Sustainable Synthesis of Silver Nanoparticles Using Aloe Vera Gel: Nature's Antimicrobial Marvel

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ABSTRACT

Introduction: In the ever-evolving landscape of nanotechnology, the synthesis of nanoparticles has witnessed a transformative shift towards sustainable and environmentally conscious methodologies. Traditional approaches, often marred by the use of toxic chemicals, have spurred concerns about environmental impact and human health[1]. In response to these challenges, this research embarks on a pioneering exploration, centering on the optimization and characterization of Aloe Vera Gel (AVG)-Silver Nitrate ($AgNO_3$) complexes for the eco-friendly synthesis of silver nanoparticles (AgNPs)[3]. Unlike conventional methods, this research employs Aloe Vera extract as the sole reducing agent, underscoring a commitment to sustainable practices[2]. The resulting nanoparticles demonstrate promising outcomes, showcasing the potential of Aloe Vera as a potent reducing agent for AgNPs. The controlled synthesis method, with particle sizes within a crucial range, not only emphasizes the efficacy of the green synthesis but also opens avenues for controlled nanoparticle production—a significant stride in this field[3]. This study delves into the multifaceted applications of these eco-friendly synthesized AgNPs, particularly their breakthrough potential as antimicrobial agents, revolutionizing biomedical approaches to combat pathogens[3]. The versatility extends to wound healing techniques and drug delivery systems, addressing critical needs in healthcare. Throughout this investigation, Aloe Vera emerges as a remarkable bioresource, with its gel's bioactive compounds serving as a key player in the green synthesis of AgNPs[4].

Objectives:

- Optimize Aloe Vera Gel-Silver Nitrate complexes for efficient silver nanoparticle (AgNP) synthesis.
- Evaluate Aloe Vera as a green reducing agent, comparing its efficacy with traditional methods.
- Assess biomedical applications of eco-friendly AgNPs, particularly in antimicrobial and wound healing contexts.

Methodology: Fresh aloe vera leaves solution, obtained through this meticulous process, was stored at ambient temperature for subsequent utilization in further experimental procedures. The aloe vera leaf extract was subjected to optimization processes, involving varying ratios and different molarity concentrations. The characterization process utilized Scanning Electron Microscopy (SEM) for morphology, Fourier Transform Infrared Spectroscopy (FTIR) for surface functional groups, Antimicrobial Activity Testing for pathogen-fighting capabilities, and Energy-Dispersive X-ray Spectroscopy (EDX) for elemental composition analysis.

Conclusion/Results: The identification of Ag NPs was accomplished using a UV-Visible spectrophotometer. Maximum absorbance observed at 400 nm. The characterized Ag NPs demonstrated crystalline structures and potent antibacterial activities. The EDX analysis confirmed the dominant presence of elemental silver in the synthesized nanoparticles, validating the success of the green synthesis using Aloe Vera and $AgNO_3$. SEM images displayed well-dispersed, spherical nanoparticles with an average size. The absence of agglomeration and smooth surface morphology highlighted the efficacy of Aloe Vera in the eco-friendly synthesis of silver nanoparticles This systematic investigation provides valuable insights into the

optimized formation of AVG-$AgNO_3$ complexes, paving the way for their potential applications in fields such as antimicrobial agents, wound healing, and drug delivery systems.

Keywords: AgNPs, Aloe Vera Gel Extract, Ecofriendly, Green Synthesis, Sustainability.

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