Electrospun Biodegradable Nanofibers as a Tissue Engineering Candidate

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Introduction

Tissue engineering is an outgrowth of the biomaterials field and involves producing tissue substitutes from a combination of biodegradable polymers and cells specific for the tissue whose structural characteristics and function need to be restored. The most challenging step in tissue engineering is the design of an appropriate scaffold that would mimic both biological functions and structure of natural extracellular matrix (ECM). Since ECM components are in nanometer range, design of scaffolds in this range has become more attractive in the last decade. Scaffolds can be prepared in the film, foam or fibrous forms. It has been observed that cells attach and organize well on fibers with a diameter smaller than that of cells. A variety of processes have been utilized to manufacture nanofibers. In electrospinning process, a high voltage is applied to a polymeric solution and as the voltage overcomes the surface tension of the solution, fibers are ejected in the form of a jet. This process needs to be optimized in order to obtain an appropriate scaffold that can enhance adhesion, and proliferation of cells. The aim of the present study is to construct a nanofibrous scaffold of a biological polyester with the ultimate aim of using it as a tissue engineering scaffold.

Materials and Methods

Different concentrations of biodegradable poly(3-hydroxy butyrate-co-3-hydroxy valerate) (PHBV8), containing 8% of 3-hydroxyvalerate, and its four blends were prepared in chloroform or a 96:4 mixture of chloroform/N,N-dimethyl formamide (DMF) to investigate the influence of solvent, concentration, and polymer type on the properties of the nanofiber formed. Parameters such as solution concentration, voltage, distance from collector to syringe tip and the effect of some BTEAC salt on fiber structure and morphology were also studied. The resultant nano- and microfibers were collected onto a metal substrate as an interconnected, non-woven mat. Alignment of fibers was also attempted using a rotating collector in place of the static plate collector. The morphology of the electrospun fibers was studied by Scanning Electron Microscopy (SEM) and their diameter was measured via an Image J analyzer program.

Results and Discussion

SEM analysis demonstrated that increase in solution concentration results in an increase in fiber diameter and a change in bead formation and shape. Addition of salt resulted in bead-free fibers but in this case some fiber fusion occurred due to decreased solvent evaporation. Furthermore, addition of a solvent with a higher dielectric constant (DMF) to chloroform improved the electrospinning conditions and more uniform, bead-free nano- and microfibers were obtained. Fiber diameters ranged from 284 nm to 2.2 μm depending on the conditions used. Diameter of the aligned fiber was not significantly different than the random ones.

Conclusion

It was possible to produce nano- and microfibers using PHBV8 and its blends. Conductivity of the polymer solution was an important parameter and it was improved by addition of DMF as solvent. All blends showed varying fiber structure and morphologies. Furthermore, alignment of the nanofibers was possible using this biopolyester.

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