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Development of PCL/Chitosan Core-Shell Electrospun Structures

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Abstract : Skin tissue engineering is a promising field for the treatment of skin defects using scaffolds. This approach involves the use of living cells and biomaterials to restore, maintain, or regenerate tissues and organs in the body by providing; (i) larger surface area for cell attachment, (ii) proper porosity for cell colonization and cell to cell interaction, and (iii) 3-dimensionality at macroscopic scale. Recent studies on this area mainly focus on fabrication of scaffolds that can closely mimic the natural extracellular matrix (ECM) for creation of tissue specific niche-like environment at the subcellular scale. Scaffolds designed as ECM-like architectures incorporating into the host with minimal scarring/pain and facilitate angiogenesis. This study is related to combining of synthetic PCL and natural chitosan polymers to form 3D PCL/Chitosan core-shell structures for skin tissue engineering applications. Amongst the polymers used in tissue engineering, natural polymer chitosan and synthetic polymer poly(ε-caprolactone) (PCL) are widely preferred in the literature. Chitosan has been among researchers for a very long time because of its superior biocompatibility and structural resemblance to the glycosaminoglycan of bone tissue. However, the low mechanical flexibility and limited biodegradability properties reveals the necessity of using this polymer in a composite structure. On the other hand, PCL is a versatile polymer due to its low melting point (60°C), ease of processability, degradability with non-enzymatic processes (hydrolysis) and good mechanical properties. Nevertheless, there are also several disadvantages of PCL such as its hydrophobic structure, limited bio-interaction and susceptibility to bacterial biodegradation. Therefore, it became crucial to use both of these polymers together as a hybrid material in order to overcome the disadvantages of both polymers and combine advantages of those. The scaffolds here were fabricated by using electrospinning technique and the characterizations of the samples were done by contact angle (CA) measurements, scanning electron microscopy (SEM), transmission electron microscopy (TEM) and X-Ray Photoelectron spectroscopy (XPS). Additionally, gas permeability test, mechanical test, thickness measurement and PBS absorption and shrinkage tests were performed for all type of scaffolds (PCL, chitosan and PCL/chitosan core-shell). By using ImageJ launcher software program (USA) from SEM photographs the average inter-fiber diameter values were calculated as 0.717±0.198 µm for PCL, 0.660±0.070 µm for chitosan and 0.412±0.339 µm for PCL/chitosan core-shell structures. Additionally, the average inter-fiber pore size values exhibited decrease of 66.91% and 61.90% for the PCL and chitosan structures respectively, compare to PCL/chitosan core-shell structures. TEM images proved that homogenous and continuous bead free core-shell fibers were obtained. XPS analysis of the PCL/chitosan core-shell structures exhibited the characteristic peaks of PCL and chitosan polymers. Measured average gas permeability value of produced PCL/chitosan core-shell structure was determined 2315±3.4 g.m-2.day-1. In the future, cell-material interactions of those developed PCL/chitosan core-shell structures will be carried out with L929 ATCC CCL-1 mouse fibroblast cell line. Standard MTT assay and microscopic imaging methods will be used for the investigation of the cell attachment, proliferation and growth capacities of the developed materials.

Keywords : chitosan, coaxial electrospinning, core-shell, PCL, tissue scaffold
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