Oral Presentation

Development and Physicochemical Characterization of Collagen-Enhanced Silk Fibroin–Kappa-Carrageenan Scaffolds for Vital Pulp Therapy in Young Permanent Teeth

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ABSTRACT

Vital pulp therapy in young permanent teeth requires scaffolds that balance both biological function as well as mechanical stability. Here, we engineered porous scaffolds by blending collagen, silk fibroin (SF) and Kappa-carrageenan (KC) via freeze-drying method, with incremental collagen incorporation (50–200 mg) to enhance the odontogenic potential. Scaffold composition and ionic crosslinking (K^+, Ca^{2+}) were optimized to closely mimic the dental pulp extracellular matrix. Comprehensive physicochemical analyses including SEM, FTIR, DSC, TGA, contact angle measurements and 3D profilometry confirmed successful polymer integration, interconnected microarchitecture and favorable hydrophilicity. Among the tested formulations, a 2:1 SF:KC ratio displayed optimal porosity, surface roughness and hydrophilicity, while 1:2 SF:KC scaffolds exhibited superior thermal stability. These results establish a clear structure–property framework for natural polymer scaffolds, addressing challenges in reproducibility, controlled degradation and biological suitability. The engineered composites hold significant promise as next-generation bioactive materials for vital pulp therapy, supporting continued root development and improved long-term outcomes in pediatric endodontics. This study provides a blueprint for designing clinically relevant scaffolds that combine regenerative potential with functional stability.

Keywords: Vital pulp therapy, Silk fibroin, κ-Carrageenan, Collagen scaffold, Physicochemical characterization, Regenerative endodontics.

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