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Physicochemical Characterisation and Antibacterial Activities of Cerium Oxide Nanoparticles

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Diabetic wounds represent a complex biophysical microenvironment characterised by sustained inflammation, excess reactive oxygenated species, impaired fibroblastic proliferation, and prevalent bacterial infections, particularly P. aeruginosa. Dysregulated redox homeostasis and altered cellular responses in diabetic tissue significantly compromise wound healing. Although conventional therapies, including hormonal regulation, pressure reduction, wound debridement, and antibiotic treatments, have long served as the foundational approach to the management of diabetic wounds, the increased disease recurrence and heightened bacterial progression have highlighted the limitations of traditional methods. Therefore, this study evaluates the biophysical and bacterial interaction between green-synthesised cerium oxide nanoparticles (CeO2 NPs) and both P. aeruginosa bacterial and mammalian wounded cells. The comprehensive physicochemical characterisation will be used to demonstrate the band gap energy, hydrodynamic size, morphological properties, and redox activity. Additionally, the biophysical evaluation, including antibacterial assays against P. aeruginosa, will demonstrate a concentration-dependent response mediated through membrane interactions. Moreover, the application of CeO2 NPs in fibroblasts will enhance the viability and proliferative responses under oxidative stress conditions, suggesting restoration of redox equilibrium and improved metabolic activity. These findings support the potential integration of complementary bioenergetic modulation strategies in future investigations. Furthermore, the collective findings will enhance the biophysical understanding of nanobio interactions in diabetic wounds while advocating the advancement of redox-active plant-derived nanoparticles designed for resource-constrained environments.

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