Evaluation of the Effect of Nano-TiO₂ on Bioactivity and Mechanical Properties of Nano Bioglass-P3HB Composite Scaffold for Bone Tissue Engineering

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Tissue engineering (TE) is an emerging field that aims to regenerate damaged tissues and/or promote new tissue growth using a combination of cells, biomaterials and signaling molecules. One of the major challenges that tissue engineers are confronted with is designing a scaffold with appropriate physical and mechanical properties. Scaffold provides a three-dimensional (3-D) ECM analog which functions as a template required for infiltration and proliferation of cells into the targeted functional tissue or organ. Then, to emulate bone structure, porous composite scaffold should be designed. In this research the effects of Nano-Titania (nTiO₂) on the Bioactivity and mechanical properties of Nano-bioglass – poly-3-hydroxybutyrate (nBG/P3HB) Composite scaffold was evaluated. First, nBG powder was prepared by melting method of pure raw materials at a temperature of 1400°C and then the porous ceramic scaffold of nBG/nTiO₂ with 30 wt% of nBG and 3, 6 and 9 wt% of nTiO₂ was prepared by using polyurethane sponge replication method. Then scaffolds were coated with P3HB in order to increase scaffold’s mechanical properties. XRD, XRF, SEM, FE-SEM and FTIR were used in order to study the phase and elemental structures, morphology, particle size and determination of functional groups, respectively. XRD and XRF results showed that the type of the produced Bioglass was 45S5. Mechanical strength and modulus of scaffold improved by adding nTiO₂ to nBG/P3HB composite scaffold. The results of the compressive strength and porosity tests showed that the best scaffold is 30 wt% of nBG, 6 wt% of P3HB and 6 wt% of nTiO₂ with 79.5-80% of porosity in 200-600 nm, a compressive strength of 0.15 MPa and a compressive modulus of 30 MPa, which is a good candidate for bone tissue engineering. To evaluate the bioactivity of the scaffold, the simulated body fluid (SBF) solution was used. The best scaffold with 30 wt% of nBG, 6 wt% of P3HB and 6 wt% of nTiO₂ was immersed in SBF for 4 weeks at an incubation temperature of 37°C. The bioactivity of scaffolds was characterized by AAS, SEM, EDS and XRD. The results showed that bone-like apatite layer formed well at scaffold surface. It can conclude that nTiO₂ in nBG/P3HB composite scaffold could affect bioactivity and the rate of bioactivity, increasingly.