הטכניון - מכון טכנולוגי לישראל

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הפקולטה לרפואה ע״ש רות וברוך רפפורט
The Ruth and Bruce Rappaport Faculty of Medicine

The Ruth and Bruce Rappaport Faculty of Medicine at the Technion – Israel Institute of Technology

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Room 4

Development and Characterization of Crystalline-based Drug Delivery Formulations for Potential Dental Applications

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MSc Seminar

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Peri-implantitis is a multifactorial disease characterized by bacterial biofilm accumulation and immune-mediated bone loss. Traditional drug delivery systems (DDSs) often rely on polymeric or lipid-based carriers, which can induce inflammatory responses and limit drug loading capacity. To overcome these limitations, this study introduces a novel carrier-free crystalline formulation for the localized release of two therapeutic agents—one antimicrobial and one immunomodulatory—tested separately to evaluate their individual properties and release behavior.

The oral cavity presents a unique challenge for drug delivery due to continuous salivary flow, physiological activities like eating and swallowing, and a complex microbial environment. While localized drug delivery enhances therapeutic efficacy and minimizes systemic exposure, achieving sustained drug retention, under such conditions, remains difficult. Addressing this challenge, our research develops crystalline formulations designed for prolonged local drug release, targeting both bacterial colonization and immune regulation in peri-implantitis. Two drug models were used in this study, where the antimicrobial component prevents biofilm formation on implant surfaces, while the immunomodulatory component modulates macrophage activity to reduce inflammation and mitigate immune-driven bone loss. Each crystalline formulation was thoroughly characterized using various analytical techniques. Thermal properties and phase transitions were assessed via thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC). Drug release kinetics were evaluated through in vitro release studies, while scanning electron microscopy (SEM) and optical microscopy provided insights into crystal habit, morphology, and size. Structural properties were analyzed using

single-crystal X-ray diffraction (SXRD) and powder X-ray diffraction (PXRD) to confirm crystallinity and phase purity.

Together, these findings contribute to the advancement of precision drug delivery in dentistry. This research establishes a high-efficiency, carrier-free DDS that effectively targets key elements of microbial and immune-mediated aspects of peri-implantitis for potential localized application.