INTISARI

Fraktur dan tindakan bedah tulang dapat memicu resiko infeksi *osteomyelitis* sehingga memerlukan terapi antibiotik. Penggunaan antibiotik oral kurang efektif pada infeksi tulang karena adanya devaskularisasi jaringan di sekitar tulang dan pembentukan *biofilm* oleh bakteri serta berisiko menimbulkan resistensi dan toksisitas. Oleh karena itu, sediaan implan nanofiber vankomisin (VAN) dirancang mampu melepaskan obat secara lokal dan terkontrol, sekaligus bersifat osteokonduktif untuk membantu regenerasi tulang. Penelitian ini bertujuan untuk menghasilkan sediaan implan nanofiber vankomisin dengan karakter fisik yang optimal serta profil pelepasan terkontrol selama 28 hari. Proses penelitian dimulai dengan optimasi suhu dan waktu pada sintesis *bovine hydroxyapatite* (BHA) dari tulang tibia sapi menggunakan desain faktorial. Selanjutnya, dilakukan optimasi formula nanofiber vankomisin berbasis PLGA-NBHA-PEG melalui teknik elektrospinning dengan pendekatan *Response Surface Methodology* (RSM). Hasil optimasi proses pada sintesis BHA didapatkan pada suhu 1100℃ selama 6 jam pada pH sintesis 11 yang menghasilkan BHA dengan rasio Ca/P 1,67, densitas partikel 0,884±0,004 g/mL dan nilai kristalinitas 85,82%. Pada tahap pembentukan *nano bovine hydroxyapatite* (NBHA) didapatkan diameter partikel NBHA 94,03±5,90 nm. Formula optimal nanofiber VAN didapatkan pada perbandingan konsentrasi PLGA 50:50 (7,63 %), NBHA (1,370%) dan PEG 6000 (5%) yang memiliki diameter fiber dengan ukuran 91,42±0,85 nm, kekuatan tarik 2,152±0,289. Hasil uji FTIR menunjukkan adanya gugus fungsi khas dari masing-masing komponen, seperti gugus karbonil (C=O), fosfat (PO_4^{3-}), dan hidroksil (O–H/N–H) yang teridentifikasi pada spektrum. Uji pelepasan pada implan nanofiber vankomisin menunjukkan efisiensi disolusi 67,74% dalam 28 hari dengan model kinetika pelepasan Peppas–Sahlin pada fase awal dan model Higuchi pada fase lanjutan. Kesimpulan hasil penelitian menunjukkan bahwa proses sintesis BHA optimum diperoleh pada suhu 1100℃ selama 6 jam pada pH 11 dan formula nanofiber vankomisin optimum pada matriks dengan perbandingan konsentrasi PLGA 50:50 (7,63 %), NBHA (1,370%) dan PEG 6000 (5%) berpotensi sebagai terapi *osteomyelitis.*

Kata kunci: Elektrospinnig, Implan, Nanofiber, *Osteomyelitis*, Vankomisin

ABSTRACT

Bone fractures and surgical interventions may increase the risk of osteomyelitis infection, thereby requiring antibiotic therapy. However, oral antibiotic administration is less effective in treating bone infections due to devascularization of the surrounding tissue and the formation of bacterial biofilms, as well as the associated risks of resistance and systemic toxicity. Therefore, a vancomycin (VAN) nanofiber implant formulation has been developed, designed to release the drug locally and in a controlled manner while also exhibiting osteoconductive properties to facilitate bone regeneration. This study aims to develop a vancomycin nanofiber implant with optimal physical characteristics and a controlled release profile over 28 days. The research began with the optimization of temperature and duration during the synthesis of bovine hydroxyapatite (BHA) from bovine tibia bone using a factorial design. Subsequently, the vancomycin nanofiber formulation based on PLGA-NBHA-PEG was optimized via electrospinning using Response Surface Methodology (RSM). The optimal conditions for BHA synthesis were achieved at 1100℃ for 6 hours at pH 11, resulting in BHA with a Ca/P ratio of 1.67, particle density of 0.884 ± 0.004 g/mL, and crystallinity of 85.82%. During the nano bovine hydroxyapatite (NBHA) formation stage, the particle diameter was 94.03 ± 5.90 nm. The optimal vancomycin nanofiber formulation consisted of PLGA 50:50 (7.63%), NBHA (1.37%), and PEG 6000 (5%), producing fibers with an average diameter of 91.42 ± 0.85 nm and tensile strength of 2.152 ± 0.289 MPa. Fourier-transform infrared spectroscopy (FTIR) analysis confirmed the presence of characteristic functional groups from each component, including carbonyl (C=O), phosphate (PO_4^{3-}), and hydroxyl (O–H/N–H) groups. The release test of the vancomycin nanofiber implant demonstrated a dissolution efficiency of 67.74% over 28 days, with the release profile following the Peppas–Sahlin kinetic model during the initial phase and the Higuchi model during the later phase. The findings indicate that the optimal synthesis of bovine hydroxyapatite (BHA) was achieved at a temperature of 1100℃ for 6 hours at pH 11, while the optimal vancomycin nanofiber formulation with a matrix composition of PLGA 50:50 (7.63%), NBHA (1.370%), and PEG 6000 (5%) demonstrates potential as an effective therapeutic system for osteomyelitis treatment.

Keywords: Electrospinning, Implant, Nanofiber, Osteomyelitis, Vancomycin