SYNTHESIS AND CHARACTERIZATION OF CELLULOSE FIBERS CLOTHS FOR TISSUE ENGINEERING

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MASTER OF SCIENCE

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SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Science.

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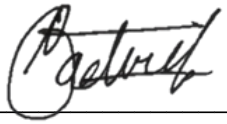
STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.



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ABSTRAK

Selulosa tergolong dalam kelas bahan yang boleh diperbaharui kerana dapat dihasilkan daripada banyak sumber yang berkaitan dengan tanaman dan telah mendapat perhatian besar dalam waktu terkini untuk mengurangkan beban persekitaran dari perlombongan untuk bahan berfungsi dan juga untuk mengurangkan jejak karbon. Selulosa dari sekumpulan tandan buah kosong (EFB) perkebunan kelapa sawit berkembang menjadi perancah untuk memperluas penggunaannya dalam kejuruteraan tisu kulit kerana dapat meniru struktur matriks ekstraselular (ECM) yang berfungsi untuk percambahan, pembezaan dan keterikatan sel. Selulosa asetat (CA) adalah turunan selulosa, salah satu polimer semula jadi yang mudah digunakan untuk menghasilkan perancah serat. Objektif utama penyelidikan ini adalah untuk membuat perancah serat berdasarkan CA untuk aplikasi kejuruteraan tisu kulit dengan teknik elektrospin. Kajian boleh dikategorikan kepada dua bahagian utama. Bahagian pertama memfokuskan pada fabrikasi tikar serat CA menggunakan kaedah elektrospinning dan bahagian kedua adalah pencirian perancah melalui mikroskopi elektron imbasan pelepasan medan (FESEM) pantulan total yang dilemahkan - inframerah transformasi Fourier (ATR-FTIR) analisis termogravimetrik (TGA) Difraksi sinar-X (XRD, sudut hubungan dan ujian MTT untuk menilai prestasi perancah. Pertama, serbuk CA dilarutkan dalam campuran asid asetik dan aseton. Kemudian, kepekatan CA (13%) dengan poli (ε-caprolactone) (PCL) (15%) disediakan dan dicampurkan dalam nisbah yang berbeza (90%) kandungan CA dan elektrospun untuk mendapatkan perancah serat halus dan bebas manik. Hasil ATR-FTIR menunjukkan bahawa interaksi antara kumpulan fungsional CA dan PCL dalam campuran. Seterusnya, semua lengkung TGA menunjukkan tren yang serupa bermaksud bahawa semua perancah mempunyai jumlah komponen yang serupa diuraikan. Peningkatan hidrofilik berkaitan dengan ikatan hidrogen antara komponen. Hidrofilik yang lebih baik menyumbang kepada peningkatan pembengkakan perancah; PCL / CA / Cur (0.5%) dan PCL / CA / Cur (1.0%) menunjukkan pembengkakan masing-masing ~ 700 dan 950%, di PBS. Kajian pelepasan ubat menunjukkan pelepasan ubat kumulatif tertinggi 60% dan 78% untuk PCL / CA 5%. Bahagian kedua penyelidikan memfokuskan pada kajian sitotoksisiti percambahan sel dan morfologi permukaan perancah serat berdasarkan ujian MTT. Kajian in-vitro menunjukkan bahawa PCL / CA / Cur (0.5 wt.%) dan PCL / CA / Cur (1.0 wt.%) perancah serat memudahkan percambahan sel fibroblas yang tinggi daripada perancah lain tanpa curcumin. Ini menunjukkan bahawa perancah dengan kandungan kurkumin tidak beracun dan biokompatibel untuk memulakan percambahan sel untuk memperbaiki tisu yang telah rosak.

ABSTRACT

Cellulose belongs to the class of renewable material as they can be produced from many plant-related resources and has received tremendous attention in recent time for reducing the environmental burden from mining for functional materials as well to decrease carbon footprint. Cellulose from empty fruit bunch (EFB) of oil palm plantation is developing into scaffolds to widen their application in skin tissue engineering as it can imitate the structure of extracellular matrix (ECM) that functions for proliferation, differentiation and attachment of the cells. Cellulose acetate (CA) is a cellulose derivative, one of the natural polymers that can easily be used to produce fiber scaffolds. The main objective of this research is to fabricate fiber scaffolds based on CA for skin tissue engineering applications by electrospinning technique. The studies can be categorized into two main parts. The first part focuses on fabricating the fiber mats of CA using electrospinning method and the second part is the characterization of the scaffolds via FESEM, ATR-FTIR, TGA, XRD, contact angle and MTT assay to evaluate the performance of the scaffolds. Firstly, CA powder were dissolved in a blend of acetic acid and acetone. Then, the concentration of CA (13%) with poly(ε-caprolactone) (PCL) (15%) was prepared and mixed in different ratios (90%) of CA content and electrospun to obtain smooth and bead-free fiber scaffolds. The ATR-FTIR results showed that the interactions between functional groups of CA and PCL in the mixtures. Next, all the TGA curves showed similar trends means that all the scaffolds had similar amount of component were decomposed. The hydrophilicity enhancements are related to the hydrogen bonding between the components. The improved hydrophilicity contributed to improved swelling of the scaffolds; the PCL/CA/Cur (0.5%) and the PCL/CA/Cur (1.0%) showed swelling of ~700 and 950%, respectively, in PBS. The drug-release studies showed the highest cumulative drug release of 60% and 78% for PCL/CA/Cur (0.5%) and PCL/CA/Cur (1.0%) fiber, respectively. The second part of the research focused on the cytotoxicity studies of the cell proliferation and surface morphology of the fiber scaffolds based on MTT assays. The in-vitro studies showed that PCL/CA/Cur (0.5 wt.%) and PCL/CA/Cur (1.0 wt.%) fiber scaffolds facilitate a higher proliferation of fibroblast cells than other scaffolds without curcumin with 223.46% and 309.21% respectively. This demonstrated that the scaffolds with curcumin content was nontoxic and biocompatible to initiate the cell proliferation for repairing broken tissues.

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