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Frontiers in nanomedicine: unlocking wound healing potentials with PVP-capped gold and silver nanoparticles and nanorods

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Recent advancements in nanotechnology have opened new avenues in medical applications, particularly in wound healing. This study explores the efficacy of gold (Au) and silver (Ag) spherical nanoparticles (NS), capped with polyvinylpyrrolidone (PVP), alongside PVP-capped Au and Ag nanorods (NR), in promoting wound healing. Both NSs and NRs were synthesized using a green chemical reduction method in water. The experimental parameters for the synthesis were exploited to ensure the highest monodispersity, biocompatibility and stability upon ageing.

Comprehensive physicochemical characterizations were conducted. Atomic Force Microscopy (AFM) provided detailed morphological insights of the nanostructures. UV-Visible Spectroscopy (UV-vis) was utilized to assess the plasmonic properties and optical features (molar extinction, optical diameter, aspect ratio, particle concentration). Dynamic Light Scattering (DLS) and Z-potential analyses offered information on the size distribution and stability of the colloidal suspensions.

In vitro tests of cell migration on murine fibroblasts by the scratch assay demonstrated the capability of NSs and NRs to promote or inhibit the wound healing process, depending on the specific conditions that, in turn, affect the cytotoxicity and reactive oxygen species (ROS) production, as measured MTT and MitoSOX assays, respectively. Laser confocal microscopy (LSM) imaging supported these findings by evidencing different levels of perturbation for mitochondria, lysosomes, and nuclei.

The synergistic effects of the metallic nature of the nanoparticles and nanorods, combined with the stabilizing and biocompatible influence of PVP, highlight a promising direction for advanced wound healing therapies. This study not only demonstrates the potential of these nanomaterials in medical applications but also lays the groundwork for future research into their clinical applicability.