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Green synthesized silver nanoparticles promote macrophage activation and antibacterial immunity

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Received 6 October 2025; revised 12 November 2025

Urgently needed new antimicrobial strategies due to antibiotic resistance. This study aimed to develop and evaluate green-synthesized silver nanoparticles (AgNPs) with *Aloe vera* leaf extract as a low-cytotoxic, safe method to boost innate immunity. The nanoparticles were characterized by TEM, showing spherical particles 15–25 nm in size with a zeta potential of −28.6 mV, indicating high colloidal stability. UV–Vis analysis displayed a clear surface plasmon resonance peak at 420 nm. The murine macrophage cell line RAW 264.7 was used to assess cytocompatibility and immunostimulatory activity through nitric oxide release and cytokine (TNF-α, IL-6) production. Assays for macrophage clearance, minimum bactericidal concentration (MBC), and minimum inhibitory concentration (MIC) were conducted to evaluate antibacterial effectiveness against *Staphylococcus aureus* and *Escherichia coli*. The biosynthesized AgNPs maintained macrophage viability, increased pro-inflammatory cytokine and nitric oxide production at non-toxic levels, and exhibited strong antibacterial activity with low MIC and MBC values. Green-synthesized AgNPs can serve as effective, low-toxicity agents combining antimicrobial and immune-stimulating properties to help combat antibiotic resistance, as demonstrated by the enhanced bacterial clearance shown by treated macrophages.

Keywords: *Aloe vera* extract, biosynthesis, RAW 264.7 macrophages, nitric oxide, cytokine modulation, antibacterial activity