Fabrication of Blended Gelatin–Polyvinyl Alcohol–Chitosan Scaffold for Wound Regeneration

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ABSTRACT

A single type polymer had very limited function and property which was not enough to be applied in the complex real situation. This study aimed to prepare the composited scaffolds by blending the gelatin, polyvinyl alcohol and chitosan together. The blended scaffolds were fabricated by making the final concentration of 7% gelatin, 0.5 % PVA and 0.1% chitosan and crosslinking by glutaraldehyde. The Young's modulus was investigated by using atomic force microscopy (AFM). The pore size was investigated using the scanning electron microscope (SEM). The swelling rate of scaffolds were tested by water displacement method. The degradation rate of the scaffolds was studied using lysozyme digestion. The MTT assay was applied within this study in order to find out the relative cell viability upon culturing with the gelatin and the blended scaffolds compared to tissue culture plates. Collagen type IV expression was investigated in mouse fibroblasts cultured on both scaffolds for 10 days using real time PCR. The results showed that Young's moduli of gelatin and blended scaffold were 53.30±26.80 kPa and 98.01±17.50 kPa, respectively. The average pore size of gelatin and blended scaffolds were 336.33±52.25 µm and 68.17±8.91 µm, respectively. The sample's porosity of gelatin and blended scaffolds were 85.41±2.11% and 21.48±1.01%, respectively. The swelling rate and the degradation rate of gelatin scaffold were higher than blended scaffold. The MTT

assay showed that the blended scaffold supported cell proliferation better than gelatin scaffold. Collagen type IV expression of mouse fibroblasts cultured on blended scaffolds was higher than gelatin scaffolds. In conclusion, these results illustrated that blended scaffolds were able to provide a better environment for fibroblast proliferation and collagen type IV expression.

Keywords: Gelatin, Chitosan, Polyvinyl alcohol, Wound regeneration

INTRODUCTION

There was increasing requirement for safer and more effective therapeutic methods for wound coverage and skin tissue repairing in a variety of clinical situations, such as acute skin wounds, burn wounds, and chronic skin ulcers. The split thickness skin autograft was the dominant desirable therapeutic method for coverage of excised burn wounds when the available donor sites for autografting were so limited, especially in instances where patients were faced with very large areas of burn wounds. These wound coverages required repeated harvesting from available donor sites, which led to pain and scar at the donor sites that extended the time for skin recovery, and such patients had to stay longer in the hospital (Huang and Fu, 2011). Because of the limitations with regards to application of autografts and allografts, and the tremendous needed for the same in clinical applications for wound regeneration in patients with various wound situations, bioengineered skin substitutes have been developed quickly so that new alternative methods were provided for clinicians to restore skin and solve a variety of skin defects (Rendon et al., 2010; Shishatskaya et al., 2016; Yang et al., 2016). The substitutes should have some fundamental properties to guarantee that they could create the proper environment for promoting wound healing, such as having appropriate physical and mechanical properties and having a controlled degradation rate. The desirable materials of skin substitutes should fulfill the following requirements: (1) be able to maintain local moist environment of the skin; (2) be able to protect the wound from side-infection; (3) should have the ability to absorb the wound fluids and exudates; (4) be able to minimize the wound surface necrosis; (5) be able to stimulate cell growth and differentiation; and (6) be elastic, non-toxic, non-antigenic, biocompatible, and biodegradable (MacNeil, 2007).

With regards to these characteristics, a variety of biomaterials, both of natural origin and of synthetic origin, have been used for medical applications, such as chitosan, alginate, collagen, gelatin, polyglycolic acid, polycaprolactone, and polylactic acid. All these substances were currently the most-used materials