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Characterization of collagen-chitosan scaffolds for skin tissue engineering

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Abstract – Collagen-chitosan porous scaffolds were produced by the freeze and lyophilizing method. Samples were characterized using scanning electron microscope (SEM), attenuated total reflection Fourier transformed infrared spectroscopy (ATR-FTIR), thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC). Highly interconnected porous structures were obtained. Results point out that the polymers are fully miscible.

Patients with full thickness skin injuries suffer from a substantial loss of dermis. Its regeneration does not occur spontaneously in adult individuals. Due to limited availability of autografts and allografts, tissue engineered dermal equivalents have been developed. They can be used alone or in combination with epithelial sheets as promising alternatives to autografts for the treatment of large full-thickness defects [1].

Collagen is a fibrous protein that corresponds to 30% of the total body proteins and 6% of the total body weight [2]. It is largely used in tissue engineering because of its excellent biocompatibility and biodregadability. Chitosan is a high molar mass deacetylated product from chitin, the second most abundant polysaccharide. As collagen, it is also biocompatible and biodegradable. Furthermore it has excellent wound healing properties. There are no natural collagen-chitosan blends, but the individual characteristics of each polymer can create unique mechanical, structural and degradation properties if the two polymers are used in artificial blends. Within this context, the aim of the present work is to produce collagen-chitosan porous scaffolds for skin repair, since in the year 2000 more than R$ 55 billions were spent with burnings treatment in Brazil.

Chitosan was purchased from Sigma-Aldrich Co. Collagen type I Apcoll-S was a gift sample from Devro Medical. Collagen suspension was slowly dropped into the chitosan solution and blended at room temperature to make a 1:1 (w/w) collagen-chitosan mixture. Composite scaffolds were prepared by freezing and lyophilizing the collagen-chitosan solution. Single component scaffolds were also prepared using the same methodology. Samples were characterized using scanning electron microscope (SEM), attenuated total reflection Fourier transformed infrared spectroscopy (ATR-FTIR), thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC).

SEM micrographs of the composite scaffolds showed an interconnected porous structure. Image analysis revealed that the mean pore size was around 13 µm and 80% of porosity. These values were between those of the single component scaffolds. FTIR spectra of collagen-chitosan samples showed characteristic bands of both polymers slightly shifted. TGA results indicate that the composite scaffolds have a better thermal stability than the single component ones. The basic DSC curves of chitosan scaffolds show a characteristic band of bound water. Composite scaffold shows the same band as chitosan shifted to higher temperatures, for water in collagen is more strongly bound [3].

FTIR and TGA findings indicate that the two polymers interact to form a fully miscible blend. Results also showed that the composite scaffolds have intermediate properties. They preserved highly porous structure after lyophilization, typical for the single component scaffolds.

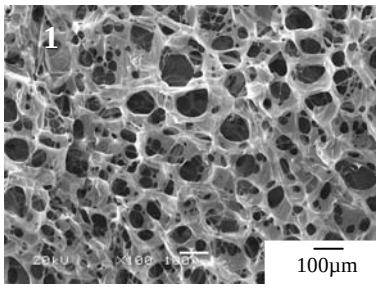

Figure 1: Collagen-chitosan composite (SEM, x100).

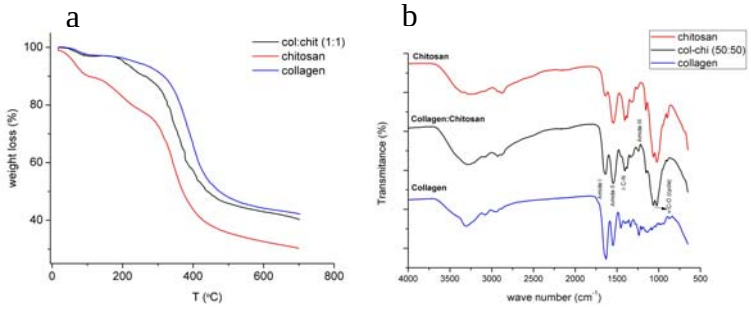

Figure 2: (a) Thermogravimetric analysis and (b) FTIR spectra

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