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Characterization Of Hybrid Hydrogels Combining Natural Polymers

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Abstract

Hydrogels have been proposed as promising candidates in biomedical engineering, biomaterials research, and soft tissue modelling. The unique properties of hydrogels, such as excellent biocompatibility, degradation abilities, and ability to form chemical bonds between macromolecules, make them valuable in a variety of applications [1]. Using different types of polymeric materials allows for fine-tuning of chemical and physical properties within the resultant hydrogel, which may be critical to drug partitioning, physiological compatibility, chemical stability, environmental response, and mechanical integrity [2,3]. However, there are still challenges for achieving successful design of a hydrogel in biomedical applications.

In this study, our aim is to design more suitable hybrid hydrogel scaffolds for biomedical applications, which can show the healing effect of adding natural polymers to the scaffold structure. Four different methods, namely swelling behaviour analysis, rheometry, fourier-transform infrared spectroscopy (FT-IR), and scanning electron microscopy (SEM) were employed to assess and compare the properties of hydrogels.

Hydrogel H2 is formed by blending natural gelatin polymers with synthetic PEG polymers, while hydrogel H3 is obtained by chemically bonding gelatin polymer chains to PEG polymers during crosslinking using UV light. The results revealed that the hybrid hydrogel (H3) formed through the chemical bonding of gelatin to PEG exhibited superior properties in the final hydrogel structure compared to the pure PEG hydrogel (H1). These advantages included improved durability and pore sizes conducive to cell accommodation in tissue engineering applications.

When evaluating the swelling behaviour, H3 demonstrated a higher swelling ratio compared to H2, indicating a greater water absorption capacity. Rheometry data showed no significant difference in degradation rates between H2 and H3, suggesting that the chemical bonding of gelatin to PEG did not significantly impact the degradation behaviour of the hydrogel. SEM images supported this observation by illustrating that H3 was significantly more porous than H2.

FT-IR analysis confirmed the presence of similar compounds in all three hydrogel samples, with the exception of the varying permeability of the C=O bond of PEG. SEM images show that porous structures are observed in the hydrogels, which would be expected of them to provide cell migration, proliferation, and emplacement.

In conclusion, the results show that the composition of Gel-MA and PEG (H3) is the most promising among the three hydrogels for biomedical applications. This conclusion is based on its enhanced physical and chemical properties, high swelling capacity, and pore structure suitable for future cell placement in tissue engineering.

References

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