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Nano-Hydroxyapatite-Enhanced PLA Microspheres - Osteogenic Potential for Bone Repair Applications

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Abstract

Treating bone defects encompasses autologous/ allogeneic bone grafting and the utilization of synthetic bone substitutes. Donor site morbidity and infection transmission can hinder the healing capacity of bones. The surge in demand for tissue-engineered bone grafts arises due to their ability to provide consistent composition, varied sources, and architecture. This study focused on the adaptability of Poly Lactic acid (PLA)/Nano- hydroxyapatite (nHAp) composite microspheres as a tissue engineering scaffold. nHAp (10%. 20%, and 30 %) were effectively embedded into PLA microspheres by emulsion solvent evaporation method, and there was no significant difference in mean diameters (29.86 ± 6.47 µm, 28.12 ± 5.48 µm and 29.81 ± 5.33 µm) concerning nHAp levels. Invitro cellular evaluation was conducted for rat mesenchymal stem cells(rMSCs) and was observed that both PLA microspheres and composite microspheres exhibited the ability to support cell adhesion. However, composite microspheres displayed superior adhesion and proliferation of rMSCs compared to PLA microspheres. The findings revealed that incorporating nHAp had a prominent impact on promoting the osteogenic differentiation of rMSCs. During the 7th and 14th day periods of cell culture, the PLA/nHAp sample exhibited a significantly increased positive staining for alkaline phosphatase (ALP) activity compared to the pure PLA sample. This enhancement suggests that nHAp facilitates the osteogenic differentiation process of rMSCs in the composite microspheres. The mineralized nodules exhibited positive staining for alizarin red on day 14, indicating the presence of calcium deposits and affirming the osteogenic differentiation of the cells which substantiates the osteoinductivity effect of nHAp on the cellular phenotype. Scanning electron microscopy (SEM) provided detailed insights into cell adhesion and the formation of mineralized nodules. The study highlights enhanced bone regeneration capability in the composite material, emphasizing its potential in addressing osteology challenges.

Keywords: Bone repair, nHAp, Osteogenic differentiation, PLA

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