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ORIGINAL PAPER

Preparation and characterization of biomimetic tussah silk fibroin/chitosan composite nanofibers

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Abstract Tussah silk fibroin (TSF)/chitosan (CS) composite nanofibers were prepared to mimic extracellular matrix by electrospinning with hexafluoroisopropanol (HFIP) as a solvent. The viscosity and conductivity of TSF/CS blend solution were analyzed and the morphology, secondary structure, and thermal property of TSF/CS composite fibers were investigated by SEM, ^{13}C CP/MAS-NMR, X-ray diffraction, and DSC Techniques. The electrospinnability of TSF solution was improved significantly by adding 10 wt% CS, and morphology of electrospun TSF nanofibers changed from flat strip to cylindrical. At the same time, the average fiber diameters decreased from 542 to 312 nm, accompanying by an obvious improvement in fiber diameter uniformity. However, when the CS content in blend solution was more than 15 wt%, the diameter of electrospun TSF/CS nanofibers appeared to be polarized which can be attributed to phase separation of the two components in composite nanofibers. Blending 10 wt% CS did not change the conformation of TSF in TSF/CS composite nanofibers, and TSF in composite nanofibers at various composition ratios had mainly taken the α-helix structure. The thermal decomposition temperature of electrospun TSF/CS composite nanofibers decreased with the increase of CS content due to the lower decomposition temperature of CS. To study the cytocompatibility and cell behavior on the TSF/CS nanofibers, human renal mesangial cells were seeded onto electrospun TSF/CS composite nanofibers. Results indicated that the addition of CS promoted cell attachment and spreading on TSF nanofibers significantly, suggesting that electrospun TSF/CS composite nanofibers could be a candidate scaffold for tissue engineering.

Keywords Tussah silk fibroin · Chitosan · Electrospinning · Nanofiber

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Introduction

The natural extracellular matrix (ECM) proteins in the body, which provide mechanical support and regulate cell activities, are mainly composed of collagen and proteoglycans whose compositions depend on tissue type [1]. Constructing the tissue engineering scaffolds that mimic the natural ECMs as the environment of cell growth, proliferation, and functional expression has always been an important topic of tissue engineering field. Nanofiber scaffolds prepared by electrospinning have high specific surface area, porosity, and porous 3-D structure which can be applied in tissue regeneration and repair field widely, and these scaffolds can mimic the structural characteristics of natural ECMs better in contrast to traditional scaffolds [2].

Collagen is the structural protein of ECM, but poor mechanical properties, rapid degradation in aqueous solution, and complicate extraction process limit its use in certain medical applications, particularly in vivo applications including tissue engineering. Silk fibroin is another structural protein having simple extraction process. Silk fibroins, including mulberry silk and wild silk, are the