UNIVERSITI TEKNOLOGI MARA

FABRICATION OF SIMVASTATIN LOADED POROUS PLGA SCAFFOLD: IMPROVING THE MECHANICAL STRENGTH FOR BONE TISSUE ENGINEERING

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ABSTRACT

The use of poly(lactic-coglycolic acid) (PLGA) in the form of simvastatin (SIM) with porous PLGA microparticles (PMP) often results in an initial uncontrolled burst of drug release and compromised mechanical integrity. Addressing these limitations is crucial for enhancing the therapeutic efficacy of these delivery systems. **Objective:** This study aims to improve the structural, release, and mechanical properties of porous SIM/PMP by incorporating various polymers: chitosan (Chi), pectin (Pec), and pluronic F127 (F127). **Methodology:** Employing a modified double emulsion solvent evaporation method, two method modifications were tested. In Method Modification 1 (MM1), biopolymers were integrated into the internal aqueous phase, while Method Modification 2 (MM2) involved adding them to the external phase. The samples underwent lyophilization and were stored for analysis. **Results:** The study revealed that 1.0% Chi SIM/PMP (MM2) significantly reduced the initial burst release of SIM, maintaining a controlled release over 21 days, as confirmed by High-Performance Liquid Chromatography (HPLC). Additionally, pluronic F127 enhanced the compressive strength of the scaffolds, surpassing both pectin and chitosan. **Conclusion:** Pluronic F127, a synthetic block copolymer, was identified as the most effective biopolymer for augmenting the release and mechanical properties of SIM/PMP scaffolds. This research highlights the potential of specific biopolymers in overcoming the inherent limitations of porous SIM/PMP microparticles, paving the way for more efficient drug delivery systems.

Keywords

Simvastatin, PLGA, Microparticle, Chitosan, Pluronic F127, Pectin, Drug delivery, Bone Tissue Engineering

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CHAPTER ONE
INTRODUCTION

1.1 Research Background

Bone tissue has a self-healing ability for small defects less than 6 mm, but severely damaging bone tissue puts it beyond self-recovery (Pereira et al., 2020; Culla et al., 2022; Koushik et al., 2023). Significant bone injuries or defects brought on by old age, car accidents, fracture non-union, or the removal of a bone tumour are major issues in orthopaedics that have a negative impact on one's health and quality of life (Qu et al., 2019). Several forms of bone grafts, such as autografts, allografts, and synthetic grafts, have been employed to correct these problems. However, all three sources have drawbacks. For example, there is a limited supply of autologous bone, which can result in donor site complications and graft resorption issues, whereas allograft and xenograft bone are associated with issues such as incompatibility with the host and transmission of disease and infection. In addition, all three presents with high surgical costs and therefore tissue regeneration is seen as an appealing strategy for bone repair.

In regard to this matter, bone tissue engineering was introduced with the aim to promote new functional bone regeneration by utilizing a synergistic combination of scaffolds, cells, and growth factors, where these three are regarded as the important factors in tissue engineering (Ruiz-Alonso et al., 2021; Francis et al., 2023). Tissue engineering scaffolds are being developed to regenerate or repair tissues and organs in order to overcome the limitations of traditional grafts used for tissue or organ repair caused by an insufficiency of suitable autograft (patient's own tissue) and allograft (third party tissue) (Amini, Laurencin, et al., 2012). Scaffolds, which are typically made of polymeric biomaterials, are important in tissue regeneration to provide mechanical support, adequate transport of nutrients and oxygen, and the transmission of biochemical signals that modulate cells. The goal of this strategy is to create a microenvironment that encourages cell growth, recruitment, adhesion, proliferation, and differentiation.