyzed the physicochemical properties of the biomaterial. The gel was prepared using various solvent systems (water, DMSO, and DMF) and different molar ratios of HA, chitosan, and DOX (1.0:0.1-0.5:0.05-0.25 mol). Optimal conditions for obtaining injectable hydrogels with the desired physicochemical characteristics were determined by combining variable reaction conditions. To purify the obtained hydrogel samples from additional products, washing, centrifugation, and dialysis methods were employed. The prepared samples were analyzed structurally and physicochemical analyzed using IR and UV spectroscopy techniques. The prepared injectable gel exhibited characteristic signals in the IR spectra of natural biomaterials, corresponding to the O-H, N-H, C6-H, amid-II, C-O-C, and C-C bonds from HA, chitosan, and DOX, found at 3200-3600 cm^{-1}, 2960 cm^{-1}, 1577 cm^{-1}, 1066 cm^{-1}, and 600-894 cm^{-1}, respectively. The presence of HA in the gel was evidenced by distinct signals of the N-acetyl group C=O at 1659 cm^{-1} and the carboxylate ion C=O bond at 1633 cm^{-1}. Additionally, characteristic signals for the C=O and C=C (aromatic ring) symmetric and asymmetric stretching vibrations of DOX were observed at 1721 cm^{-1} and 1560-1650 cm^{-1}, indicating the presence of the drug within the hydrogel. Changes in the intensity of amid (I/II/III) bonds within the range of 1310-1558 cm^{-1} suggest that the molecules are interconnected through amid (-CO−N(H/R)-) linkages. The loaded DOX amounts (0.009-0.065%, wet wt.) in the HA-OCS-DOX hydrogels were measured by UV spectrophotometric method.

In conclusion, this study synthesized gel-based biomaterials containing doxorubicin (HA-OCS-DOX) from sodium hyaluronate and chitosan. FTIR analysis of the gel-based biomaterials showed characteristic vibrations for DOX, including C=O stretching at 1721 cm^{-1} and aromatic C=C vibrations in the range of 1560-1650 cm^{-1}, confirming its successful incorporation. This HA-OCS-DOX hydrogel offers new opportunities for improving cancer treatment strategies by enhancing local drug concentration and minimizing side effects compared to traditional chemotherapy.