MSW MANAGEMENT -Multidisciplinary, Scientific Work and Management Journal
ISSN: 1053-7899
Vol. 36 Issue 1, 2026, Pages: 3587-3589

A Review on Synthesis, Characterization and Application of Silver Oxide Nanoparticles

Lishanthi P,[1] Dr. N.J. Sangeetha*
Research Scholar (2511328142002)[1]
Women's Christian College,
Affiliated to Manonmaniam Sundaranar University,
Abishekapatti, Tirunelveli – 627012, Tamil Nadu, India.
*Assistant professor, Department of Chemistry,
Women's Christian College, Nagercoil, Tamil Nadu, India.
* Corresponding author, E-mail : ponulisa2002@gmail.com

Abstract

The Green synthesis of Silver oxide Nanoparticles serves as an eco-friendly route using phytochemical from plant extract for reduction, capping and stabilization of nanoparticles. This review highlights the biosynthesis via petals of flowers, leaves, stem and root extract from herbal plants, focusing their role as bio-reducing agents. Essential variables include the extract concentration, pH, temperature and reaction time characterized by UV-Vis, XRD, FT-IR, TEM analysis revealing crystalline size with unique morphologies. Herbal part indicated flower extract yields spherical nanoparticles, leaf & stem extract yields broad spectrum in anti-oxidant activity and root extract yields potential cytotoxic result from alkaloid and terpenoid. The scope of nanoparticles includes biomedicine, environmental remediation and agriculture. This overview demonstrated green nanotechnology's potential for sustainable solution.

Keywords : Green synthesis, Silver oxide nanoparticles, Nanotechnology, reducing agent, Herbal plant.

Introduction

The word "Nano" describes itself intern and nanometer range between 10 and 100nm formulated from decades. The unique size and extended surface area paved new way for new brand applications. The nature of toxicity depends on the optimization and size of the nanoparticles. The Silver oxide nanoparticles is also called as p-type semiconductor which possess higher bandgap than bulk material with respect to lack of space between the energy levels. [4]. In addition to different metal oxide nanoparticles, Silver oxide nanoparticles are one of the most familiar branch of metal oxide nanoparticles with its distinct uses. Even though the nanoparticles possess large surface with quantum size of crystals. The synthesized nanoparticles possess significant effect because of physicochemical characteristics of the material is largely affected by their varied crystal size [32]. The plant part such as flower, fruit, stem, leaf and root possess various phytochemicals and biomolecules such as polyphenols, flavonoids, alkaloids, tannins, terpenoids, saponins, proteins, enzymes, vitamins and polysaccharides take over the responsibility in converting metal ions into metal oxide nanoparticles [17]. The physical and chemical methods for fabrication of metal oxide nanoparticles are valuable and threatening to our lives. "Green chemistry suggests numerous strength when compared to physical and chemical method of nanoparticles because of their environment friendly nature and implementation. The green method of chemistry is essential and safe approach which can be used to synthesize silver oxide nanoparticle with unique morphology, size and shape[10]. The metal oxide nanoparticles are highly relevant to industrial applications of applied nanoscience, extensively utilized in diverse industries, in addition to textile, food, health, agriculture and cosmetics[32]. Amongst various synthesis methods such as physical, chemical and biological routes this review analyzes the environment friendly biological synthesis method for the fabrication of metal oxide nanoparticles from flower, root, leaves and stem etc. The essential characterizations and applications of metal oxide nanoparticles are explored with great attention to get visible knowledge.

Nanoparticles synthesis methods

To completely leverage the capacity of Silver oxide nanoparticles from herbal resources, it is essential to understand their fabrication and characterization methods. The nanoparticles with perfect crystal size are synthesized by the subsequent three methods

Physical methods : The synthesis which facilitates to yield pure nanoparticles without using extra reagents is known as Laser ablation method. This method controls the shape and size of synthesized nanoparticles by proper excitation and managing the parameters during the process. This method is quite frequently used by various researchers to improve the quality of the nanoparticles. The nanoparticles synthesized by this method is used as a bactericidal agent which was demonstrated by various researchers including gram-positive and gram-negative bacteria. [31]

Chemical methods : Hydrothermal method of fabrication is an approach which depends on the reaction carried out within the solution. In general, this process involves the material preparation through varying temperature from room temperature to high temperature mixture of solution. This process purely depends on the controlling of vapor pressure to analyze the morphology of the synthesized material. The synthesized nanoparticles are not stable at extreme temperature. It is involved in the production of nanowires, tubes and complex oxides. [6]

Biological method : Green synthesis methodologies relies on the natural reducing agent from the plant extract through various parameters such as solvent, temperature, pH condition. In this method biological sources like plants, fungi, starch and bacteria can be chosen as reducing agent to convert metal ions into metal oxide nanoparticles. [6]

Literature study on Green approach

Leaves based Silver oxide nanoparticles :

Abdulmaleek *et al.,* (2023) reported the synthesized nanoparticles were spherical with size ranges between 20-100 nm by the SEM analysis. The elemental composition of silver oxide nanoparticles was Ag(80%), O (10.26%) and C (9.74%) revealed by EDX spectroscopy.

Abhasi *et al.,* (2020) synthesized the silver oxide nanoparticles using aqueous and ethanolic leaves extract as reducing agent. The synthesized nanoparticles were investigated for anti-cancer potential and exhibited 79.4% scavenging activity and 87.54% brine shrimp assay against HUH-7 and HepG2 cell line.

Archana *et al.,* (2020) revealed the face centered cubic structure of nanoparticles by XRD analysis. It highlighted their potential in fuel cells, sensor due to their semiconducting properties.

Asif *et al.,* (2024) fabricated the chemical and green synthesis of silver oxide nanoparticles using *Datura innoxia* leaves. The green synthesized nanoparticles exhibited small size, spherically agglomerated shape, high anti-cancer and anti-viral activity compared to chemically synthesized silver oxide nanoparticles.

Dhoondia *et al.,* (2012) investigated the synthesis of metal oxide nanoparticles using *Lactobacillus mindensis* from an X-ray photographic labroratory. The biosynthesized nanoparticles are considered safe for human medical application like coating of catheters or wound dressing etc.

Fayyadh *et al.,* (2021) investigated the surface morphology and size of nanoparticles using FE-SEM method. The synthesized metal oxide nanoparticle have shown excellent anti-microbial activity against the tested microbe's strain.

Iqra *et al.,* (2023) synthesized nanoparticles represented the complete removal of malachite green in the presence of persulfate ion. Photocatalysis method acted as a good eliminator of toxic organic pollutant from the environment.

MSW MANAGEMENT -Multidisciplinary, Scientific Work and Management Journal
ISSN: 1053-7899
Vol. 36 Issue 1, 2026, Pages: 3587-3589

Korkmaz *et al.,* (2021) revealed the microwave assisted silver oxide nanoparticles with good absorbance peak and crystallite size. The nanoparticles showed widespread usage in medical polymers and nano drugs.

Latif *et al.,* (2023) studies showed the anti-leishmanial activity of synthesized nanoparticles was significant with good inhibitory concentration. The physicochemical parameters were analyzed using TGA, FT-IR and Zeta potential.

Mahadevan *et al.,* (2023) investigated the photoluminescence and optical properties of synthesized nanoparticles revealed distinct emission peak with strong absorption. The silver oxide nanoparticles have great impact in controlling and preventing infections.

Mohanaparameswari *et al.,* (2024) revealed the energy band gap and morphology of the nanoparticles synthesized from leaves extract as stabilizing agent. The anti-bacterial activity of synthesized nanoparticles from *P. amboinicus* have better activity with good inhibition zone than *S. trilobatum.*

Muruganantham *et al.,* (2019) exhibited the higher concentrated nanoparticles have sheet shaped appearance whereas lower concentration showed spherical shaped nanoparticles. The anti-bacterial activity of *E. coli* and *S. aureus* are also evaluated.

Pradeesh *et al.,* (2020) synthesized nanoparticles by chemical precipitation using herbal extract and silver nitrate solution. It reveals that the increase in concentration of nanoparticles increases the anti-cancer efficiency.

Redijili *et al.,* (2024) evaluated the anti-microbial test and demonstrated the effectiveness of silver oxide nanoparticles against both gram-positive and gram-negative bacteria. The photocatalytic test revealed moderate efficiency with synthesized silver oxide nanoparticles in dye degradation.

Saka *et al.,* (2024) synthesized polycrystalline and rod shaped nanoparticles using *P. macrosolen* leaves extract. The prepared nanoparticles was highly sensitive to *E. coli* than *S. aureus.*

Shirazi *et al.,* (2022) bioengineered the silver oxide nanoparticles with the use of ultrasonic irradiation and the prepared leaves extract. The ultrasound introduced nanoparticles gave a uniform and spherical shaped nanoparticles than heating method.

Sultan *et al.,* (2023) evaluated the strong cytotoxicity of the nanoparticles using breast cancer cell line (MCF-7) and concluded that it can be used for treating many infectious disease and cancer.

Ullah *et al.,* (2023) bio-synthesized multifunctional silver oxide nanoparticles which exhibited excellent anti-microbial efficiency. The α-amylase inhibition reported 66% inhibition in cyto-toxicity assay.

Widyaningtyas *et al.,* (2018) fabricated the silver oxide nanoparticles using *V. amygdalina* extract as bio-reductant. The designed metal oxide nanoparticles degraded 71.59% of methylene blue in the photocatalytic activity.

Flower and Fruit based Silver oxide nanoparticles :

Abad *et al.,* (2023) proposed the significance of *pomegranate peel* extract through the synthesis of silver oxide nanoparticles. The synthesized nanoparticles revealed effective zone of inhibition against four bacterial strain and one fungus strain.

Hattab *et al.,* (2025) developed nanoparticles from *Hibiscus flower* extract. The synthesized cubic crystal can be used in catalysis, biomedical device for sustainable nanotechnology.

Mahlambi *et al.,* (2022) investigated the starch-capped silver oxide nanoparticles. The synthesized nanoparticles exhibited absorbance peak between 350-366 nm and particle size ranged between 2- 14 nm which was characterized by UV-Visible and TEM analysis.

Miranda *et al.,* (2024) synthesized nanoparticles exhibited the Zeta potential at -10.2mV with electrostatic repulsion between them. It exhibited potential anti-bacterial effect against both non-resistant and multi-drug resistant strains.

Zareiyan *et al.,* (2023) investigated the morphology of nanoparticles using *Opuntia humifusa* fruit extract. The total phenol content, flavonoid and anthocyanin content were evaluated and found to be high in extract solution.

Stem and Root based Silver oxide nanoparticles :

Ghmari *et al.,* (2021) reported the green synthesis of silver oxide nanoparticles with spherical shape and crystalline nature. The FT-IR spectroscopy revealed that the functional groups in the extract are responsible for the stability of nanoparticles.

Ismail *et al.,* (2019) evaluated the anti-leishmaniasis activity of synthesized silver oxide nanoparticles. the nanoparticles showed significant effect on the parasite growth compared to anti-leishmanial drug leishmania donovani.

Kalaivani *et al.,* (2024) reported the anti-bacterial activity of synthesized silver oxide nanoparticles. The face centered cubic crystal of nanoparticles was revealed by X-ray diffraction spectroscopic studies.

Manikandan *et al.,* (2017) investigated the use of silver oxide nanoparticles using *Ficus* root extract as a stabilizing agent. This suggested that the nanoparticles will be useful in toothpaste as germicidal agent after extensive investigation.

Muhammad *et al.,* (2023) compared the anti-inflammatory properties of synthesized silver oxide nanoparticles against standard pharmacological drugs. The results revealed that the silver oxide nanoparticles are compatible with diclofenac sodium and can cure inflammation related diseases.

Sujatha *et al.,* (2023) investigated the green synthesis of silver oxide nanoparticles using *Diospyros Montanna* bark extract. This study highlighted the significant effect against hepatocellular(HepG2) carcinoma cell through autophagy and decreased mitochondrial membrane potential.

Conclusion

In conclusion, the synthesis of silver oxide nanoparticles offers various advantages in terms of safety, cost-effectiveness and sustainability. Green resources acts as reducing and stabilizing agent for the fabrication of controlled nanoparticles. This paper exhibits both natural and artificial synthesis of silver oxide nanoparticles using different methods. The future prospect of plant-mediated nanoparticles fabrication includes a laboratory work for characterizations and elucidation of phytochemicals involved in the synthesis of nanoparticles using this bioinformatics tools.

Reference

1. Abad, KW, Ahmed, NA & Nadir, FH 2023, ‘Synthesis of Ag_2O nanoparticles via fresh *pomegranate* peel extract for bio applications’, *Journal of Nano Biomedical Engineering*, vol.15, no.4, pp.363-368.
2. Abbasi, AB, Javed, I, Jamal Abdul, N, Syeda Anber, Z, Amir, S, Siraj Uddin, Safia Hameed, Farhat Gul, Sobia, K & Tariq, M 2020, ‘Environment friendly green approach for the fabrication of Silver oxide nanoparticles: Characterization and diverse biomedical applications’, *Journal of Microscopy Research and Technique*, vol.83, no.11, pp.108-1320.
3. Abdulmaleek, OR, George, IN, Idongesit, EO & Patricia, AE 2023, ‘Green route synthesis and characterization of Ag_2O nanoparticles using *Ocimum gratissimum* leaf extract’, *Journal of Materials and Environmental Science*, vol.14, no.12, pp.1494-1503.
4. Archana, Shailesh Narain, S & Ritu, S 2020, ‘Ag_2O nanoparticles synthesized by green method from *Artocarpus Heterophyllus* for antibacterial and antimicrobial application’, *Materials Today*, vol.28, no.5, pp.1-5

MSW MANAGEMENT -Multidisciplinary, Scientific Work and Management Journal
ISSN: 1053-7899
Vol. 36 Issue 1, 2026, Pages: 3587-3589

5. Asif, M, Wajeeha, I, Muhammad Fakhar, A, Zahid, H, Malik, S, Mudassir, H, Javed, R, Kholood, AD & Noora, HQ 2024, 'Synthesis and characterization of chemically and green synthesized Ag_2O nanoparticles for evaluation of antiviral and anticancer activity', *Journal of Pharmaceuticals*, vol.17, no.908, pp.1-13.
6. Bouafia, A, Laouini, ES, Ahmed, ASA, Soldatov, VA, Algarni, H, Chong, FK & Ali, MAG 2021, 'The recent progress on Silver nanoparticles synthesis and electronic application', *Journal of nanomaterial,* vol.11, 2318
7. Dhoondia, HZ & Hemlatta, C 2022, '*Lactobacillus* mediated synthesis of Silver oxide nanoparticles', *Journal of Nanomaterials and Nanotechnology*, vol.2, pp.34-39.
8. Fayyadh, AA & Muneer, HJ 2021, 'Green Synthesis of Silver Oxide Nanoparticles for antimicrobial assays', *Journal of the Mechanical Behaviour of Material*, vol.30, pp.228-236.
9. Ghmari, EB, Hanane Farah & Abdellah Ech-Chahad 2021, 'A New Approach for the Green Biosynthesis of Ag_2O Nanoparticles, Characterization and Catalytic Application', *Bulletin of Chemical Reaction Engineering & Catalysis*, vol.16, no.3, pp.651-660.
10. Hassanien, R, Abed-Elmageed, AAI & Husein, DZ 2019, 'Photocatalytic study and Anticancer activity of green synthesized Ag nanoparticles using *Drumstick* leaf extract', *Journal of Nanoscience and Nanotechnology applications*, vol.3, no.1, pp.1-13.
11. Hattab, KA 2025, 'Eco-Friendly Synthesis and Structural Analysis of Ag /Ag_2O NPs derived from *Hibiscus Sabdariffa Extract'*, *Academia open*, vol.10, no.2, pp.1-7.
12. Iqra, Rozina Khattak, Bushra Begum, Raina Aman, Q, Hajera, G, Muhammad Sufaid, K, Sanaullah, K, Naheed, B, Changseok .H & Najeeb Ur Rahman 2023, 'Green synthesis of Ag_2 O microparticles using *green tea leaves* extract for an efficient removal of malachite green from water: synergistic effect of persulfate', vol.13, no.227, pp.1-21.
13. Ismail, HH, Salah Abdulla, H & Entsar, JS 2019, 'The Anti-Leishmaniasis activity of green synthesis of Ag_2O nanoparticles', *Annals of tropical medicine & public* health, vol.22, no.4, pp.1-10.
14. Kalaivani, P & Mathubala, G 2024, 'Green synthesis of Silver oxide nanoparticles using *Prosopis cineraria* bark extract and its antibacterial activity', *Journal of Physics*, vol.28, no.1, pp.1742-1766.
15. Korkmaz, N & Ahmet, K 2021, 'Microwave assisted green synthesis of Ag, Ag_2O and Ag_2O_3 nanoparticles'. *Journal of the Turkish Chemical Society Chemistry* 8(2), 585-592
16. Latif, AMF, Ayoub, A, Ibrahim Houmed, Barwako Houssein, K, Jalludin, M, Meryem, L, Abdelmjid, A & Tarik, A 2023,'*Ericaria amentacea* algal extracts: A sustainable approach for the green synthesis of Ag_2O nanoparticles and their effectiveness against Leishmaniasis'. Journal of processes 11(11), 1-18
17. Magesh, M, Madhuri, LT, Mir Waqas, A, Vijaya, K & Chinnasamy, R 2024, 'Sustainable synthesis of Ag nanoparticles from Cassia auriculata flower extract: synthesis, spectral characterization, its biomedical and environmental applications'. Journal of Nanotechnology for Environmental Engineering 9(2), 161-175
18. Mahadevan, A, Clarison Chinnadurai, M, Suresh, R, Yogeshwaran, A & Logababu, P 2023,'The proliferation of refined optical and emission properties of Ag_2O nanoparticles using various leaf extract'. *Frontiers in Advanced Materials Research* 5(1), 94-102
19. Mahlambi, NP & Moloto, MJ 2022, 'Starch-capped Ag_2O nanoparticles: synthesis, characterization and antibacterial activity'. *Digest Journal of Nanomaterials and Biostructures* 17(3), 921-930
20. Manikandan, V, Palani, V, Jung, HP, Woo-Suk, C, Yool-Jin, P, Palaniyappan, J, Min, C & Byung, TO 2017'Green synthesis of Ag_2O nanoparticles and its antibacterial activity against dental pathogens'. *Journal of Biotechnology* 7(1), 72-79
21. Miranda, ZJ, David Vaca, V, Karla, V, Saskya, EC, Rebecca, GP, Jorge, HM, Arianna Mayorga, R, Carlos Barba, O, Elena Coyago, C, Alexis Debut & Linda, PG 2024,'Green synthesis of Ag_2 O nanoparticles from *Mauritia flexuosa* fruit extract: characterization and bioactivity assessment'. *Journal of nanomaterials* 14(1875), 1-26
22. Mohanaparameswari, S, Balachandramohan, M, Ganesh kumar, K, Revathy, MS, Sasikumar, P, Rajeevgandhi, C, Vimalan, M, Pugazhendhi, S, Khalid, MB, Sajjad, H, Salim, A, Ghassan, MS & Khalid Hossain 2024,'Green synthesis of Ag_2O nanoparticles using *Plecentranthus amboinicus* and *Solanum trilobatum* extracts as an eco-friendly approach; characterization and antibacterial properties'. *Journal of Inorganic and Organometallic polymer and materials* 34(7), 3191-3211
23. Muhammed, S, Asif, A, Jehangir, S, Muhammad, H, Muhammad, K, Behramkhan, AK & Arshad, I 2023,' The green synthesis, characterization and anti-inflammatory activity of Ag_2O nanoparticles using *Moringa oleifera* stem extract'. *International Journal of Natural and Applied Science* 4(1), 80-97
24. Murugananthan, N, Govindharaju, R, Jayaseelan, R & Sundararajan, G 2019, 'Green synthesis and characterization of Ag_2O nanoparticles using plant extract'. *Journal of Applied Science and Computations* 6(6), 987-1004
25. Pradheesh, G, Santhanam Suresh, Joghee, S & Vincent Alexramani 2020, 'Antimicrobial and Anticancer activity studies on green synthesized Ag_2 O nanoparticles from the medicinal plant *Cyathea nilgiriensis holttum*'. *International Journal of Pharmaceutical investigation* 10(2), 146-150
26. Redijili, S, Houria, G, Riadh, B, Fateh, M, Derradji, C, Amel, B & Chawki, D 2024,'Green synthesis of Ag_2O nanoparticles: Eco-friendly approach for sustainable solutions'. Journal of Industrial Crops and Product 223(2025)120168
27. Saka, A, Subhash, R, Leta, TJ, Ramaswamy, K, Rengasamy, D, Neha, M &Nagaprasad, N 2024, 'Investigating antibacterial activity of biosynthesized silver oxide nanoparticles using *Phragmanthera Macrosolen* leaf extract'. *Nature portfolio* 14(1), 1-18
28. Shirazi, SM, Mahdi Moridi, F, Alireza, F, Kamal Ghanemi, Maurizio, B & Pooyan, M(2022,'Bioengineered synthesis of phytochemical-adorned green Ag_2O nanoparticles of *Mentha pulegium* and *Ficus carica* extracts with high anti-oxidant, anti-bacterial and anti-fungal activities'. *Nature portfolio* 12(21509), 1-15
29. Sujatha, V, Gunaseelan, K, Alagesan, V, Chinnasamy, T, Sancharan, A, Salman, BD, Sameer, AG, Mohammad, HA, Mohammad, S & Thiyagarajan, R 2023, 'Biomimetic formation of Ag_2O nanoparticles through *Diospyros montana* bark extract: its application in dye degradation, antibacterial and anticancer effect in human hepatocellular carcinoma cells'. *Journal of King Saud University* 35(3), 1-9
30. Sultan, EA, Hussein, IA & Abdulqadier, HN 2023, 'Synthesis of Silver Oxide Nanoparticle using Different Precursor and Study Cytotoxicity Against MCF-7 Breast Cancer Cell line'. *Journal of Nanomedicine Research* 8(3), 259-267
31. Tanoira, PR, Arias, FM, Potel, C, Fernandez, CR, Castro, PS, Boutinguiza, M, Gorgolas, M, Lusquinos, F & Pou, J 2022, 'Silver Nanoparticles produced by laser ablation are effective preventing peri-implantitis multispecies biofilm formation', *International journal of Molecular science* 23, 12027
32. Ullah, Z, Farhat, G, Javed, I, Banzeer, AA, Sobia, K, Wadie, C, Mohammed, AE, Sibel, ED & Tariq, M 2023,'Biogenic synthesis of multifunctional Ag_2O nanoparticles using *Parieteria alsinaefolia* aqueous extract and assessment of their diverse biological applications'. *Journal of Microorganisms* 11(4), 1069
33. Widyaningtyas, LA, Yoki, Y & Dewangga Oky, BA 2019, 'Ag_2O nanoparticles fabrication by *Vernonia amygdalina* leaf extract : synthesis, characterization and its photocatalytic activities' Journal of Material Science and Engineering 509(1), 1757-899
34. Zareiyan, F & Habibollah Khajehsharifi 2023, 'Study of *Opuntia humifusa*: phytochemical analysis of aqueous fruit extract and green synthesis of Ag_2O nanoparticles'. *Journal of natural product research* 39(3), 460-46