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Bacterial Inhibition and Osteogenic Potentials of Sr/Zn Co-Doped Nano-Hydroxyapatite Composite Scaffold for Bone Tissue Engineering Applications

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Introduction

Introduction: Bacterial infection associated with bone grafts is one of the major challenges that can lead to implant failure. Treatment of these infections is a costly endeavor; therefore, an ideal bone scaffold should merge both biocompatibility and antibacterial activity. Antibiotic-impregnated scaffolds may prevent bacterial colonization but exacerbate the global antibiotic resistance problem. Recently, various bio-ceramics such as nano-hydroxyapatite (nHAp) have been used in bone tissue engineering in combination with other biomaterials. In this study, we fabricated a nHAp scaffold doped with Zn and Sr metal ions, as Zn has antimicrobial properties and can promote bone formation, while Sr ion is known to increase bone mineral density. We also added poly lactic-co-glycolic acid (PLGA) polymer to enhance the scaffold stability and mechanical properties.

Aims & Objectives: To fabricate bio-composite scaffolds of Sr/Zn doped nHAp with and without PLGA polymer, and investigate their antimicrobial properties. Furthermore, to examine the cytocompatibility and osteoblastic cell proliferation on Sr/Zn-nHAp-PLGA composite scaffolds.

Methodology

Sr/Zn doped nHAp-PLGA scaffolds were fabricated with different ratios of Sr and/or Zn ions (1%, 2.5%, and 4%) using the chemical precipitation method and supercritical CO_2 gas. The scaffolds' **antibacterial activity** against *Staphylococcus aureus* was evaluated by counting bacterial colony forming units (CFU) numbers in tryptone soya agar (TSA) plates after 24 hours of direct contact with the scaffolds. **MTT assay** was used to estimate osteoblast cells proliferation in the fabricated scaffolds.

Results

CFU numbers showed a dose-dependent reduction as Zn concentration increased, with 4% Zn showing the best antibacterial properties in all Zn-containing scaffolds. PLGA incorporation to Sr/Zn-nHAp didn't affect Zn antibacterial activity and 4% Sr/Zn-nHAp-PLGA scaffold showed 99.7% bacterial growth inhibition.

MTT assay showed that Sr/Zn co-doping supported osteoblast cell proliferation with no apparent cytotoxicity and the highest doping percentage in 4% Sr/Zn-nHAp-PLGA was found to be ideal for cell growth.

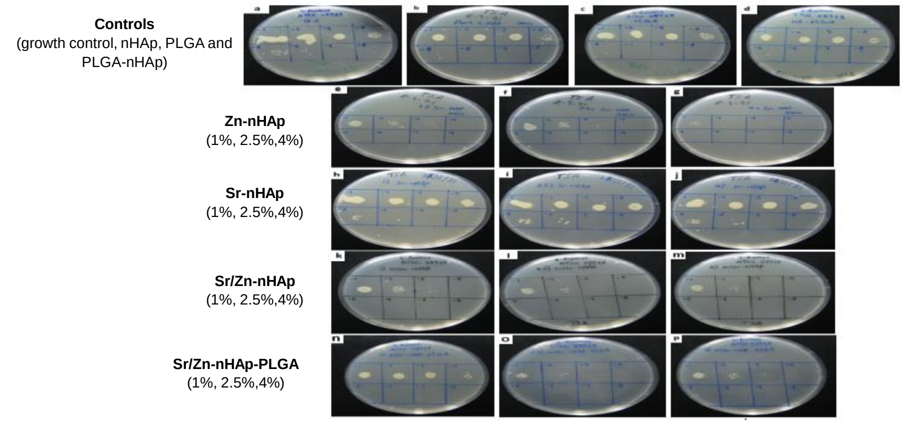

Fig. 1: Photographs of bacterial colonies in TSA plates, each square sector represents a serial dilution from 10^{-1} – 10^{-8} left to right

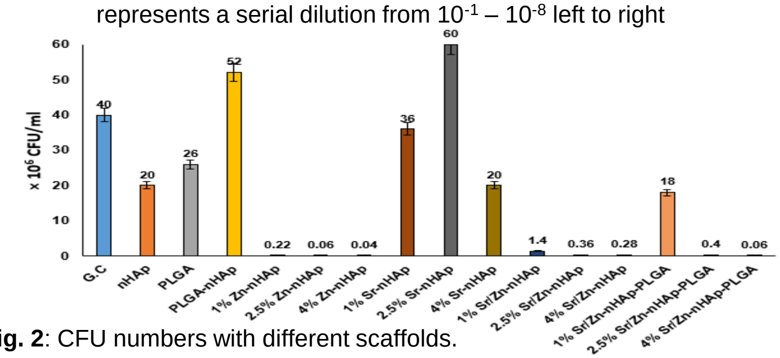

Fig. 2: CFU numbers with different scaffolds.

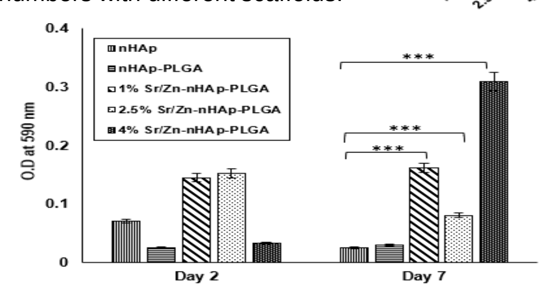

Fig. 3: MTT assay. *** $p < 0.001$ compared to nHAp.

Conclusion

These findings demonstrate the potential for a 4% Sr/Zn-nHAp-PLGA scaffold with enhanced antibacterial activity and cytocompatibility as a suitable candidate for bone regeneration.

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