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Carica papaya loaded PVA-Gelatin nanofibrous scaffold: a wound dressing material

Every year millions of people worldwide encounter mishaps that may arise from burns, surgery, accidents, or chronic diseases compromising the skin's integrity. These incidents can either result in lifelong functional impairment of the affected part of the body or may ultimately cause an individual's death due to microbial invasion and wound infection. One promising approach to promote skin regeneration is developing a nanofibrous scaffold that can mimic the native extracellular matrix and is capable of supporting cell adhesion, proliferation, and differentiation. Therefore, we have synthesized a drug-loaded nanofibrous scaffold using the electrospinning technique as a wound dressing material in the present work. The nanofibrous scaffold is used for various biomedical applications due to its ability to serve as an excellent framework for cell adhesion, proliferation, and maturation leading to new tissue formation. Our starting material choice is unique as we have blended two biodegradable polymers, namely polyvinyl alcohol (PVA), a synthetic material, with gelatin (gel), a natural polymer. Gel is a biopolymer with excellent biocompatibility, biodegradability, inexpensive, and is an excellent alternative to collagen, a major extracellular matrix component. However, it is challenging to synthesize nanofibrous scaffolds of gel alone. Also, gel suffers stability issues and has low bioavailability, which may affect the wound healing process. Therefore, PVA was used as the supporting material to develop the nanofibrous scaffold.

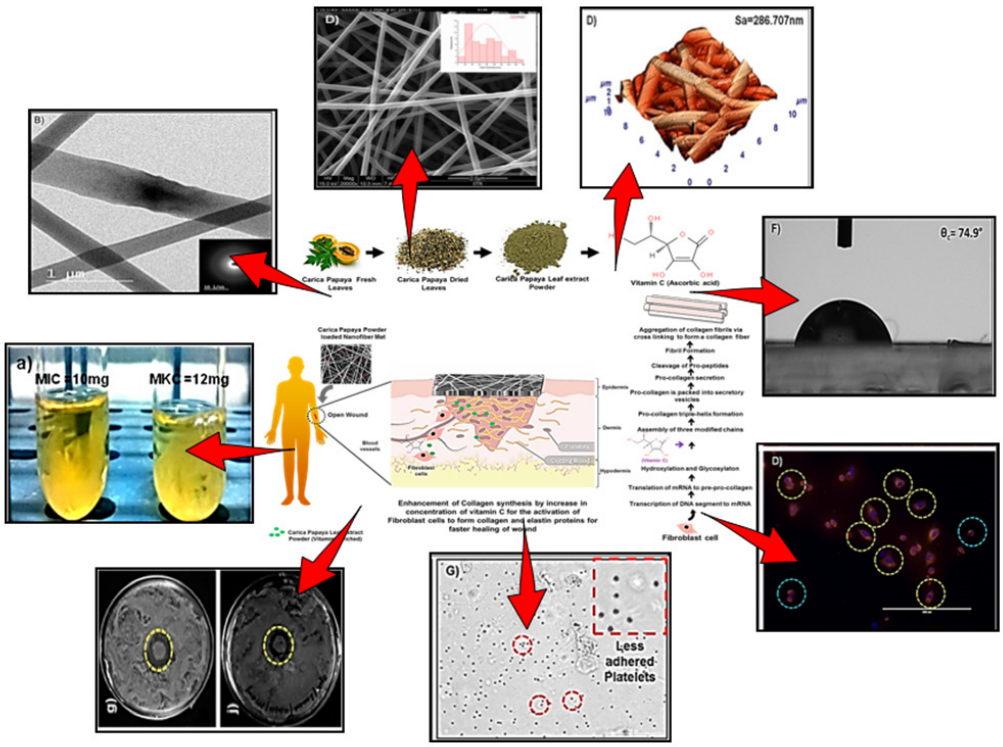

Fig. 1.

PVA is non-toxic, water-soluble, and is chemically stable. Nevertheless, this synthetic polymer suffers a significant drawback, which is poor cell adhesion property. Therefore, PVA/gel were mixed in different ratios in the present work, and various scaffolds were synthesized (10:0, 9:1, 8:2, 7:3…..0:10). The scaffold with PVA/Gel in the ratio 7:3 was observed to be the most stable and devoid of beads. Therefore, this ratio was chosen for further studies. Another advantage of our scaffold was its sustainable nature, i.e., synthesis at room temperature and no toxic solvents such as Hexafluoroisopropanol and 2,2,2-Trifluoroethanol. Carica papaya was used as the drug because of its antibacterial and wound healing activity. The nanoscaffold allowed the controlled and sustained release of the drug from its interior, establishing an optimal wound repair environment. The as-synthesized Carica papaya-loaded PVA/Gel scaffold was first physicochemically characterized using various analytical techniques such as scanning electron microscopy (morphology and diameter of the nanoscaffold), transmission electron microscopy (morphology and drug loading), X-ray diffraction (to validate the amorphous nature of our as-synthesized nanoscaffold), Fourier-transform infrared spectroscopy (to understand the surface chemistry and drug loading), contact angle measurement (to determine the hydrophilicity of our drug-loaded nanoscaffold), and atomic force microscopy (to determine the surface roughness of our as-synthesized drug-loaded nanofibrous scaffold). After understanding the surface chemistry, morphology, and drug loading inside the nanofibrous scaffold, its potential as a broad-spectrum antibacterial material was tested against the Gram-positive (*S. aureus*) ad Gram-negative (*E. coli*) bacteria.

The non-toxicity and biocompatibility of our as-synthesized drug-loaded nanofibrous scaffold were tested using the MTT assay. Live and dead cell imaging was performed using fluorescent microscopy using Hoechst (DNA binding dye) and Rhodamine B (stains the cytoplasm) dyes. The high surface area and microporous nature of our nanoscaffold allowed fibroblast adhesion, proliferation, and differentiation. Finally, the hemocompatibility of our drug-loaded nanofiber was tested using the goat blood. The obtained data showed fewer adhered platelets (comparable to the negative control) onto the drug-loaded scaffold's surface compared to PVA/Gel alone. This could be attributed to the presence of Carica papaya inside the nanofiber. Hence, from the obtained data, it is clear that our as-synthesized drug-loaded nanofibrous scaffold is amorphous, non-toxic, antibacterial, and hemocompatible, making it a desirable candidate for wound dressing application.

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