

Development and in vitro evaluation of nano-hydroxyapatite-based biomaterial for enamel remineralization in early carious lesions

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Statement of the Problem: The management of early-stage dental caries has shifted towards non-invasive remineralization strategies. Biomimetic materials like nano-hydroxyapatite (nHAp) offer promising potential due to their structural similarity to natural enamel. This study explores the development of a novel nHAp-based biomaterial enhanced with fluoride ions and evaluates its efficacy in remineralizing early carious lesions.

Methodology : A composite biomaterial was synthesized using sol-gel techniques to produce nano-hydroxyapatite particles (20–80 nm) doped with fluoride ions. Human enamel specimens with artificially induced early carious lesions were divided into three groups: Group A (control), Group B (treated with commercial fluoride toothpaste), and Group C (treated with nHAp-fluoride composite). Samples were subjected to pH cycling for 10 days to simulate the oral environment. Surface hardness was measured using Vickers microhardness testing, and remineralization was assessed via scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDX).

Results: Group C exhibited the highest increase in microhardness (32% improvement) compared to Group B (18%) and Group A (2%). SEM images revealed smoother, more uniform enamel surfaces in Group C, with EDX confirming higher calcium and phosphate deposition. The fluoride-doped nHAp composite significantly enhanced mineral uptake, indicating effective enamel repair.

Conclusion & Significance: The novel fluoride-doped nano-hydroxyapatite biomaterial demonstrated superior enamel remineralization capabilities compared to conventional fluoride treatments. Its structural compatibility with natural enamel and ability to restore mineral density highlight its potential in early caries management and preventive oral care.

Biography

Farah Nadeem is a biomaterials researcher and academic with over 12 years of experience in dental tissue engineering and restorative material development. She holds a Ph.D. in Biomaterials Science from McGill University. Her research focuses on the synthesis and clinical translation of nanostructured materials for oral regeneration. Dr. Nadeem has authored numerous peer-reviewed publications and is actively involved in national dental health innovation projects across Canada.

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