SCAFFOLDS FROM BIODEGRADABLE ALIPHATIC POLYESTERS FOR TISSUE ENGINEERING

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Introduction

Tissue engineering is an interdisciplinary field and involves creation of human natural tissues to treat patients suffering from organ failure or tissue loss [1]. Design of a scaffold is a first step in cell transplantation to restore the function of a tissue or an organ. Highly porous scaffolds are needed to guide cells attachment, their growth and tissue regeneration in three dimensions. Biodegradable and biocompatible polymers such as poly (L-lactide) (PLLA), poly (glycolide) (PGA) have already been fabricated into scaffolds for tissue engineering [2,3]. Several fabrication techniques have been developed, namely solvent casting, particulate leaching [2], emulsion freeze drying [4], and phase separation [5].

In the present study we describe the production method of porous scaffolds from biodegradable copolymers: poly(L-lactide-co-glycolide) and poly(glycolide-ε-caprolactone) and report the results of their textural, physico-chemical properties, as well their stability in conditions simulating biological environment. Obtained materials can be used as scaffolds for cartilage and bone tissue engineering.

Materials and methods

Poly(L-lactide-co-glycolide) (PGLA) (15:85, M_n= 88 000, d=1.9 -2.3) and poly(glycolide-ε-caprolactone) (PGCap) (12:88, M_n= 56 000, d=2.1) have been synthesized according to the method described previously [6]. PGLA and PGCap scaffolds were prepared by solvent casting, particulate leaching technique: 1) polymers were dissolved in methyl chloride, 2) particles of sodium chloride or sodium citrate of defined size were added, 3) the solvent was extracted by evaporation followed by vacuum treatment, 4) the porogen particles were leached out by immersion in distilled water, 5) water residues were removed in vacuum chamber at 40°C.

The scaffolds were analysed by XPS (SSI X-probe, Fissons), SEM (Jeol JSM 5400), FTIR (FTS Digilab 60, Bio-Rad). To study the hydrodegradation process materials (300 mg) were immersed in 100 ml of distilled water (37°C, 10 weeks, water was exchanged every week); electrical conductivity and pH of water were measured every two days.

Results and discussion

Figure 1 presents representative SEM images of the salt leached PGCap scaffolds. It is apparent that salt particles acting as porogens resulted in creation of polymer matrix of defined porosity and pore size. Total porosity up to 60%, and dimension of the pores in the range of 200 ± 100 and 600 ± 100 μm for materials produced with sodium chloride and sodium citrate, respectively have been obtained. Hydrodegradation studies indicate that both PGLA and PGCap-based materials do not release degradation products within 7-8 weeks of incubation: any changes of pH or conductivity of incubation fluid are observed (data not presented). Slight variations of these parameters after 8 weeks reveal that hydrolysis of ester bonds commence, what is consistent with the literature data [7]. However, such changes are so small that neither FTIR nor XPS can reflect structural modification upon hydrolytic degradation after 10 weeks of experiment (data not presented). This suggests that much longer contact time with water is needed to cause a complete degradation of the material. It is in agreement with the requirements of tissue engineering: degradation and resorption kinetics have to be controlled in such a way that the bio-resorbable scaffold retains its physical properties for at least 6 months [8].

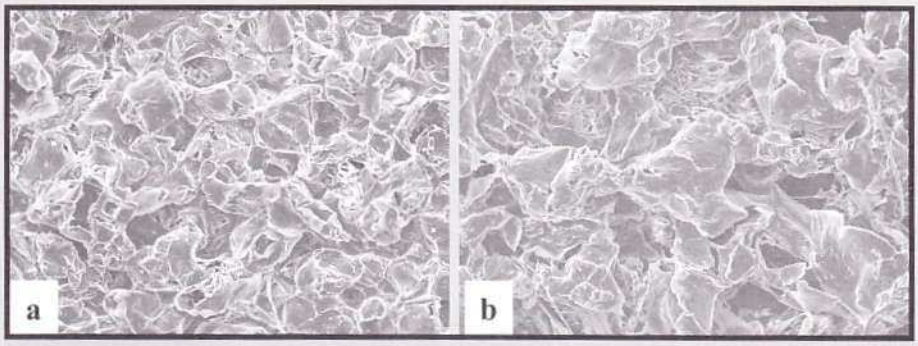

FIG.1. Micrographs of PGCap scaffolds produced by: NaCl (a) and sodium citrate; (b) leaching (SEM, 50x).

Conclusion

The results presented above and data reported in the literature [7,8] indicate that our scaffolds should satisfy the requirements of tissue engineering, in particular chondrocyte and osteoblast seeding in order to regenerate cartilage and bone tissue.

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