BIMETALLIC Au-Ag NANOPARTICLES LOADED NANOFIBERS FOR THE POTENTIAL TREATMENT AGAINST ANTIMICROBIAL RESISTANT WOUND INFECTIONS

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By

ANKIT KUMAR MALIK

Department of Pharmaceutical Engineering & Technology
Indian Institute of Technology
(Banaras Hindu University)
Varanasi-221005
India

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6. Summary and conclusions

This research collectively demonstrates the significant potential of bimetallic nanoparticle-integrated biopolymer systems for accelerating the healing of multidrug-resistant (MDR) microbial wound infections, offering efficacy without the adverse effects associated with conventional formulations. Two distinct but complementary approaches were explored: Au-Ag-TMC-NPs-NFs (using trimethyl chitosan) and G-S-CMC-Pep-NPs-NFs (incorporating the LL-37 peptide with carboxymethyl cellulose). Both systems function through a dual mechanism: targeting MDR pathogens by downregulating efflux pump gene expression to overcome resistance, while simultaneously promoting tissue regeneration. Critically, both dressings provided sustained, controlled release of therapeutic agents directly at the wound site, enabling accelerated healing within a 12-day timeframe.

Molecular validation via western blot analysis confirmed a key shared outcome: enhanced collagen deposition, a critical factor in tissue repair and wound closure. This molecular evidence strongly suggests both formulations actively stimulate the underlying biological processes of healing. Furthermore, real-time monitoring using ultrasound/photoacoustic imaging provided consistent, non-invasive confirmation of improved healing dynamics across both systems. This included increased vascularity, improved oxygen saturation levels, and a greater degree of wound closure, offering direct visual and functional proof of efficacy.

Despite these promising results, the studies share notable limitations. Both investigations relied on MDR microbial strains isolated solely from local hospitals, potentially limiting the generalizability of the findings against globally diverse MDR pathogens. Additionally, each study evaluated only a single therapeutic delivery system (the respective nanofiber dressing). Future research must therefore expand the scope: testing these formulations against MDR isolates from diverse geographical locations and

exploring alternative delivery platforms (e.g., hydrogels, sprays, films) to optimize applicability and performance.

In conclusion, the Au-Ag-TMC-NPs-NFs and G-S-CMC-Pep-NPs-NFs dressings represent highly promising platforms. Their demonstrated ability to combat MDR infections while actively promoting tissue regeneration—validated through molecular biology and advanced imaging—positions them as strong candidates for clinical translation. They provide a robust foundation for developing next-generation, dual-function wound therapies that effectively address the critical challenges of antimicrobial resistance and impaired healing. Future work focusing on broader pathogen testing and delivery method diversification will be essential to fully realize their potential impact on wound care.