ISSN: 2277–4998

International Journal of Biology, Pharmacy and Allied Sciences (IJBPAS)

'A Bridge Between Laboratory and Reader'

www.ijbpas.com

SYNTHESIS OF SILVER NANOPARTICLES: ADVANCES, APPLICATION AND FUTURE PROSPECT

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Received 22nd Jan. 2021; Revised 24th Feb. 2021; Accepted 25th March 2021; Available online 1st April 2021

https://doi.org/10.31032/IJBPAS/2021/10.4.1039

ABSTRACT

Nano science has gained a lot of attention in the field of technology for the future. In every area, the revolution in nanotechnology and nanoparticle synthesis is astounding. Plants are a simple way to synthesise silver nanoparticles, and their products have been used to make metallic nanoparticles.Silver nanoparticles are applicable for numbers of medicinal work, in making of pharmaceutical products, in industrial use to increase advance technology and for many other important applications like this. Anticancerous properties of silver nanoparticle may be higher approachable needs in future of nano research. However, there is still a need for a pure way to combine the names of AgNPs that is both economically and environmentally viable.

Keywords: Silver nanoparticles, Synthesis of silver nanoparticles, Nanotechnology

INTRODUCTION

In comparison to other methods of AgNPs synthesis, the synthesis of silver nanoparticles is the most approachable process for current nano science for such fundamental reasons as being eco-friendly, inexpensive and approachable, readily accessible, and requiring little energy. Green synthesis is a method of synthesis that uses different agents derived from plants and is superior to chemicals. Silver has an antimicrobial activity that has been used for decades **[1]**. Silver nanoparticles are synthesised for medicinal purposes, such as anti-cancer and antimicrobial activities, which is why it is the most common nano science field in the world right now.Nanoparticles and structures were first used by the Romans in the fourth century, and it proved to be one of the most fascinating examples of nanoscience in the ancient world. One of the most important and purposeful achievements in the ancient glass industry is a Lycurgus cup from the British Museum collection **[2]**. The scale of the nanotechnology industry is now comparable to that of biotechnology, and the projected growth rates are much higher in the coming years **[3]**. Silver nanoparticles have a large surface area per unit mass and release silver ions into the atmosphere, which are bioactive against a wide variety of bacteria. The nanoparticles range in size from 1 to 100 nm. AgNPs can be made using a variety of methods, including biological, chemical, and physical methods. Chemical method is suitable for large-scale development of silver nano particles because it is less time consuming, but it involves capping agents to stabilise AgNPs.**[4]**. At the industrial level, biological components were used in various ways for the separation of silver nano particles in order to standardise their technological level. If we're talking about green synthesis or some other form of synthesis, a solvent is needed for the synthesis of nanoparticles, and water is the most suitable solvent method **[5]**. Many factors influence the nano particle, such as the stability of AgNPs and their influence on their fate, transport, and toxicity **[6]**.

NANOPARTICLES

The term "nanoparticles" refers to particles with a size of 1nm to 100nm in at least one of the three dimensions. Nanoparticles' physical, chemical, and biological components change in fundamental ways at this size level, affecting both atomic structures / molecules and the pile of corresponding building materials **[7]**. Materials with a wide range of chemicals, especially common metal carbon and biomolecules, can be used to make nanoparticles. Nanoparticles come in a variety of shapes and sizes, including spheres, cylinders, platelets, tubes, and more. Nanoparticles are normally synthesised in order to satisfy the needs of the applications in which they will be used.

TYPES OF NANOPARTICLES

There are a few types of nanoparticles, each of which is completely different and has very different chemical and physical properties based on the cofactor bonded with nanoparticles, resulting in variants **[8]**. Metal bolded with nanoparticles play various roles depending on their properties and play important roles in various fields and also at the industrial level. In the future, we might be able to get more variety by bonding various metals to nanoparticles to get different outlets with more accessible applications and prospects. Here are some examples of nanoparticle types: 1. Nanoparticles of silver, 2. Nanoparticles of gold, 3. Nanoparticles of magnetite 4. Nanoparticles of palladium and platinum, 5. Titanium and Titanium Dioxide nanoparticles, 6. Cadmium Sulphide nanoparticles, and 7. Zinc Sulphide nanoparticles **[9]**.

ANTIMICROBIAL ACTIVITY OF SILVER NANOPARTICLES

Silver has long been recognised as a potent antibacterial agent, and it has been widely used in traditional healing practises. Several silver-based chemicals have been used as antimicrobial agents with great success **[10]**. In the medical industry, silver compounds are used to treat burns and a variety of other ointments **[11]**. Since silver nanoparticles have a higher surface area than their volume, they have been thoroughly tested for their antimicrobial properties, resulting in better antimicrobial efficiency than stainless steel. Gram-positive bacteria like Staphylococcus aureus and Bacillus subtilis, as well as Gram-negative bacteria like Klebsiella pneumoniae and Salmonella typhus, display possible antibacterial activity in silver nanoparticles **[12]**. Electron microscopy has been used extensively to investigate the field, and it has revealed the interdependence of the size of silver nanoparticles and bacteria **[13]**. However, the mechanism of silver nanoparticle inhibition is only partially known. There are many theories on how silver nanoparticles work in microorganisms to produce a microbicidal impact.

CHARACTERIZATION METHOD OF AGNPS

UV– VIS spectroscopy

In previous study, the ELICO SL-159 Spectrophotometer was used to conduct UV-Vis visual analysis at a distance of 350–470 nm. The UV-Vis spectrum of the reaction mixture was used to reduce the amount of pure silver ions introduced into the mould culture **[14]**.

FT-IR spectroscopy

Measurements of bio transformed products usable during external filtrate ice using Fourier-Transform infrared spectroscopy In previous research, FT-IR samples were recorded on FT-IR metal (Digital series Excalibur 3000, Japan) attached to reflectance mode (DRS-800) and diluted with potassium bromide at a ratio of 1: 100 **[15]**.

TEM analysis of silver nanoparticles

Surface morphology and size of nanoparticles were studied by transmission electron microscopy with a fast power of 80 kV in past research. Silver nanoparticles were loaded into carbon-containing copper pits, and a solvent was present allowed to evaporate under infra lamp for 30 minutes.

CURRENT RESEARCH AND FUTURE PROSPECTS OF NANO SYNTHESIS

The mechanisms that NP viruses use are still unknown. Since several studies claim that antibacterial activity in oxidative stress or ROS, and in some NPs, such as MgO NPs, an antibacterial mechanism is not linked to viral metabolism control. As a result, future studies on NP antibodies should be considered **[16]**. Specific cleaning steps and a lack of understanding of processes are the two main roadblocks in the biosynthesis of NPs using bacteria **[17]**. Controlling the shape and size of particles, as well as achieving the unity of the solution process, are major challenges in the biosynthesis of NPs. Before this green man-made solution becomes an efficient and competitive way of producing NPs in the industry, it appears that a range of significant technical challenges must be addressed **[18]**. Increased output handling is a significant challenge. Furthermore, little is known about the mechanical properties, and more information is required to improve nanoparticle biosynthesis in an economically and logical manner. The following are some of the most important considerations to consider when developing NPs.

APPLICATIONS OF SILVER NANOPARTICLES SYNTHESIS

Silver nanoparticles have a variety of properties, including antimicrobial, anticancer, larvicidal, catalytic, and wound-healing properties. Because of its known benefits, the biogenic synthesis of silver nanoparticles using plants, as well as its medicinal properties and other possible applications, is gaining traction. This critical review aims to give readers a better understanding of the Phyto-mediated synthesis of silver nanoparticles, as well as their significant applications in various fields and embedded marking techniques **[19]**. Silver nanoparticles have been shown to have catalytic redox properties in species like dyes and chemicals like benzene. The chemical makeup of nanoparticles has a big impact on their ability to generate energy. It's also worth noting that complex catalysis is accomplished by extracting a reactant form into a catalytic substrate. Nanotechnology plays a key role in most of the systems that compete with traditional approaches of cancer care, research, and diagnosis **[20]**. The active end classes, which include proteins, peptides, or monoclonal antibodies that can bind directly to the workplace or a targeted tissue without coming into contact with other cells, are a key feature of these nanoparticles **[21]**. Bio-based approaches are still in the early stages of progress, with the most pressing issues being the stability and incorporation of biosynthesized NPs, as well as regulating crystal growth, shape, size, and size distribution. Furthermore, NPs are generated naturally, as opposed to those produced by chemically superior polydisperse. The development of key parameters that regulate biological growth, cellular activity, and enzymatic processes can control the characteristics of NPs (growth processes and response conditions) **[22]**. The equipment's features are not clarified and addressed in a straightforward and comprehensive manner. As a result, further research is required to pinpoint specific response mechanisms as well as enzymes and proteins involved in nanoparticle biosynthesis. The use of bacteria to mass-integrate NPs is fascinating because it removes the need for dangerous, harmful, and costly chemical compounds in the synthetic and stabilising processes **[23]**. Natural synthesis appears to be capable of producing stable nanoparticles with well-defined sizes, morphologies, and synthetics by improving the reaction conditions and selecting the best bacteria.

Anticancer activity of silver nanoparticles:

The application of nanotechnology to cancer care offers the promising prospect of destroying cancer cells while causing minimal damage to healthy tissues and body parts. Cancer cells can be detected and eliminated using nanoparticles until they form a tumour. Drugs can also be carried by nanoparticles and released on target cells.These particles are used as comparison agents in magnetic resonance imaging of targets for diagnosis and treatment monitoring.Due to its unique properties as well as the healing power of treatments, silver nanoparticles have sparked a lot of interest among the growing products of nanoproducts in the field of nanomedicine. Nanoparticles can kill cancer cells by destroying their cell walls **[24]**.

Medical application of functionalized magnetic nanoparticles

Magnetic nanoparticles have a variety of properties, which has led to advancements in a variety of medical systems. The reaction of magnetic particles to magnetic force is their most distinguishing characteristic, and it has been used in applications such as drug detection and cell filtering segmentation. Magnetic nanoparticles have recently gotten a lot of attention because of their ability as MRI comparator agents and cancer treatment agents (hyperthermia) **[25]**. As their surface area converges over a poorly charged cell, magnetite cationic liposomes (MCLs), one of the groups of cationic magnetic particles, may be used as carriers to inject magnetite nanoparticles into targeted cells; additionally, they have received requests for hyper thermic care **[26]**.

CONCLUSION

Beyond ten years ago, the synthesis of silver nanoparticles has always been a very appealing field for science. Many different types of environmental pollutants (for example, organic matter from plants, bacteria, fungi, yeast, and plant extract) are used in resource integration and/or manufacturing. Plant extracts, for example, have been shown to be effective at stabilising and reducing the effects of a mixture of controlled substances (i.e., controlled substances shape, size, properties, and other specific features).

ACKNOWLEDGEMENT

It's our privilege and honour to express our sincerest gratitude to the Parul University, Vadodara, Gujarat for providing me all the necessary support and facilities including state of the art infrastructural facilities with advanced technological scientific laboratories and everything else that was required to carry out this work

REFERENCE

[1] Morilla, Maria Jose, and Eder Lilia Romero. Nanomedical Therapeutic and Prophylaxis Strategies against Intracellular Protozoa in the Americas. Nanotechnology in Diagnosis, Treatment and Prophylaxis of Infectious Diseases. Elsevier, 2015. 297–317.

[2] Bayda, Samer. The History of Nanoscience and Nanotechnology: From Chemical–Physical Applications to Nanomedicine. Molecules 1, December 2019: 112

[3] Wennersten, Ronald, Jan Fidler, and Anna Spitsyna. Nanotechnology: A New Technological Revolution in the 21st Century. Handbook of Performability Engineering. Springer London. 943–952.

[4] Krithiga, Narayanaswamy, Athimoolam Rajalakshmi, and Ayyavoo Jayachitra. Green Synthesis of Silver Nanoparticles Using Leaf Extracts of *Clitoria ternatea* and *Solanum nigrum* and Study of Its Antibacterial Effect against Common Nosocomial Pathogens. Journal of Nanoscience, April 2015: 1–8.

[5] Singh, Jagpreet. GreenSynthesis of Metals and Their Oxide Nanoparticles: Applications for Environmental Remediation. Journal of Nanobiotechnology 1, October 2018: 19-24.

[6] Sharma, Virender. Stability and Toxicity of Silver Nanoparticles in Aquatic Environment: A Review.ACS Symposium Series. American Chemical Society, January 2013. 165–179.

[7] Salman Ali. Application of Nanomaterials in Environmental Improvement.Nanotechnology and the

Environment. Intech Open, December 2020: 18-20.

[8] Nomiya, Kenji. Synthesis and Structural Characterization of Silver(I), Aluminium(III) and Cobalt (II) Complexes with 4-Isopropyltropolone (Hinokitiol) Showing Noteworthy Biological Activities. Action of Silver(I)-Oxygen Bonding Complexes on the Antimicrobial Activities.Journal of Inorganic Biochemistry 1,January 2004: 46–60.

[9] Jayaseelan. Novel Microbial Route to Synthesize ZnO Nanoparticles Using *Aeromonas hydrophila* and Their Activity against Pathogenic Bacteria and Fungi. *Spectrochimica Acta* Part A: Molecular and Biomolecular Spectroscopy. October 2012: 78–84.

[10] Panáček, Aleš. Silver Colloid Nanoparticles: Synthesis, Characterization, and Their Antibacterial Activity. The Journal of Physical Chemistry B 33, August 2006: 16248–16253.

[11] Guilger-Casagrande, Mariana, and Renata de Lima. "Synthesis of Silver Nanoparticles Mediated by Fungi: A Review. *Frontiers in Bioengineering and Biotechnology*. 2019: 13-16

[12] Peng, Ling. Antitumor Activities of Dammarane Triterpene Saponins from *Bacopa monniera*. Phytotherapy Research 6, December 2009: 864–868.

[13] Morones, Jose Ruben *et al*. The Bactericidal Effect of Silver Nanoparticles.Nanotechnology 10, August 2005: 2346–2353.

[14] Sun, Qian *et al*. Green Synthesis of Silver Nanoparticles Using Tea Leaf Extract and Evaluation of Their Stability and Antibacterial Activity. Colloids and Surfaces A: Physicochemical and Engineering Aspects, March 2014: 226–231.

[15] Sadeghi, Babak, and F. Gholamhoseinpoor. A Study on the Stability and Green Synthesis of Silver Nanoparticles Using Ziziphora Tenuior (Zt) Extract at Room Temperature. Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, January 2015: 310–315.

[16] Fukushi, Keisuke, and Tsutomu Sato. Using a Surface Complexation Model To Predict the Nature and Stability of Nanoparticles.Environmental Science & Technology 5, March 2005: 1250–1256.

[17] Li, Xiangqian. Biosynthesis of Nanoparticles by Microorganisms and Their Applications. *Journal of Nanomaterials* 2011: 1–16.

[18] Gudikandula, Krishna, Pranitha Vadapally, and M.A. Singara Charya. Biogenic Synthesis of Silver Nanoparticles from White Rot Fungi: Their Characterization and Antibacterial Studies. OpenNano, 2017: 64–78.

[19] Saifuddin, N., C. W. Wong, and A. A. Nur Yasumira. Rapid Biosynthesis of

Silver Nanoparticles Using Culture Supernatant of Bacteria with Microwave Irradiation. E-Journal of Chemistry 1, 2009: 61–70.

[20] Wang, Linlin, Chen Hu, and Longquan Shao. The Antimicrobial Activity of Nanoparticles: Present Situation and Prospects for the Future. International Journal of Nanomedicine, February 2017: 1227–1249.

[21] Iravani, Siavash. Bacteria in Nanoparticle Synthesis: Current Status and Future Prospects.International Scholarly Research Notices, October 2014: 1–18.

[22] Malarkodi, Chelladurai. Bactericidal Activity of Bio Mediated Silver Nanoparticles Synthesized by *Serratia nematodiphila*. Drug Invention Today 2, June 2013: 119–125.

[23] Sridevi, Lakshmi. Implementation of Response Surface Methodology for Phenol Degradation using *Pseudomonas putida* (NCIM 2102). Journal of Bioremediation and Biodegradation *2011*. 2011: 1-7.

[24] Firdhouse, Jannathul, and Lalitha. Biosynthesis of Silver Nanoparticles and Its Applications. Journal of Nanotechnology 2015: 1–18.

[25] Konishi. Microbial Deposition of Gold Nanoparticles by the Metal-Reducing Bacterium Shewanella Algae. Electrochimica Acta 1, November 2007: 186–192.

[26] Ito, Akira. Medical Application of Functionalized Magnetic Nanoparticles." *Journal of Bioscience and Bioengineering* 1. 2005: 1–11.