Biohybrid Hydrogel Membranes with Doxycycline or Silver Nanoparticles with Applications in Wound Management

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Complex injuries often necessitate specialized medical interventions[1], and hydrogels have emerged as a favoured option for treating such wounds due to their distinctive attributes and the capacity to integrate and release therapeutic substances [2]. Our primary objective was to formulate and characterize an optimized biohybrid hydrogel membrane that combines natural and synthetic polymers, along with bioactive compounds such as collagen, hyaluronic acid [3], and pharmacologically active substances like doxycycline [4] or silver nanoparticles [5]. Oscillatory rheometry confirmed the robust gel-like characteristics of the resulting hydrogel membranes.

Our results showed that the obtained hydrogel membranes have suitable characteristics for the intended applications. Hydrogel samples containing a low dose of doxycycline exhibited a swelling index of 285.68 ± 6.99%, a degradation rate of 71.6 ± 0.91% at 20 hours, and achieved a cumulative drug release of approximately 90% at pH 7.4 and 80% at pH 8.3 within 12 hours. The introduction of npAg influenced the physical properties of the hydrogel membranes. Additionally, doxycycline containing samples demonstrated remarkable antimicrobial efficacy against seven commonly encountered bacterial strains associated with wound infections and complications. Biocompatibility assessments revealed that the samples maintained over 80% cell viability. However, the inclusion of smaller-sized nanoparticles resulted in reduced cellular viability. The obtained biohybrid hydrogel membranes exhibit favourable characteristics, making them suitable for use as wound dressings.

References

[1] E.M. Tottoli, R. Dorati, I. Genta, et al., *Pharmaceutics.* **2020**, *12*, 735.

[2] E. Rezvani Ghomi, M. Niazi, S. Ramakrishna, *Polym. Adv. Technol.* **2023**, *34*, 520.

[3] S. Mousavi, A.B. Khoshfetrat, N. Khatami, et al., *Biochem. Biophys. Res. Commun.* **2019**, *518*, 625.

[4] J. Stechmiller, L. Cowan, G. Schultz, *Biol. Res. Nurs.* **2010**, *11*, 336.

[5] I.X. Yin, J. Zhang, I.S. Zhao, et al., *Int. J. Nanomedicine.* **2020**, *15*, 2555.