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DEVELOPMENT OF HYBRID MATERIALS FOR ACCELERATED WOUND HEALING BASED ON BACTERIAL CELLULOSE AND HYDROXYAPATITE

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Introduction. Bacterial cellulose (BC) is a natural polymer characterized by its remarkable mechanical strength, elasticity, biocompatibility, and biodegradability. This substance finds application across diverse domains; however, it is predominantly recognized for its utilization in biomedical fields, including wound dressings and drug delivery systems [1]. A prevalent approach involves the fabrication of hybrid materials utilizing bacterial cellulose to enhance its inherent properties. The principal hypothesis of our research posited that the integrating of cellulose with hydroxyapatite (HA), the main inorganic compound of natural bones, would prolong the release of pharmaceuticals from the cellulose matrix. There exists a substantial demand for controlled drug release systems. The gradual and regulated release of active substances is anticipated to diminish the frequency of drug administration while simultaneously augmenting treatment efficacy [2].

Main part. For the fabrication of hybrid materials, we employed the technique known as pattern formation. This approach is relatively uncomplicated and does not require sophisticated apparatus or protocols, thereby it is less time-consuming in comparison to conventional in situ synthesis methodologies [3]. Furthermore, this technique is likely to yield a more homogenous distribution of hydroxyapatite within the cellulose matrix, as opposed to surface deposition strategies frequently used in biomimetic mineralization [4].

To assess the structural, quantitative, and qualitative properties of the synthesized materials, we utilized established methodologies such as scanning electron microscopy (SEM), atomic force microscopy (AFM), Fourier transform infrared spectroscopy (FTIR), and X-ray diffraction analysis (XRD). We selected ultraviolet–visible (UV-Vis) spectroscopy to examine the interactions with tetracycline hydrochloride (TET), a prevalent antibiotic chosen as a model drug substance. The antibacterial efficacy of the TET-encapsulated materials was evaluated against *Thermophilic streptococcus* strains. Molecular docking techniques were employed to analyze the binding affinity of TET to BC and HA.

Conclusions. It has been shown that when HA patterns are added, the total time of antibiotic release from cellulose increases by 24 hours. The rougher surface of hybrid materials compared to pure cellulose promotes better cell proliferation and differentiation. Using FTIR spectroscopy, it was found that TET binds to the material due to hydrogen bonds. This binding mechanism is optimal because it allows the antibiotic to attach to the cellulose surface, but the bond remains weak enough for tetracycline to be easily released. The lower value of the Gibbs free energy obtained from molecular docking indicates that TET binds better to HA than to BC. It suggests that the hybrid material will retain the antibiotic better than pure cellulose, which is consistent with experimental data.

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