PREPARATION AND CHARACTERIZATION OF BIO-HYBRID HYDROGEL MATERIALS

DAGMARA MALINA[1]*, KATARZYNA BIALIK-WĄS[2], KLAUDIA PLUTA[1]

[1] INSTITUTE OF INORGANIC CHEMISTRY AND TECHNOLOGY, CRACOW UNIVERSITY OF TECHNOLOGY, POLAND
[2] INSTITUTE OF ORGANIC CHEMISTRY AND TECHNOLOGY, CRACOW UNIVERSITY OF TECHNOLOGY, POLAND
*E-MAIL: DAGMARA.MALINA@PK.EDU.PL

[ENGINEERING OF BIOMATERIALS 158 (2020) 30]

Introduction

In recent decades, research attention has been focused on the development of modern hydrogel dressings due to their open porous structure, moisture retention, and good mechanical strength, ensure an optimal environment for cell migration and proliferation [1-5]. Therefore, the main goal of the presented research was to obtain bio-hybrid hydrogel matrices modified with the carrier-drug system [2,3]. Active hydrogel dressings, currently available on the market, do not have additional medicinal substances, therefore, the authors were made attempts to introduce a carrier-drug system into the hydrogel matrix to improve the wound healing process and its recovery.

Materials and Methods

The first stage of research concerned the synthesis of thermosensitive polymeric carriers by radical polymerization reaction in optimally selected reaction conditions. Then, the active substance (hydrocortisone) was introduced into polymeric carriers - the amount of the drug was selected on the basis of ointments available on the market. The systems were subjected to DLS analysis to determine the average particle sizes. In a further stage, bio-hybrid sodium alginate/poly(vinyl alcohol) based hydrogel matrices modified with various carrier-drug systems were obtained. The conducted research included the assessment of physicochemical properties of obtained hydrogel matrices i.e. determination of gel fraction, degree of hydrogel swelling, degradation studies as a function of pH and conductivity changes of distilled water and simulated body fluid in time. Additionally, the chemical structure of obtained hydrogels was confirmed using FT-IR spectroscopic technique.

Results and Discussion

The size of the drug carriers is an extremely important parameter. In this study, the analysis of the average particle size of a thermosensitive polymer carrier was 118 nm. In turn, analysis of the encapsulated carriers showed that both the amount of drug introduced and the encapsulation time directly affect the average particle size. The thermosensitive carrier containing 25 mg of the drug is characterized by an average particle size of 391 nm, while after the introduction of 50 mg of the drug it increases to 617 nm. FIG. 1. shows the average particle size of a thermosensitive polymer carrier - drug system containing 50 mg of drug in varied mixing time.

The gel fraction value (%GF) represents the insoluble gel fraction as a result of inter-molecules crosslinking formation. The obtained bio-hybrid hydrogel matrices with the carrier-drug system are characterized by higher levels of crosslinking (approx. 65%) compared to materials containing no active substance (approx. 60%).

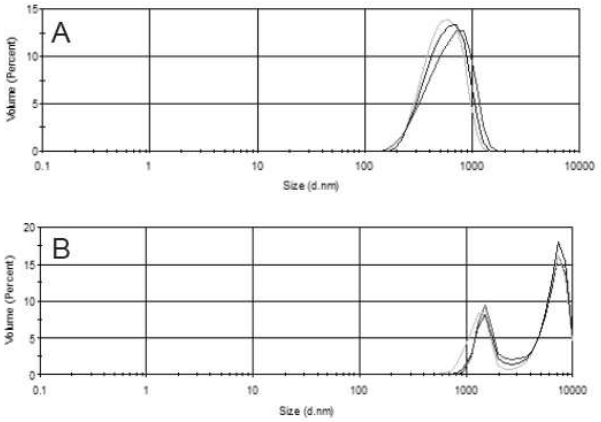

FIG. 1. The average particle size of the thermo-sensitive carrier-drug system, containing 50 mg of the drug after 10 min (A) and 24 h (B) mixing time.

The results of swelling tests indicate that the obtained bio-hybrid hydrogel matrices show a slightly higher absorption capacity in the water environment than the phosphate buffer. Based on the conducted research, it can be concluded that systems containing a higher concentration of the drug have greater sorption capacity in each of the media used. This is due to the fact that the packing density of the chains in the hydrogel matrix decreases as the additional components in the system increase. If a higher concentration of the drug is used, which is then released from the hydrogel matrix, additional gaps are created that can replace the absorbed fluid.

The analysis of FT-IR spectra confirms the chemical structure of the obtained bio-hybrid hydrogel matrices. In the case of modifications with a thermosensitive carrier, a much more intense band can be observed in the 3200-3500 cm^{-1} range, which most likely originates from the strong hydrogen interactions that occur between individual components. This is also confirmed by the determined %GF, which in the case of bio-hybrid matrices containing a thermosensitive carrier was the largest, which indicates a significant cross-linking of the matrix.

Conclusions

Based on the obtained results and observations, it can be concluded that the bio-hybrid hydrogel matrices are stable materials, and exhibit desirable features from the point of view of wound care applications. The conducted research may prove to be an important step in the fight against skin diseases and by developing new bio-hybrid hydrogel matrices modified with antibacterial agents, including antibiotics, nanoparticles, peptides or metal ions.

Acknowledgments

This research was supported by The National Centre for Research and Development — project LIDER/41/0146/L-9/17/NCBR/2018.

References

[1] S. Utech, A.R. Boccaccini, J. Mater. Sci. 51 (2016) 271-310.
[2] E.A. Kamoun, E.R.S. Kenawy *et al.*, J. Adv. Res. 8 (2017) 217-233.
[3] T.R.R. Singh, G. Laverty *et al.*, CRC Press; 1 edition, 2018.
[4] M. Ding, L. Jing *et al.*, Mater. Today Adv. 8 (2020) 100088.
[5] A. R. Abbasi, M. Sohail *et al.*, Int. J. Biol. Macromol. 155 (2020) 751-765.