博　士　論　文　の　内　容　の　要　旨

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論文題目	Study on fabrication of bioactive polymeric fibers for wound care and bone regeneration. 創傷被覆材および骨再生治療効果を有した生体活性高分子繊維の作製に関する研究

（博士論文の内容の要旨）

Over the past few decades, different spinning techniques have been explored for their abilities to fabricate complex fibrous structures having great potential for biomedical applications. The biocompatible and biodegradable systems made of polymeric fibers are of great interest in biomedicine, particularly in wound healing due to their high surface-to-volume ratio, interconnected structure, open pore structure, and tunable surface and mechanical properties, apart from utilizing inherent properties of the polymers used in the production of the fibrous scaffolds. The modern fiber spinning techniques also allow us to incorporate bioactive components within their matrix, making it possible to deliver them topically to the targeted areas, which can be beneficial for improving the healing process.

Bio-textiles based on natural, regenerative, and synthetic fibers are highly desirable in regenerative applications. They are designed for their use in a specific biological environment, where they are evaluated for their interaction with the cells and other biological fluids and measured as biocompatibility and biostability.

Electrospinning is a versatile technique for development of a wide variety of nanofibers. It is employed for developing electrospun fibers for a wide range of applications from separations membranes to tissue engineering. Electrospinning has improved the qualities of the pristine polymers by enabling the incorporation of nanoparticles and other bioactive compounds, and this have been particularly important for the tissue engineering applications, drug delivery, and wound care; the three themes of regenerative medicines. Nanofibers are an important material for regenerative medicine as they can mimic the morphology of the extracellular matrix and can support and hold the growth of cells and tissues within the body. Nanofiber’s functionality can be extended by incorporating them with other bioactive compounds and materials.

In the present work we explored electrospinning technique to develop bioactive compounds incorporated polymeric nanofibers for wound care and bone tissue engineering. We evaluated their physicochemical and biological properties as potential scaffolds for regenerative applications.

Chapter 1 provides an overview of the thesis book, including previous literature about fibrous scaffolds for regenerative medicine and related techniques used to manufacture fibrous scaffolds for tissue engineering.

Chapter 2 concludes a study on Manuka honey incorporated cellulose acetate nanofibrous mats as a potential wound dressing. Here we report the fabrication of cellulose acetate (CA) - manuka honey (MH) composite nanofibrous mats as a biocompatible and antimicrobial wound dressing. CA mats with different quantities of MH were developed by electrospinning. The ATR-FTIR spectra confirm the inclusion of MH in the composite CA-MH nanofibrous mats. The fibers were continuous and bead-free with good mechanical properties. The fiber diameter increased with an increase in MH content. Inclusion of MH in the electrospun composite CA-MH nanofibrous mats shows high efficacy in preventing bacterial growth on the wound surface. The MH-loaded CA nanofiber mats showed good antioxidant abilities. In contrast, the ability to free radicalize the DPPH depended on the factors of MH content in the fiber and the time of immersion in the DPPH solution. Besides, the nanofibrous mat’ s high porosity (85 - 90 %) and WVTR values of 2600 to 1950 g/m2/day, suitable for wound breathability, and the mats show high cytocompatibility to NIH3T3 cell line in in-vitro testing, proving to be effective for promoting wound healing.

Chapter 3 concludes a study on essential oil incorporated cellulose acetate nanofibrous matrix for antibacterial, and antioxidant wound dressing. Blumea balsamifera oil-loaded cellulose acetate nanofiber mats were prepared by electrospinning. The inclusion of blumea oil increased the nanofiber diameter. FTIR spectra confirm the addition of blumea oil in the nanofiber mats. The XRD pattern suggests that the inclusion of blumea oil has caused a misalignment in the polymer chains of the cellulose acetate. Thus, a decrease in the tensile strength was observed for the blumea oil-loaded nanofibers. The increase in fiber diameter causes a reduction in the porosity of the nanofiber mats. The blumea oil-loaded nanofiber mats showed antibacterial efficacy against Escherichia coli and Staphylococcus aureus. The blumea oil showed antioxidant abilities against the DPPH solution. MVTR of the neat and blumea oil-loaded nanofiber mats were in the range of 2450 - 1750 g/m2/day, which is adequate for the transport of air and moisture from the wound surface. Blumea oil-loaded mats showed good cell viability ~92% for NIH 3T3 cells in more extended incubation periods. A biphasic release profile was obtained, and the release followed the first-order kinetics depending upon the highest value of the coefficient of correlation R2 (88.6 %).

Chapter 4 summarizes the work focused on developing the illite clay-based nanofibrous scaffold for bone tissue engineering. The research work was based on the hypothesis that illite an aluminosilicate addition in the nanofibrous scaffold will help in improving the hydroxyapatite mineralization on the prepared scaffold. Furthermore, the prepared scaffolds were subjected to detailed *in vitro* biological evaluation using MC3T3-e1 cells to determine the osteoconductivity of the as-prepared scaffolds. The research work concludes that the addition of the illite improved the biomineralization of the prepared scaffolds but also helped MC3T3-e1 cells to differentiate into osteoblasts. The study concludes that there is a need for a detailed *in vivo* evaluation of the prepared scaffolds before subjecting them to the practical environment.