ABSTRACT

Bone tissue damage caused by trauma, infection, and degenerative diseases such as osteoporosis has encouraged the development of biomaterials as bone graft substitutes. Hydroxyapatite (HAp) is widely used due to its similarity to the mineral component of natural bone; however, it still exhibits limitations in bioactivity and mechanical properties. This study aimed to synthesize and characterize Si-HAp/Gelatin composite granules with various levels of silicon substitution using the oven drying method and to evaluate the effect of silicon substitution on the resulting material characteristics. HAp and Si-HAp were synthesized using the sol-gel method with silicon substitution levels of 0, 2.5, 5, 7.5, and 10 mol%, employing tetraethyl orthosilicate (TEOS) as the silicon source. The synthesized powders were then composited with gelatin at a ratio of 70:30 (w/w) and formed into granules using the oven drying method. Characterization was performed using Fourier Transform Infrared Spectroscopy (FTIR), X-Ray Diffraction (XRD), and Scanning Electron Microscopy-Energy Dispersive X-ray (SEM-EDX). The results showed that the synthesis of HAp and Si-HAp successfully produced white powders with a mass of approximately 7–8 g, and HAp/Gelatin as well as Si-HAp/Gelatin composite granules were successfully obtained with irregular shapes and homogeneous structures. FTIR analysis confirmed the presence of PO_4^{3-} and OH^- functional groups, while SEM-EDX revealed the presence of Ca, P, O, and Si elements and indicated morphological changes toward denser and more agglomerated structures with increasing silicon substitution. XRD analysis showed that hydroxyapatite remained the dominant phase up to 7.5 mol% silicon substitution, accompanied by changes in d-spacing, crystallinity, and crystallite size, whereas at 10 mol% silicon substitution, the hydroxyapatite phase was no longer identified and transformed into calcium pyrophosphate and calcium phosphate phases. Overall, silicon substitution influenced the chemical characteristics, morphology, and crystal structure of the material, and substitution up to 7.5 mol% was still able to maintain the primary characteristics of hydroxyapatite as a potential bone graft substitute material.

***Keywords**: hydroxyapatite, Si-HAp, gelatin, bone graft substitute, oven drying.*