Development of Multilayer Nanofiber Wound Dressings Enhanced with Bio-Selected Stingless Bee and Manuka Honey via Electrospinning

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Abstract

Chronic diabetic wounds remain a critical public health challenge, as conventional dressings such as gauze tend to adhere to regenerating tissue, causing re-injury upon removal, and fail to maintain proper moisture balance. This study aimed to develop a multilayer nanofiber wound dressing incorporating the bioactivity of stingless bee honey, a locally sourced bioresource, in comparison with Manuka honey, a widely used medical-grade honey, via electrospinning. Preliminary bioactivity screening using DPPH, protein denaturation, and antiglycation assays showed that stingless bee honey exhibited higher antioxidant activity, while Manuka honey showed superior anti-inflammatory and anti-glycation effects. However, stingless bee honey retained its bioactivity more stably when blended with polyvinyl alcohol (PVA), and was therefore selected for fiber fabrication. The optimal condition, 10% wt honey in PVA at a flow rate of 0.3 mL/hr, produced continuous, bead-free fibers with an average diameter of 456.57 ± 25.64 nm. This active layer was further developed into a bilayer structure by overspinning with polycaprolactone (PCL) and integrating a medical-grade bordered adhesive. The bilayer structure significantly enhanced water resistance, reducing permeability from 25.39% to 0%, increased tensile strength to 5.75 MPa, nearly doubled elongation at break, and sustained over 60% bioactivity for up to 7 days. The prototype caused no damage to simulated skin and withstood more than 50 flexion cycles without detachment. This innovation demonstrates strong potential as an accessible, cost-effective smart wound dressing to advance chronic wound care for diabetic patients.

Keywords: nanofiber wound dressing, stingless bee honey, Manuka honey, electrospinning, diabetic chronic wound.