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Porous silk fibroin/alpha tricalcium phosphate composite scaffolds for bone tissue engineering: A preliminary study

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Abstract. Scaffolds with mechanical properties that mimic the tissue to be restored are critical to maintain the morphology and function of a scaffold after implantation and during tissue regeneration. Silk fibroin (SF), a protein from the *Bombyx mori* silk worm cocoon, is currently employed in the biomedical field and tissue engineering. The objective of this study was to construct three-dimensional porous silk fibroin/alpha tricalcium phosphate scaffolds for bone tissue engineering application. The scaffolds were fabricated using a solvent casting and salt leaching technique. The hybrid strain of degummed Thai silk fibroin, Nangnoi Srisaket 1 x Mor, was dissolved in hexafluoroisopropanol at 16% (w/v). Alpha tricalcium phosphate (α-TCP) was incorporated to produce 4, 8, 12, and 16 wt% solution and sucrose (particle size 250-450 μm; sucrose/silk fibroin = 8.5/1 w/w) was used as a porogen. The microstructure and pore size, calcium and phosphorus contents, and compressive modulus were evaluated. The scanning electron microscope images revealed the microstructure of scaffolds to be square shaped with continuous interconnected pores. The average pore size of the scaffolds was 265.70 $\pm$ 67.45 μm. The scaffolds containing 8% (w/w) α-TCP exhibited the highest compressive modulus (64.84 $\pm$ 16.65 kPa) and the highest calcium content. The results suggested that the scaffolds containing α-TCP may be a potential candidate for application in bone tissue engineering applications.

Introduction

Bone grafting is a treatment used to repair bony defects or fractures. An autograft is the gold standard for bone graft; however, it burdens the patient with an additional surgical site. Allografts and xenografts have the risk of disease transmission, foreign body reaction, and graft rejection. Arising from the limitations of such grafts, the novel and promising strategies such as tissue engineering have been developed to improve the treatment and quality of life of patients. Tissue engineering is one promising strategy to stimulate tissue formation through the use of cells, growth factors, and biomaterials.

Biomaterials for use in three - dimensional porous scaffolds for bone tissue engineering have been investigated. Natural polymers have more advantages than synthetic biodegradable polymers and ceramics; for instance, biodegradability, non-toxicity, and cellular function support. Silk fibroin (SF) derived from *Bombyx mori* cocoon demonstrates good mechanical properties [1], biodegradability [2], less immunological response [2], and is easily shaped in several architectures. Furthermore, SF scaffolds present versatility in processing for tissue engineering, for example, in nerves [3], cartilage [4], and bone [5,6]. In addition to improving osteoconductivity and osteoinductivity, ceramics were added to the SF scaffolds.

Alpha tricalcium phosphate (α-TCP) is a bioresorbable ceramic and is the major component of the powder of commercial bone cements. According to high solubility and biodegradability, α-TCP is expected to be useful for bone substitution and scaffolds for bone tissue engineering either alone or blended with other calcium phosphate. Oh et al. (2010) revealed that the differentiation of