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A Review On Green Synthesis Of Gold/Silver Nanopraticles Using Bacteria

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ABSTRACT:

Nanoparticles contribute to eco-friendly and convent to physical and chemical methodand sustainable of green synthesis.In this review bacteria has biological factories breakdown of gold/silver nanoparticles of their capability to decrease metal ions from metabolic and enzymatic process. The bacterial cell compounds and metabolites have ability to reduce and stabilizing agent that have capability to formation of nanoparticles with under control morphology and size.The green synthesis is a eco-friendly synthesis which leads to usage of harmful chemical,decreases consumption of energy and pose pathway of sustainable in high scale production of nanoparticles.Their are varies techniques which are used gold/silver nanoparticles as characterized while biosynthesis,techniques such as Fourier Transform Infrared Spectroscopy [FITR],Scanning Electron Microscopy[SEM],UV-Visible Spectroscopy,X-Ray Diffraction[XRD].The nanoparticles are synthesized and they contribute important to antioxidants activity and significant microbial.They leads to environmental remediation production of medicines and nanotechnology.Synthesis of gold/silver nanoparticles process is eco-friendly which is harmless to environment.

INTRODUCTION:

It is a science of creating new materials,systems and devices within nanoscale between 1 to 100 nm using any matters by manipulating it is called nanotechnology.It is leading technique in the science fieldTheir are different nanoparticles such as silver/gold as unique properties.In their chemical, biological and physical properties.Their are some bacterial species such as bacillus species.Streptomyces,pseudomonas, e-coli this are most widely used to synthesis gold/silver nanoparticles.The nanoparticles synthesis process done in extracellular or intracellular based on types of organism and usage of properties & conditions.Their are some ancient techniques involved in synthesis of nanoparticles they are physical methods&decreasing chemicals,this are always contribute large consumption of energy and unfavourable biproducts to control this restrictions green synthesis techniques have developed cost effective eco-friendly and sustainable.In green synthesis biological properties like plants& microorganism such as fungi,bacteria and algae,they contribute to natural bioreactors for production of nanoparticles.Among all the microorganism bacteria have important role in production.Because bacteria as capability of high growth rate easy cultivation process,tolerate and decrease ions into secure nanoparticles.In the process of green synthesize gold/silver nanoparticles utilize bacteria that leads to approach sustainable and collaborate nanotechnology and microbiology.Nanotechnology shows effects to reach large stability and varies suitable applications in environmental science,medicine and biotechnology. Green synthesis of nanoparticles of gold/silver is a cost effective process and always utilizes large energy toxics solvents reducing agents stabilizes which are ancient physical or chemicals synthesis of gold/silver which leads to bio-compatibility and environment concerns. In green synthesis microbes such as actinomycete are often used because of their high rapid growth and easy cultivation in simple conditions.This microbes can secrete metabolites and enzymes such as polysaccharides and proteins these decreases caping agents.By manipulating culture under suitable conditions often shows possible restriction over nanoparticles shape&size.In recent research the nanoparticles of bacteria vs fungi,bacteria shows synthesis more than fungi when manipulating growth rate it is advantage bacteria. Key parameters and optimizations include pH from 10-11,temperature and incubation time that is higher temperature using supernatant,it control cell debris metal ion concentration may high concentrations leads to aggregation and low concentration leads to reduction capping and stabilizing to protect from aggregation and cabin affects surface bearing and interactions with bacteria.

ADVANTAGES:

1.Eco-friendly

2.Less toxicity.

3.Low energy/chemical usage for many suitable methods

4.Better potential for biomedical and environmental biocompatibility.

LIMITATIONS:

1.Size&shape is controlled by many chemicals techniques.

2.Purications of nano particles from biomolecules may be difficult.

3.Cost effective.

3. Bacterial species used for Au/Ag nanoparticle synthesis

Common genera reported include *Bacillus*, *Pseudomonas*, *Shewanella*, *Rhodopseudomonas*, *Escherichia*, *Actinobacteria* and lactic acid bacteria. Different strains show varied ability to produce AuNPs and AgNPs—with size, shape and yield depending on strain metabolism and secreted biomolecules. Classic examples: *Rhodopseudomonas capsulata* for AuNPs and many *Bacillus* and *Pseudomonas* strains for AgNPs. ScienceDirect+1.

4. Mechanisms of bacterial-mediated synthesis (extracellular vs intracellular)

Two broad routes are described:

- **Extracellular synthesis:** bacterial secreted enzymes, proteins, peptides, or metabolites reduce metal ions in the culture supernatant forming NPs outside cells. This simplifies downstream separation. Enzymes such as nitrate reductase, reductive cofactors (NADH-dependent reductases), and extracellular polysaccharides or proteins often act as both reducers and stabilizing/capping agents. Nature+1

- **Intracellular synthesis:** metal ions are attracted to charged groups on the cell wall, internalized, and reduced inside the cell by intracellular enzymes and biomolecules, forming intracellular NPs that require cell disruption for recovery. Mechanistic studies point to electron transport chains and enzymatic reduction as drivers. Frontiers

Key mechanistic point: Nitrate reductase (and other reductases) have been repeatedly implicated as a principal enzyme mediating Ag^{+}/Au^{3+} reduction in many bacterial systems, often with NADH or other electron donors providing reducing equivalents. Control of pH, temperature, metal ion concentration and growth phase affects enzyme expression and thus NP formation. Nature+1

5. Parameters controlling nanoparticle properties

Factors influencing size, shape, dispersity, and yield:

- **pH:** influences reduction kinetics and capping interactions (acidic vs alkaline conditions yield different shapes).
- **Temperature:** speeds reaction but can denature capping biomolecules.
- **Metal ion concentration and precursor type:** higher concentrations often produce larger/more aggregated NPs.
- **Reaction time and biomass/supernatant concentration.**
- **Light exposure:** reported as a modulator (photoreduction in some strains).

Careful optimization yields spherical, rod, triangular, or anisotropic morphologies; reproducibility remains a challenge for scale-up. BioMed Central+1

6. Characterization techniques

Standard characterization suite includes: UV–Vis spectroscopy (surface plasmon resonance peaks ~400–450 nm for AgNPs; ~520 nm for AuNPs depending on size), TEM/SEM for morphology and size, DLS and zeta potential for hydrodynamic size and stability, XRD for crystalline nature, FTIR for capping biomolecules, and ICP-MS/AAS for metal quantification. Correlating spectroscopic signatures with biological capping improves understanding of stability and bioactivity. Nature+1

7. Applications of bacterially synthesized Au/Ag NPs

- **Biomedical:** antimicrobial coatings, wound dressings, diagnostic labels (AuNP optical properties), anticancer studies (AuNP-mediated photothermal therapy), and drug delivery vehicles. Numerous studies show potent antibacterial activity of biogenic AgNPs against Gram-positive and Gram-negative strains. SpringerLink+1
- **Catalysis & environmental remediation:** catalytic reduction of dyes and organic pollutants, heavy-metal removal, and use in sensors. Biotech Asia
- **Agriculture & food safety:** nanopesticides and antimicrobial food-packaging components (emerging). BioMed Central

8. Toxicity, biosafety and environmental impact

Although "green", microbial NPs can be cytotoxic (especially AgNPs) depending on dose, size, surface chemistry, and dissolution to ionic species. Evaluations must include (i) in vitro cytotoxicity on mammalian cell lines, (ii) hemocompatibility, (iii) in vivo biodistribution and clearance, and (iv) environmental fate. Biomolecule capping can mitigate toxicity, but systematic toxicology data and standardized assays are still limited. SpringerLink+1

9. Challenges and gaps

- **Scalability & reproducibility:** batch-to-batch variability due to biological systems.
- **Mechanistic ambiguity:** precise roles of specific enzymes and metabolites often inferred but not definitively proven. Genetic/biochemical studies are needed. SpringerLink
- **Standardization of reporting:** lack of uniform reporting of synthesis conditions and characterization metrics hinders cross-study comparisons.
- **Regulatory and safety hurdles:** translational work needs robust toxicology and GMP-compatible processes.

CONCLUSION:

The green synthesis a biological process of gold/silver nanoparticles using bacteria which is most commonly used microorganism is synthesis of nanoparticles.This process is cost effective and alternative to chemicals and physical techniques sustainable and it is eco-friendly. This biological process reduces the use of toxic chemicals and leads to environmental safety and less consumption of energy by synthesizing the nanoparticles highly products valuable and nanoparticles leads valuable medicines in industries and bio-remediation.

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