



Modified gauze impregnated with SBH-based Ag-NPs, ZnO-NPs, and bimetallic Ag/ZnO-NPs for enhancing wound healing efficacy

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ABSTRACT

The study aims to evaluate the wound healing efficacy of modified gauze impregnated with Stingless Bee Honey (SBH)-based silver nanoparticles (Ag-NPs), zinc oxide nanoparticles (ZnO-NPs), and bimetallic silver-zinc oxide nanoparticles (Ag/ZnO-NPs). The antimicrobial properties of these nanoparticles against *Staphylococcus aureus* (*S. aureus*) and *Escherichia coli* (*E. coli*) were also investigated, focusing on their potential as advanced wound care dressings. Gauze was impregnated with SBH-based Ag-NPs, ZnO-NPs, and Ag/ZnO-NPs and tested for antimicrobial activity by determining the zone of inhibition (ZOI). Wound healing efficacy was evaluated in a comparative study using Sprague-Dawley rats with full-thickness wounds ($n = 6$ per group). Wound closure rates were measured at different time points; 0, 4, 8, 12, 16, and 20 days with statistical analysis performed using one-way ANOVA. ZnO-NPs demonstrated the highest wound closure rate, achieving a healing improvement of 50.54% by day 4, meanwhile Ag-NPs and bimetallic Ag/ZnO-NPs exhibited healing improvements of 38.12% and 35.13% on the same day, respectively. However, after 8 days, bimetallic Ag/ZnO-NPs showed the consistent highest healing rate until the end of the study. Antimicrobial testing revealed significant inhibition zones for all nanoparticle types against *S. aureus* and *E. coli*, with Ag-NPs showing consistency activity, suggesting their potential as an advanced wound care dressing. ZnO-NPs and Ag/ZnO-NPs also showed efficacy, albeit to a lesser extent. These findings highlight the feasibility of nanoparticle-impregnated gauze for effective wound management.

1. Introduction

Wound healing is a multifaceted and dynamic process that necessitates the coordinated interaction of cells, growth factors, and the extracellular matrix to restore tissue integrity and function (Kida et al., 2020). This intricate process unfolds in several overlapping stages, including haemostasis, inflammation, proliferation, and remodelling. Various factors, including infections, inflammation, and slow tissue regeneration, can significantly impede this process, particularly in chronic wounds where healing is notably prolonged and complicated (Fallah et al., 2021; Okur et al., 2020; Scepankova et al., 2021). The

presence of underlying health conditions such as diabetes or vascular insufficiencies can further exacerbate these issues, leading to increased morbidity and healthcare costs. Conventional wound dressings, such as gauze and hydrocolloids, primarily function as protective barriers against external contaminants. However, they are often limited in their ability to prevent infections or actively promote tissue regeneration, which can result in complications and extended recovery times (Ezzelarab et al., 2019; Lotfinia et al., 2023).

In response to these limitations, there has been growing interest in utilising natural substances with proven medicinal properties for enhancing wound care. One such candidate is Stingless Bee Honey

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