

ABSTRACT

Beta-tricalcium phosphate (β -TCP) is one of the widely used biomaterials in bone tissue engineering due to its biocompatibility, osteoconductivity, and natural degradability. However, its main drawback lies in its low mechanical strength and relatively fast degradation rate. To enhance its performance, silicon dioxide (SiO_2) was added, which possesses excellent mechanical and bioactive properties. This study aimed to evaluate the effect of SiO_2 concentration variations on the mechanical and chemical structural characteristics of β -TCP/ SiO_2 composites.

The β -TCP/ SiO_2 composites were prepared by mixing synthesized β -TCP with SiO_2 in different amounts of 0.5, 1.0, 1.5, 2.0, and 2.5 grams, corresponding to 17–50 wt% SiO_2 . A 5% Na_2HPO_4 solution served as the liquid phase to form a composite paste. The β -TCP powder was synthesized using the sol–gel method with $\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$ and KH_2PO_4 as precursors.

The resulting composites were characterized using FTIR, XRD, and SEM–EDX, while the compressive strength was tested using a Universal Testing Machine (UTM). FTIR analysis revealed an increase in the intensity of Si–O–Si absorption bands at 1100 cm^{-1} , 805 cm^{-1} , and 466 cm^{-1} with increasing SiO_2 content, accompanied by a reduction in phosphate bands from β -TCP. XRD results confirmed the dominance of the crystalline β -TCP phase with minor modifications in the diffraction pattern. The compressive strength test showed that the sample containing 1 gram of SiO_2 (29%) exhibited the highest mechanical strength ($F_{\text{max}} = 79.92\text{ N}$), while further addition of SiO_2 decreased the strength. SEM–EDX analysis demonstrated a uniform distribution of SiO_2 within the β -TCP matrix and a porous surface structure that supports bone tissue growth. Therefore, the β -TCP/ SiO_2 composite containing 1 gram (29%) of SiO_2 is considered the most optimal formulation due to its superior combination of mechanical strength, structural stability, and bioactivity, showing strong potential as a scaffold for bone tissue engineering applications.

Keywords: *Beta-tricalcium phosphate, Bone Scaffold, Composite, Silica, Sol-gel Method.*