Biosynthesis of silver nanoparticles using *Aspergillus fumigatus* and characterization study

Sowbhagya Lakshmi Matcha[a*] and Nagakrishna Taidala[b]

[a]*Department of Chemistry, Jawaharlal Nehru Technological University-Gurajada, Vizianagaram, India-535003.*

[b]*Department of Physics, M.R.A.G.R. Government Polytechnic, Vizianagaram, India-535002.*

*Corresponding Author E-mail: sowbhagya.che@jntukucev.ac.in

Abstract

Silver nanoparticles (Ag-NPs) have been synthesized using a variety of techniques, however because of their enormous size and little surface area, their catalytic activity has diminished. So, this article reports on the fungus-mediated synthesis of Ag-NPs. The generated particles were determined to be 23.6 nm when the synthesized Ag-NPs were further examined using XRD, SEM, EDS, and UV-Vis spectroscopy to evaluate the particle size, surface, crystalline nature, and phase formation of Ag-NPs. Ag-NPs are a fantastic class of broad-spectrum antibacterial agent. More noticeably, *Aspergillus fumigatus*' Ag-NPs may have powerful antibacterial activity against specific infections.

Keywords

Silver nanoparticles; *Aspergillus fumigates;* biosynthesis.

DOI: 10.48047/ecb/2023.12.Si8.667

1. Introduction

Silver nanoparticles (Ag-NPs), which have promising applications in biomarkers, diagnostics, cell labeling, and drug delivery systems, etc., are developed and altered using nanotechnology as a platform. They function as nanomedicines and anti-microbial agents to cure a variety of ailments (Sing et al. 2011). Over the past 20 years, research and development in this field have spread quickly over the globe. There are several chemical processes in the literature for producing nanoparticles; all of these procedures use toxic compounds, which have raised significant environmental concerns. As a result, researchers in the field of synthesis of nanoscale materials have been actively looking at biological systems from a different angle (Ahmad et al. 2003).

The majority of microorganisms, including yeast, fungus, bacteria, and actinomycetes,

have been taken into account for the production of NPs and their uses in the biological and pharmaceutical industries (Sastry et al. 2003). The fungus have very good characteristics for the synthesis of NPs, and the microorganisms have metabolic activity. The synthesis of Ag-NPs is caused by physicochemical features seen in fungi. Ag-NPs have historically and are currently employed as anti-bacterial chemicals in textiles, the healthcare sector, and food storage due to their physico-chemical characteristics. Ag-NPs now have anti-inflammatory, antiviral, and antifungal properties that have been recognised as part of their anti-microbial action (Prakash et al. 2012). Fungi have an advantage over bacteria and algae for the creation of nanoparticles, and those that have mycelia can endure flow pressure, agitation and other conditions in the bioreactors.

According to (Saha et al. 2011), the fungus *Fusarium solani* USM3799, *F.oxysporium*, *Coriolus versicolor*, and *Aspergillus niger* can produce Ag-NPs. (Nithya et al. 2009) Recently reported on the synthesis of Ag-NPs using the white root fungus *C.verscolar*. The synthesis of Ag-NPs by the *Aspergillus fumigatus* strain and the antibacterial activity of Ag-NPs against specific human diseases are the main topics of this work.

2. Experimental section

2.1 Materials

Silver nitrate ($AgNO_3$) was received from HiMedia company, India and *Aspergillus fumigates* were purchased from IMT, Chandigarh, India.

2.2 Synthesis of Ag-NPs

The cell filtrate (50 mL) was first combined with $AgNO_3$ (10 mL) solution (10 mM) for the biosynthesis of Ag-NPs, and a sample without $AgNO_3$ was used as a reference. These solutions were then kept at 24 to 28 °C in an incubator. To prevent any unintended reactions during the experiment, all reaction mixtures were kept in the dark. After the samples were centrifuged using a centrifugation technique at 8,000 rpm for 10 min, the purified product was collected for further characterization and use in anti-bacterial activity.

2.3 Characterization of Ag-NPs

With a control as the reference, the synthesised Ag-NPs were initially examined using a UV-Visible spectrophotometer (UV-2450, Shimadzu) in the 200–800 nm range. Additionally, X-ray diffraction (XRD, Bruker) investigation was performed on Ag-NPs at a scan rate of 0.02 sec-1. Using a JEOL-JSM-6610 SEM, scanning electron microscopic (SEM-EDS) analysis was

performed to determine the morphology of the prepared Ag-NPs. FTIR spectrum obtained from IR prestige 21 with the scan from 500 to 4000 cm^{-1}.

3. Results and Discussion

3.1 Scanning Electron Microscope Analysis

SEM analysis was used to further describe the size and shape of the synthesised Ag-NPs. SEM imaging revealed that the Ag-NPs produced by Aspergillus fumigates strain MF1 extract were 50 nm in size, spherical in shape, with a minor proportion of elongated particles (Fig.1). According to (Sadowski et al. 2008), SEM revealed the Ag-NPs' size and shape. Aspergillus niger produced Ag-NPs with a size of about 25 nm. The drying process can change the form of the particles (Ahmad et al. 2002). The obtained particle size was concurred with XRD results i.e., 23.6 nm and in addition, the purity of a compound was confirmed by EDS analysis which showed an optical absorption sharp peak at 3 keV (Fig.2) which is the distinctive absorption of metallic Ag-NPs (Magudapathy et al. 2001).

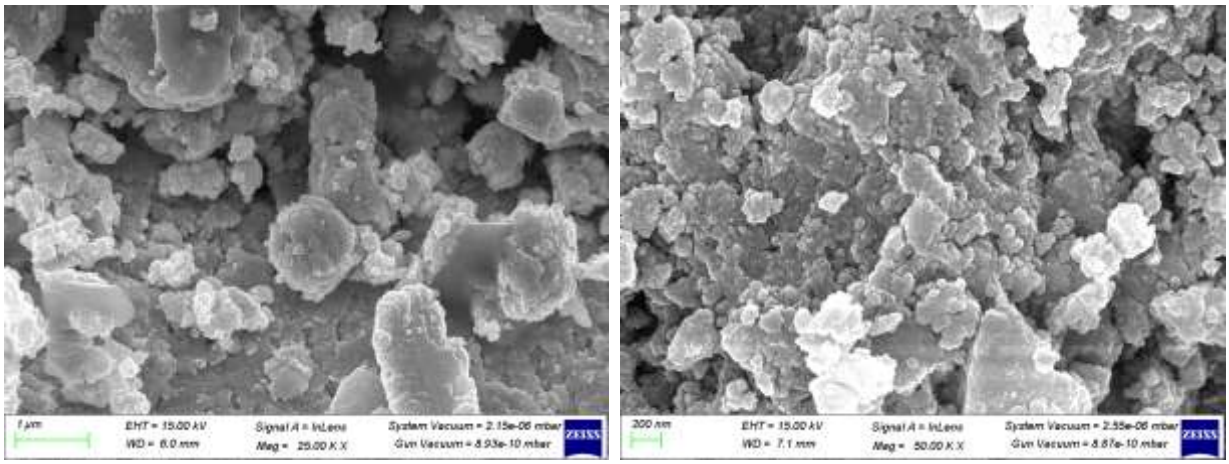

Fig.1: SEM images of prepared Ag-NPs

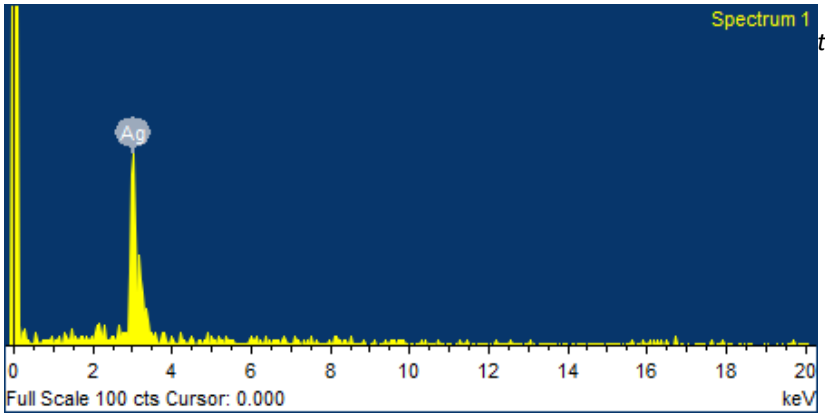

Fig.2: EDX spectrum of prepared Ag-NPs

3.2 UV- Visible spectra of Ag-NPs

When UV-visible spectroscopy was used to monitor the surface plasmon resonance of colloidal Ag-NPs solution, the UV-visible absorption spectra of the synthesized Ag-NPs revealed a distinctive peak at 445 nm for 72 hours of incubation as shown in Fig.3. According to (Wiley et al. 2006), bioactive chemicals are in charge of reducing metal ions for the creation of NPs. Ag-NPs were synthesised utilising *A.flavus*, which exhibits maximum absorption spectra at 425 nm, according to (Saeed Moharrer et al. 2012) publication. In contrast, Ag-NPs produced by *A.clavatus* showed their highest absorbance at 420 nm (Saravanan et al. 2010). The biosynthesis of Ag-NPs employing the *A.consortium* was reported by (Samuel et al. 2017), with the greatest absorbance peak occurring at 425 nm in the visible area due to plasmon resonance.

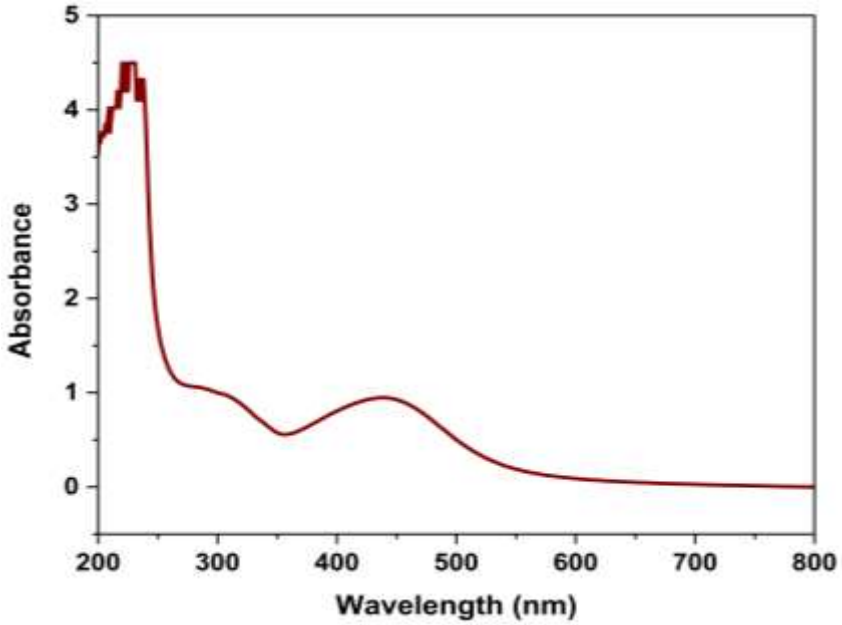

Fig.3: UV-visible absorption spectra of Ag-NPs

3.3 X-ray diffraction analysis of Ag-NPs

The Bragg's peaks in Fig. 4 depict the synthesized Ag-NPs' crystalline structure. The creation of pure Ag-NPs was confirmed by the presence of three distinct diffraction peaks at 2 angles of 38º, 44º, 64º, and 77º, which correspond to the (111), (200), (220), and (311) planes, respectively. For example, (Abeer et al. 2013) reported the crystalline nature of the Ag-NPs, and that strong XRD peaks were seen from *A.terreus* at 2 angles of 38.25°, 44.48°, 65°, and 77.68°, respectively. These match the face-centered cubic (fcc) unit cell of the Ag-NPs structure (JCPDS File No. 04-0783). Ag-NPs from *A.niger* were confirmed by X-ray diffraction research to have a lattice plane indexed to the (111), (200), (220) and (311), according to (Hemasekhar et al.2017) publication with the Bragg reflections with 2θ values of 38 0 , 44 0 , 64 0 , 77 0 , (JCPDS file no:4-783). The average crystalline size (S) of fungus mediated synthesis of Ag-NPs (23.6 nm) was calculated from Debey Scherer equation (1).

$$S = k\lambda/\beta\cos\theta \qquad \text{Eq.1}$$

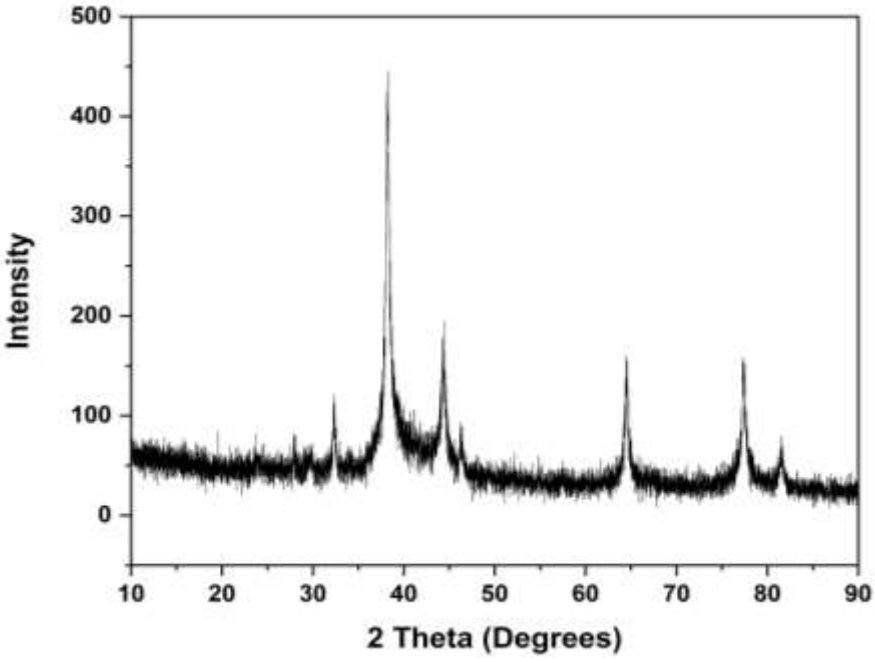

Fig. 4: X-ray diffraction analysis of Ag-NPs

3.4 FTIR analysis

As can be seen in Fig.5, the peak around at 3363 cm^{-1} towards the incidence of O-H groups of water components. The bands from 2360 cm^{-1} to 2373 cm^{-1} are due to the presence of aldehydic C-H stretching and 1650 cm^{-1} keep up a correspondence to the carbonyl group precise assimilation. With this, the peaks at 1110 cm^{-1} is related to C-OH stretching.

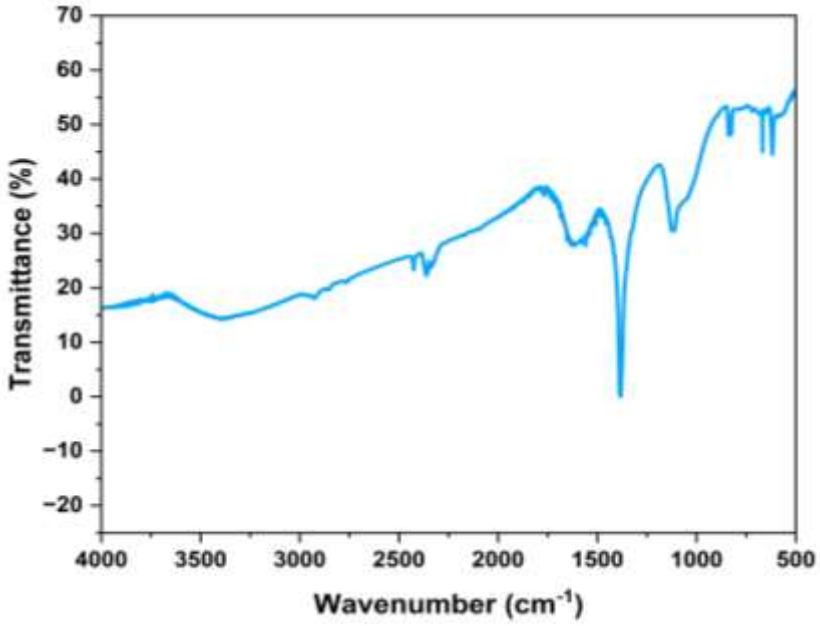

Fig.5: FTIR spectrum of Ag-NPs

4. Conclusion

The biological manufacture of Ag-NPs by various microorganisms, such as bacteria, fungus, and actinomycetes, is safe, practical, affordable, and time-efficient. It offers active appropriate advancements without the use of harmful components. A. fumigates strain produces Ag-NPs in the current study by reducing silver nitrate. On the in vitro studied bacteria, these Ag-NPs have potent antibacterial actions, most likely through destroying membrane integrity. Future research should focus more on developing an appropriate pharmaceutical formulation utilizing these nanoparticles as well as investigations on various biological activities in many sectors.

References

Abeer RM., Abd EI-Aziza., Monira R., AL.Othmanao., Saleh A. Eifan.a, Mohamed A., Mahmoudb Majrashic M., 2013. Green synthesis of silver nanoparticles using *Aspergillus terreus* (KC462061). Dig J Nanomater Bios., 8(3)., p.1215-1225.

Ahmad A., Mukherjee P., Mandal D., Senapati S., Khan M., Kumar R., Sastry M., 2002. Enzyme mediated extracellular synthesis of CdS nanoparticles by the fungus, *Fusarium oxysporum*. J Am Chem Soc., 124 (41)., p. 12108–12109.

Ahmed A., Mukherjee P., Senapathi D., Khan MI., Kumar R., Sastry M., 2003. Extracellular biosynthesis of silver nanoparticles using the fungus *Fusarium oxysporum*. Colloids Surf Biointerfaces., 28(4)., p.313-318.

Hemashekhar B., Chandrappa CP., Govindappa M., Chandrasekhar N., Nagaraju G., Ramachandra YL., 2017. Green synthesis of silver nanoparticles from endophytic fungus *Aspergillus niger* isolated from *Simarouba glauca* leaf and its antibacterial and antioxidant activity. Int J Eng Res Appl., 7(8)., p.17-24.

Nithya R. and Ragunathan R., 2009. Synthesis of silver nanoparticle using *Pleurotus sajor caju* and its antimicrobial activity. Dig. J Nanomater Biostruct., 4(4)., p.623-629.

Prakash R. and Thiagarajan P., 2012. Syntheses and characterization of silver nanoparticles using *Penicillium* sp. isolated from soil. IJAST., 1., p.138-149.

Magudapathy P., Gangopadhyay P., Panigrahi BK., Nair KGM., Dhara S., 2001. Electrical transport studies of Ag nanoclusters embedded in glass matrix. Physica B Condensed Matter. 299., p.142–146.

Saeed M., Behroz M., Reza AG. and Mehdi Y., 2012. Biological synthesis of silver nanoparticles by *Aspergillus flavus* isolated from soil of Ahar copper mine. Indian J Sci Technol., 5(S3)., p.2443-2444.

Sadowski Z., Maliszewska HI., Grochowalska B., Polowczyk I., Kozlecki T., 2008. Synthesis of silver nanoparticles using microorganisms. Materials Science-Poland., 26(2)., p.419-424.

Saha S., Chattopadhyay D., Acharya K., 2011. Preparation of silver nanoparticles by bio-production using *Nigrospora oryzaeculture* filtrate and its antimicrobial activity. Dig J Nanomater Biostruct., 6(4)., p.1519-1528.

Samuel P., Prince L., Prabakaran P., 2011. Antibacterial activity of marine derived fungi collected from South East Coast of Tamilnadu, India. J Microbiol Biotechnol Res., 1(4)., p.86-94.

Saravanan M., Nanda A., 2010. A biosynthesis of silver nanoparticles from *Aspergillus clavatus* and its antimicrobial activity against MRSA and MRSE. Colloids Surf B., 77 (2)., p.214-218.

Sastry M., Ahmad A., Khan IM., Kumar R., 2003. Biosynthesis of metal nanoparticles using fungi and actinomycete. Current Sci., 85(2)., p.162-170.

Singh R. and Singh NH., 2011. Medical application of nanoparticles in biological imaging cell labelling antimicrobial agents and anticancer nanodrugs. J Biomed Nanotechnol., 7(4)., p.489-503.

Wiley BJ., Im SH., Li ZY., McLellan J., Siekkkinen A., Xia Y., 2006. Maneuvering the surface plasmon resonance of silver nanostructures through shape-controlled synthesis. J Phy Chem., 110(32)., p. 15666-75.