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Article title	Green Synthesis and Characterization of ZnO Nanoparticles Using *Pelargonium odoratissimum* (L.) Aqueous Leaf Extract and Their Antioxidant, Antibacterial and Anti-inflammatory Activities.
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Abstract

Nanoparticles (NPs) exhibit distinct features compared to traditional physico-chemical synthesis and they have many applications in a wide range of fields of life sciences such as surface coating agents, catalysts, food packaging, corrosion protection, environmental remediation, electronics, biomedical and antimicrobial. Green-synthesized metal NPs, mainly from plant sources, have gained a lot of attention due to their intrinsic characteristics like eco-friendliness, rapidity and cost-effectiveness. In this study, zinc oxide (ZnO) NPs have been synthesized employing an aqueous leaf extract of *Pelargonium odoratissimum* (L.) as a reducing agent; subsequently, the biosynthesized ZnO NPs were characterized by ultraviolet-visible spectroscopy (UV-Vis), dynamic light scattering (DLS), Fourier transform infrared (FTIR) spectroscopy, X-ray diffraction (XRD), field emission scanning electron microscopy (FESEM) and energy-dispersive X-ray spectroscopy (EDX), high-resolution transmission electron microscopy (HRTEM) and selected area electron diffraction (SAED). Moreover, aqueous plant leaf extract was subjected to both qualitative and quantitative analysis. Antioxidant activity of ZnO NPs was assessed by DPPH assay, with varying concentrations of ZnO NPs, which revealed scavenging activity with IC_{50} = 28.11 µg.mL^{-1}. Furthermore, the anti-bacterial efficacy of the green synthesized ZnO NPs against four foodborne pathogenic bacterial strains was examined using the disk

diffusion assay, and *Staphylococcus aureus* (ATCC 8095), *Pseudomonas aeruginosa* (ATCC10662) and *Escherichia coli* (ATCC 25922) were found to be the most sensitive against biosynthesized ZnO NPs, whereas the least sensitivity was shown by *Bacillus cereus* (ATCC 13753). The anti-inflammatory effect was also evaluated for both ZnO NPs and the aqueous leaf extract of *P. odoratissimum* through the human red blood cells (HRBC) membrane stabilization method (MSM) *in vitro* models which includes hypotonicity-induced hemolysis. A maximum membrane stabilization of ZnO NPs was found to be 95.6% at a dose of 1000 $\mu g.mL^{-1}$ compared with the standard indomethacin. The results demonstrated that leaf extract of *P. odoratissimum* is suitable for synthesizing ZnO NPs, with antioxidant, antibacterial as well as superior anti-inflammatory activity by improving the membrane stability of lysosome cells, which have physiological properties similar to erythrocyte membrane cells and have no hemolytic activity. Overall, this study provides biosynthesized ZnO NPs that can be used as a safe alternative to synthetic substances as well as a potential candidate for antioxidants, antibacterial and anti-inflammatory uses in the biomedical and pharmaceutical industries.

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