PREPARATION OF PSYLLIUM HUSK POWDER BASED MICROPOROUS COMPOSITE SCAFFOLDS FOR TISSUE ENGINEERING

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Introduction

Tissue engineering is a mixed discipline that majorly focuses on the recreation and regeneration of diseased or damaged tissues [1], [2]. Tissue engineering scaffolds are an absolute necessity that provides a conducive environment for cell growth and reproduction with respect to its three-dimensional structure, pore size, strength, cell attachment, degradation rate etc [3], [4]. Plantago ovata or psyllium husk is one of the most widely used and commercially available plant-derived polysaccharides in Indian markets [5]. It has been used in many biomedical applications because of its ease of availability, low cost, non-toxicity, biodegradability and safety [6]. Gelatin, a versatile and naturally occurring biopolymer helps in the modulation of cell adhesion because of the presence of cell adhering moieties [7], [8]. 1-ethyl-3-(3-dimethylaminopropyl)-1-carbodiimide hydrochloride (EDC) and N-hydroxysuccinimide (NHS) has been used as a cross-linking agent as it introduces an amide or an ester bond between the functional moieties of the biopolymers. The main aim of this study is to demonstrate the fabrication and characterization of psyllium husk powder and gelatin based three-dimensional microporous scaffolds using two different methods of drying thus supporting its potential for tissue engineering applications.

Materials and Methods

Psyllium husk powder and gelatin composite scaffolds were prepared by mixing them in the ratios 50:50, 75:25 and 100:0 (w/w) respectively, in water. The mixtures obtained were cross-linked using EDC-NHS coupling reaction followed by a drying step. In the present study one set of scaffolds were dried for two days using a desiccator connected to a vacuum pump accompanied with a liquid nitrogen dip for complete drying. The other set of scaffolds was cross-linked using the same procedure as above except it was dried for two days in a freeze-drier.

Scanning electron microscopy analysis was carried out to determine the porous architecture of the scaffolds after respective drying steps. Cell culture studies were performed with L929-RFP (red fluorescent protein) mouse fibroblast cells to identify cell viability, growth and cell-cell communication within the fabricated scaffold.

Results and Discussion

From the results in FIG. 1 it is observed from the digital images of the fabricated scaffolds that the set that was dried in a vacuum desiccator and exposed to liquid nitrogen exhibits a contracted or deflated physical appearance (FIG. 1a) whereas the set of scaffolds subjected to freeze-drying protocol maintain the physical aspect and integrity of the scaffold (FIG. 1b). The difference in the physical attributes of the scaffolds prepared from two distinct procedures is due to the fact that vacuum desiccation followed by a dip in liquid nitrogen removed all the moisture from the scaffolds thereby leaving no void space within the scaffolds for it to be considered as microporous as highlighted from the SEM images (fig 1a). On the contrary, the freeze-drying procedure exploits water content as a template to create microporous structures within the scaffolds thus maintaining its porous morphology.

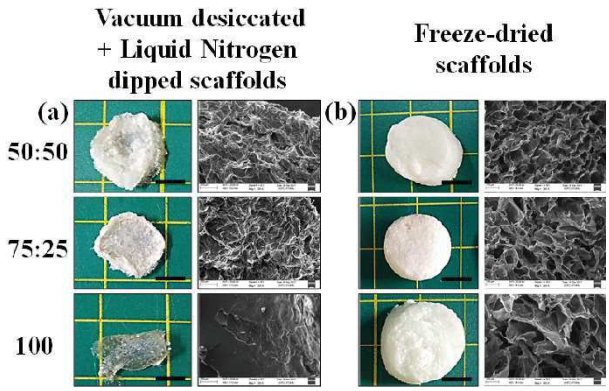

FIG. 1. The above picture represents the digital images of fabricated scaffolds by utilizing the two methods for drying the scaffolds and the SEM micrographs that depicts the porous architecture of the scaffolds. Scale bar: 0.5 cm

Conclusions

The outcomes of the conducted study led us to the conclusion that EDC-NHS crosslinked scaffolds fabricated by freeze-drying step exhibit superior porous structure in comparison to those dried in a vacuum desiccator accompanied with liquid nitrogen dip. Structure and integrity of the scaffolds were better maintained in those developed using a freeze-drier unlike the other set that presented a shrunken appearance. Therefore, in the light of the above facts, it was inferred that scaffolds fabricated by the freeze-drying process were more suitable for cell-culture and tissue engineering applications.

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