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Identifying and Designing a Suitable material for Scaffold preparation In Tissue Engineering applications

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Abstract: Cells are often implanted or seeded into an artificial structure capable of supporting three-dimensional tissue formation. These structures are typically called scaffolds.It represents important components for tissue engineering. However, researchers often encounter an enormous variety of choices when selecting scaffolds for tissue engineering. Biodegradability and Biocompatibility is often an essential factor since scaffolds should preferably be adapted and absorbed by the surrounding tissues without causing toxicity or necessity of a surgical removal from the tissue. The work aimed at the preparation of scaffold with the suitable material using a blend of natural polymer (chitosan, refined triticum aestivum) and the synthetic polymer (Polyethylene glycol). Fourier transform infrared (FTIR) spectroscopy was used to determine the chemical composition of blended samples.

Keywords: Chitosan; Polyethylene glycol; refined triticum aestivum; Scaffold; FTIR.

1. Introduction

Tissue engineering aims to restore maintain or improve tissue functions that are affected by different pathologies. Scaffolds are defined as three-dimension porous solid biomaterials designed to perform cell interactions, cell adhesion, extra cellular matrix decomposition, transport of nutrients to allow the cell survival, cell proliferation and cell differentiation, biodegradable and minimal degree of immune and inflammatory response (1). Polymeric scaffolds have unique properties such as high surface-to-volume ratio, high porosity with very small pore size, biodegradation, and mechanical property (2). Chitosan is derived from chitin, one of the most abundant natural polysaccharides. Chitosan is well known for its nontoxic, biocompatible and biodegradable properties (3). Polyethylene glycol in its most common form is a linear or branched polyether terminated with hydroxyl groups, has a characteristics of protein resistance, low toxicity and immunogenicity along with the biocompatibility (4). Wheat gluten was most likely the first plant protein to have been electrospun is the way for fabrication of nano fibrous scaffolds from other plant-derived proteins (5). It has medium gluten forming that is an elasticity of protein and it has a hydrophilic in nature.

2. Experimental Procedure

2.1. Materials

Chitosan is a derivative of chitin was purchased from HiMedia (India) with a molecular weight of 400kDa, Polyethylene glycol with a molecular weight of 9000kDa was purchased from Merck (India) and Refined triticum aestivum (plain flour) was purchased from Barn foods private limited (India).

2.2. Preparation of Polymer Blended Samples

For solubilizing, chitosan(CS) is dissolved in 3% of acetic acid glacial solution, Polyethylene glycol (PEG) is dissolved in 100% of distilled water and Refined triticum aestivum (RTA) is dissolved in 10% acetic acid glacial solution then it is stirred continuously for 4 hours. Polymer blended sample was performed by the chitosan, Polyethylene glycol and Refined triticum aestivum. For this, solutions of the polymers were prepared in the usual manner and they were mixed together in different ratios. 6 % (w/w) CS, 10 % (w/w) PEG and 1 % (w/w) RTA were blended in various ratios, 40:40:20, 65:25:10, 30:20:50, 5:85:10 and 10:70:20.

2.3. Electrospinning Process

The Electrospinning setup (Fig. 1) had a 2ml syringe fitted with a needle (16-22 gauge), mounted on a Harvard Syringe Pump. The syringe was filled with the blended polymer solution. A constant flow rate of 0.20ml/min was maintained using the syringe pump. The positive output lead of a high voltage power supply was attached to the needle. The collector of a foil is attached to the cylindrical rod, which was electrically grounded. The voltage applied to the solution was 20 kilovolts. The collector to needle distance was 20 centimeters. When the charge of the polymer at increasing voltage exceeded the surface tension at the tip of the needle, the polymer is sprayed down and it is coated on the ground plate.

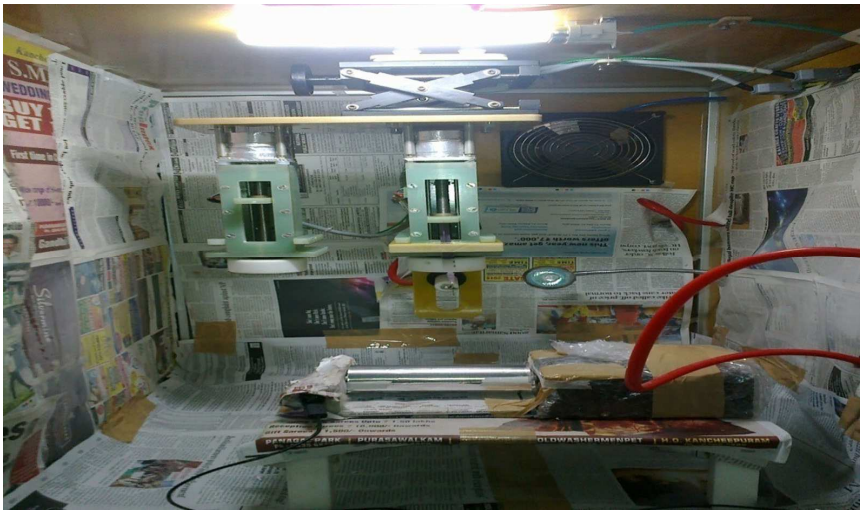

Fig. 1. Electrospinning setup

2.4. Characterization Technique

The blended samples were characterized by Fourier Transform Infrared (FTIR) Spectroscopy and optical microscope. IR radiation is passed through a sample (it is coated with 0.3g of potassium Bromide).

3. Results and Discussions

3.1. Optical Microscope Studies

In this studies, the coated sample foil with the ratio of CS: PEG: RTA (40:40:20) was characterized and analyzed, since the sample was minimally viscous it did not form the fiber. In the ratio of CS: PEG: RTA (65:25:10), the sample was more viscous so it did not ejected. In the ratio of CS: PEG: RTA (30:20:50), the sample was moderately viscous, it got ejected as a sample solution. In the ratio of CS: PEG: RTA (5:85:10), the sample was moderately viscous and it was observed that there were more beads (Fig. 2). In the ratio of CS: PEG: RTA (10:70:20), the sample was moderately viscous, it was observed as very less bead (Fig. 3).

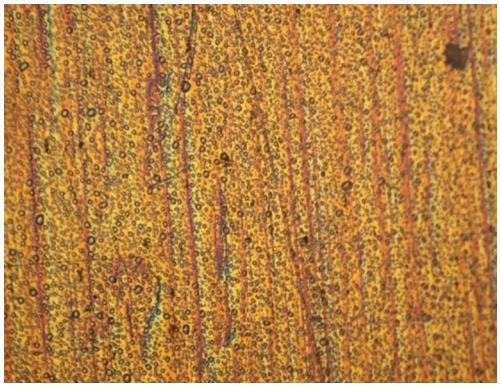

Fig. 2. CS: PEG: RTA (20:60:20)

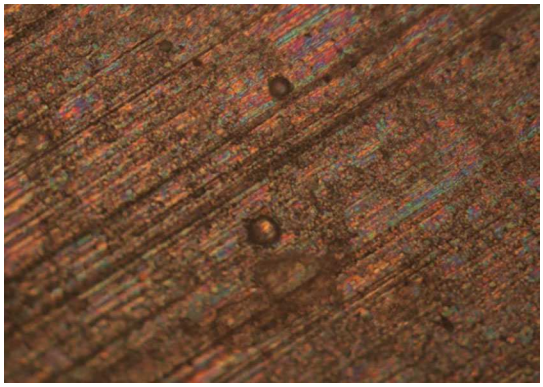

Fig. 3. CS: PEG: RTA (10:70:20)

3.2. FTIR Studies

The FTIR spectrum of the blended sample (Fig. 4) it was analyzed by the wave number of 3425.6 is a functional group of amides and the molecular motion of N-H stretch, the wave number of 3249.1 is a functional group of carboxylic acids and the molecular motion of O-H stretch, the wave number of 1712.3 is a functional group of carboxylic acids and the molecular motion of C=O stretch, the wave number of 1274.9 is a functional group of sulfones and the molecular motion of S=O stretch, the wave number of 1390.9 is a functional group of nitro groups and the molecular motion of -NO_2 (aliphatic) ,the wave number of 758.0 is a functional group of alkyl halides and the molecular motion of C-Cl stretch and the wave number of 679.0 is a functional group of acid chloride and the molecular motion of C-Cl stretch.

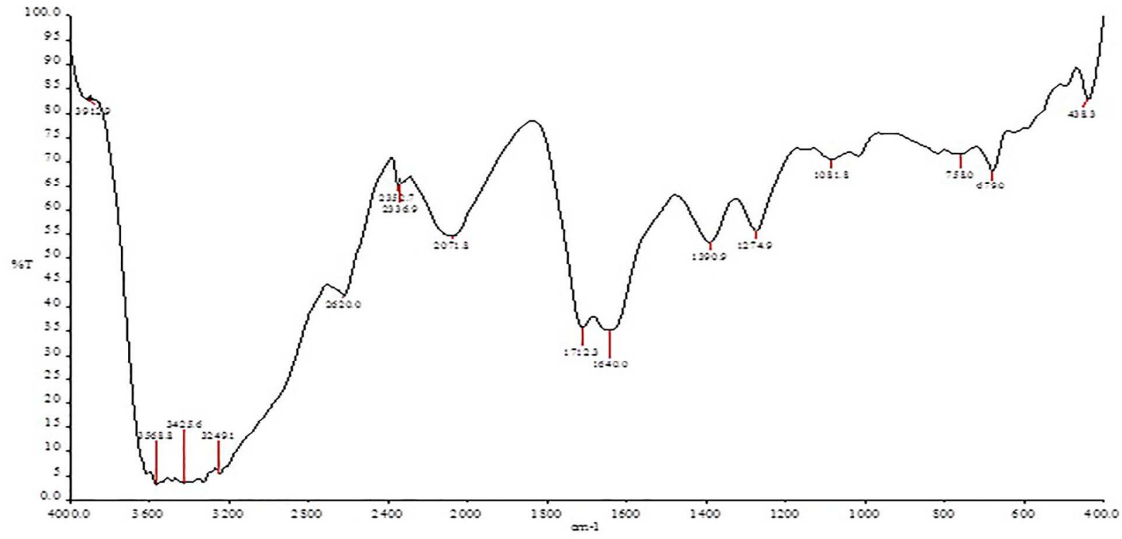

Fig.. 4. FTIR spectrum of blended sample (CS: PEG: RTA)

4. Conclusion

The electrospinning process was done by using chitosan, polyethylene glycol and Refined triticum aestivum in varying concentrations. In this, it had been observed that a fiber was formed, but it was shrinked. Another trail showed minimum bead formation. The FTIR studies confirm the functional groups present in the blended sample. The future work would involve trails to obtain fibers with proper concentration of the combination using electrospinning process.

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