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EXTENDED ABSTRACT BOOK

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A Review on Synthesis of Silver Oxide Nanoparticles

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ABSTRACT

This review discusses the synthesis, characterization and the antimicrobial properties of silver oxide nanoparticles (AgO NPs), including their importance for the growling dispute with antibiotic-resistant pathogens. The recent advancement in nanotechnology has established AgO NPs as one of the key interest areas because of their distinguished physicochemical characteristics such as high surface to volume ratios, and their exceptional antibacterial, antifungal and catalytic activities. These qualities render AgO NPs highly adaptable for use in medical, environmental and industrial sectors. The review points out existing gaps in knowledge regarding optimal synthesis techniques, the influence of nanoparticle size and shape on antimicrobial effectiveness, and the specific mechanisms by which AgO NPs exert their antimicrobial effects. AgO NPs are synthesized using chemical, physical and biological methods. To confirm that the nanoparticles are as per basic specifications of size, shape and stability, characterization techniques like dynamic light scattering (DLS), scanning electron microscopy (SEM) and X-ray diffraction (XRD) have been employed. These nanoparticles exhibit antimicrobial properties by disrupting microbial membranes, producing different reactive oxygen species (ROS), and interfering with the synthesis of DNA and proteins in microorganisms. Such multiple actions increase their efficacy against strains with multidrug resistance. This review aims at acquiring knowledge of the synthesis methods and expanding the understanding of the antimicrobial therapies in applications such as environmental remediation and targeted drug delivery.

Keywords: Silver Oxide Nanoparticles, Synthesis, Antimicrobial, Antibacterial, Reactive Oxygen Species.

1. INTRODUCTION

This review summarized the area of silver oxide nanoparticles (AgO NPs) with focus on their synthesis routes, physical and chemical properties, antimicrobial mechanisms, with particular emphasis on the ways to optimize them for biomedical and environmental applications. The main problem is set against the backdrop of the urgent need for new antimicrobial pathways as these pathogens are reaching levels of antibiotic resistance across the globe; purportedly, another aspect is that little is known about how synthesis parameters, morphology, and molecular pathways affect the antimicrobial performance of AgO NPs (Rodrigues et al,. 2024). The current literature points out three major routes of synthesis, i.e., chemical, physical, and biological (green) methods, all with its own

merits and demerits (Muhammad et al., 2023). Green synthesis harnesses the power of plant extracts or microbes and has turned popular due to its eco-friendly nature and the fact that it can boost biocompatibility (Fayyadh et al., 2021; Saka et al,. 2024). Smaller particles (<10 nm), perhaps coupled with non-spherical morphologies, tend to have higher antimicrobial activity due to enhanced surface reactivity and better interaction with microbes (Abbas et al., 2024; Aguilar-Garay et al., 2024). From a mechanistic standpoint, AgO NPs exert their action through multiple targets: membrane disruption, oxidative stress induction, stopping DNA or protein synthesis, and interference in signal transduction. Thus, these AgO NPs might act as a good option versus multidrug-resistant microorganisms (Kodintcev, 2022; Kamat & Kumari, 2023).

2. METHODOLOGY

The articles were searched in Scopus database search engine for the year 2015 and above. Any articles show the Silver Oxide Nanoparticles sytesization, characterization, antibacterial activity including membrane rupture, Ag^{+} ion release, and ROS formation (killing mechanism) were selected and examined in this review.

3. RESULTS AND DISCUSSION

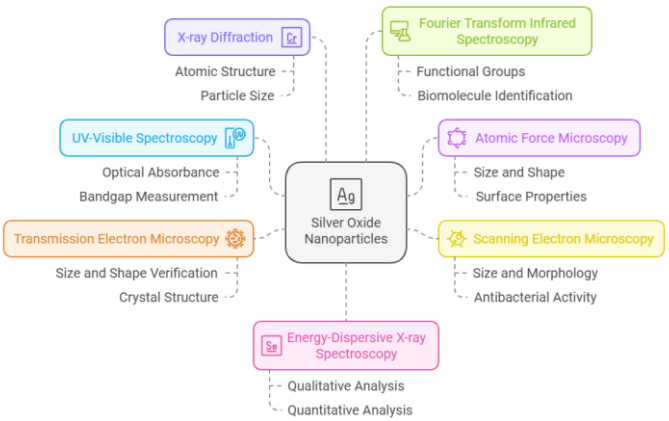


Figure 1. Various Characterization Technique

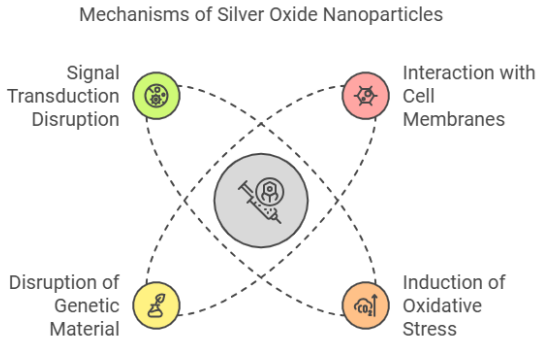


Figure 2. Mechanism in Silver Oxide Nanoparticles

Table 1. Key Feature Of Synthesis Method Of Silver Oxide Nanoparticles (Zhang et al., 2016)

Synthesis Method	Key Features	Limitation
Sol gel method	Controlled particle size and morphology	Time-consuming, potential toxicity from precursors
Micro-emulsion	Homogenous, well-characterized surface features	Requires surfactants, possible cytotoxicity
Electrochemical synthesis	High purity, no stabilizers required	Require precise reaction control
Microbial synthesis	Enzymatic reduction, sustainable	Slow process, requires controlled microbial growth
Evaporation-condesation	High purity, controlled environment	Energy-intensive specialized equipment needed
Laser ablation	No chemical contamination	Expensive laser equipment required
Sputtering	Produces uniform, high-purity nanoparticles	Costly vacuum systems needed

4. CONCLUSION

In conclusion, silver oxide nanoparticles (AgO NPs) synthesized via green methods such as those utilizing *Lawsonia inermis* extracts, are both eco-friendly and effective antimicrobial agents. The particle size and shape are critical determinants of their efficacy as smaller and well-defined nanoparticles demonstrate superior antimicrobial performance. AgO NPs exert their effects through multiple biological pathways, including membrane disruption, oxidative stress induction, interference with genetic material and inhibition of signal trasnduction. This multi-targeted action makes them highly potent against drug-resistant microorganis.

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