Section A-Research Paper
ISSN 2063-5346

Synthesis and characterization of silver nanoparticles using *Ipomoea palmata* leaf extract

Shweta Kashyap[1*], Ladly Rani[1], Rupa Verma[1], Sapna Suman[1], Prabin Kumar Mahto[2], Md Zakir Hussain[1]

[1]Department of Botany, Ranchi University, Ranchi, Jharkhand, India

[2]Department of Physics, Ranchi University, Ranchi, Jharkhand, India

Corresponding Author: shwetakashyap041@gmail.com.

Abstract

In this study, the synthesis of silver nanoparticles is reported from *Ipomoea palmata* leaf extract. The AgNPs were characterized using a UV-Visible spectrophotometer, XRD, FTIR, and FESEM with EDS. A peak at 439nm of Surface Plasmon Resonance was observed at UV-Vis. The crystalline nature face cubic centered was confirmed by XRD and the 2Ɵ value was 28.0,32.4, 44.1, 46.5, 54.9, 57.7, and 76.8 corresponding to planes 122, 111, 200, 200, 220, 220 and 311. FTIR analysis spectral peaks were observed at 3293.18, 2350, 2092.47, 1624.83, 388.16, 1108.30, 70.82, 580.86 responsible for the biomolecules OH, C-O, C=C, C=C, N-O, and C-X (Floroalkane, Chloroalkane and Bromoalkane) respectively. FESEM analysis showed that the particles are spherical in shape with size varying between 12-25 nm and the average size was 18 nm.

Keywords: AgNPs, UV-Visible spectrophotometry, XRD, FTIR, EDX, and FESEM

Introduction

Nanotechnology is the branch of science that deals the nanoparticles and their various applications such as electrical, mechanical, medical, and field structural material [Nanda et al. 2009]. The size of the nanoparticle ranges between 1-100nm. It works on the principle of a large surface-to-volume ratio, where all the nanoparticles actively participate in changing the character of the material [Leela et al 2008].

Due to the antimicrobial properties of silver, it is being used since ancient times, in various medical applications [Noginov et al,2006., Srivastava et al. 2009., Krishnaraj et al 2010]. It was been reported that AgNPs are having extraordinary antimicrobial activity [Khanna et al,2005., Satyavathi et al.,2010., Shameli et al,2010., Maldieh et al,2012]. Silver nanoparticles can be

synthesized by physical, chemical or biological methods. But the synthesis of silver nanoparticles using physical or chemical methods are costly, time taking and produces toxic chemicals [Nanda et al,2014] while the biological method of synthesis of silver nanoparticles using plant extract is safe, eco-friendly, cheap, and free from toxins [Seema et al 2010].

The genus *Ipomoea* belongs to the family Convolvulaceae with about 500 species.

Fig 1: Plant of *Ipomoea palmata*

Ethnic people worldwide including India use different *Ipomoea species* to cure various diseases and for their household Income. It also shows anti-bacterial, anti-viral, anti-fungal, and anti-cancer activity. Jharkhand is rich in wild diversity [Deepa Srivastava 2017]. The plant *I. palmata* showed antiviral [Eich et al, 1996], anti-inflammatory [Gorzal et al, 1996] and larvicidal properties [Ferreira et al, 2006]. In this study, silver nanoparticles were synthesized using its aqueous leaf extract, and its characterization was done by using standard characterization techniques.

Methodology:

Preparation of leaf extract:

5gm dried leaf powder was mixed in 100 ml distilled water and the mixture was heated at 50^0C with continuous stirring for 20min under reflux conditions. After cooling the leaf extract was filtered with Whatman No.1 filter paper. The filtrate was used for the synthesis of silver nanoparticles [Subha et al., 2016].

Biogenic synthesis of AgNPs using leaf extract:

From the prepared plant extract, 20 ml of the aqueous plant leaf extract of the plant was added drop by drop to the 1 mM of $AgNO_3$ solution appearance of brown color indicates the formation of silver nanoparticles. Then the solution was stirred at 50°C for 3 h to increase the surface plasmon resonance of synthesized silver nanoparticles. The solution of synthesized silver nanoparticles was used for UV-Visible spectrophotometry and the remaining solution was purified by repeated centrifugation at 15,000 rpm for 15 min. The supernatant was discarded and replaced with distilled water. The cycle was repeated three times. Then the synthesized nanoparticles were oven dried at 50^o-60^oC for characterization (Arunachalam et al., 2012).

Characterization of synthesized Ag-NPs

Characterization of synthesized Ag-NPs was done by using UV-Visible spectrophotometry, FTIR (Fourier Transform Infrared Spectroscopy), XRD (X-Ray diffraction), EDAX with FESEM (Fluorescence embedded Scanning electron microscopy).

Result and discussion:

UV-Visible Study

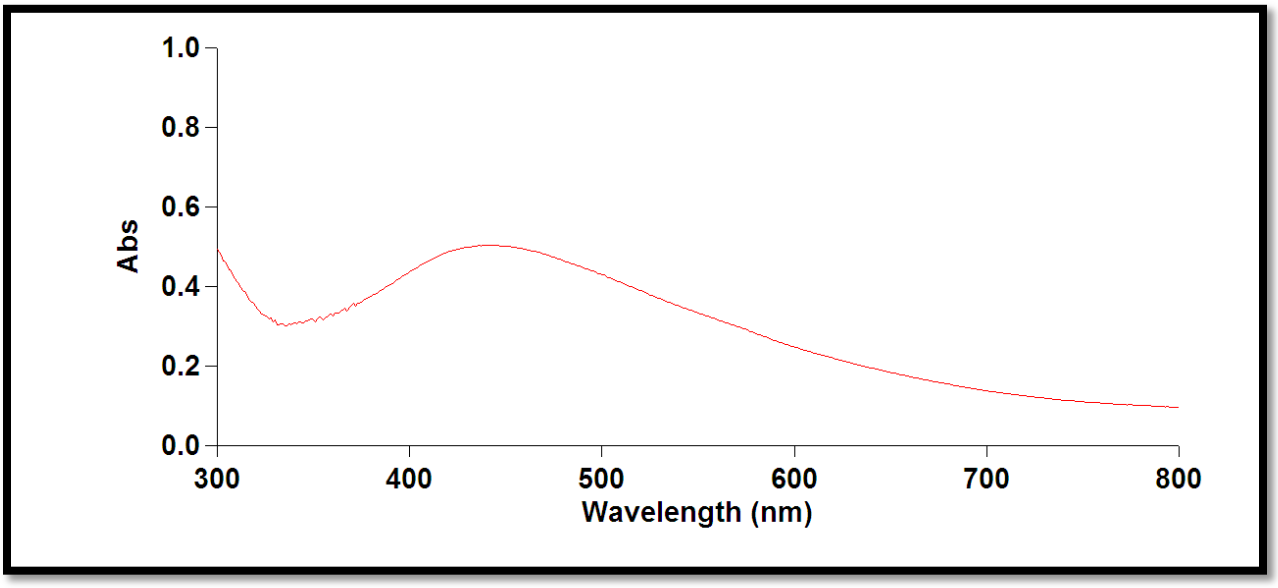

Fig 2: UV-Vis spectrophotometric analysis of *I.palmata* Forsk.

The synthesis and stability of synthesized silver nanoparticles were determined by UV-VIS spectrophotometry. It is used to determine the shape and size of synthesized silver nanoparticles [Krishnaraj et al., 2010]. The change of color from yellow to dark brown is due to the excitation of surface plasmon resonance of synthesized AgNPs [Noginov et al., 2006]. A peak was observed at

439nm. Subha et al reported that the peak was raised due to SPR and its broadening indicates the polydispersity of synthesized silver nanoparticles. Harshita et al reported the peak at 437nm in *I.cairica* leaf extract. Henglein reported that the peak between 400-500nm indicates that the size of nanoparticles is between 10-100 nm. [Henglein, 1993].

FTIR Study

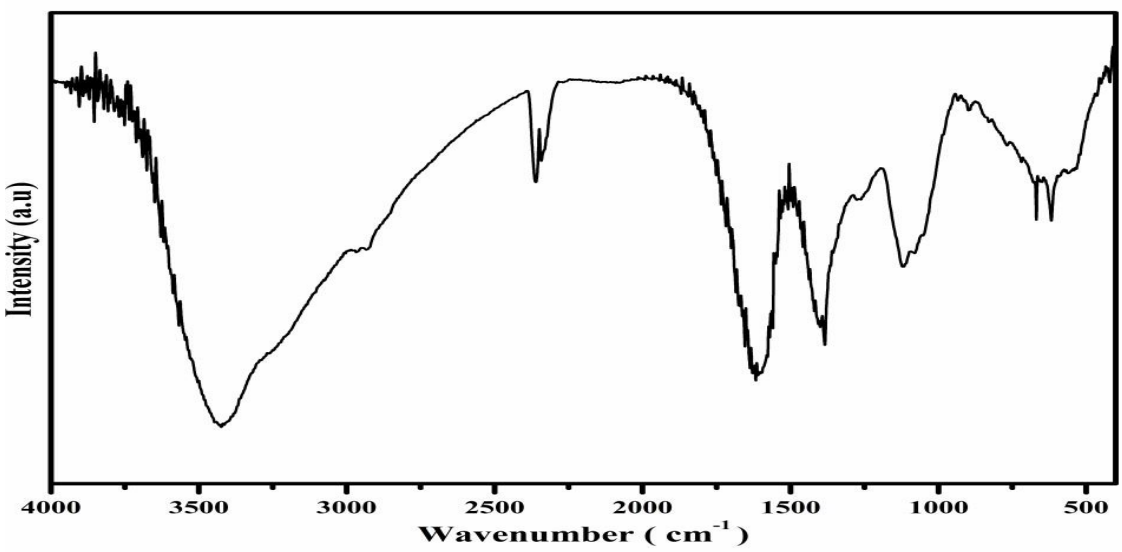

Fig 3: FTIR analysis of synthesized AgNPs

FTIR analysis was performed to categorize the biochemical compounds responsible for the reduction and stabilization of AgNPs. FTIR analysis shows peaks at 3334, 1631, 1243, 1142, 842, 612, and 522^{o} that indicate the presence of hydroxyl compounds, flavonoids, and alcoholic, phenolic, primary, and secondary amines respectively [Krishnanan et al 2006]. Kumar et al reported the reduction of silver ions to silver nanoparticles is due to the presence of carboxyl and hydroxyl groups. Satyavani reported the biochemical compound responsible for the synthesis and stabilization of AgNPs.

Crystallographic Study

XRD analysis and the resulting diffraction patterns. The XRD patterns revealed four distinct peaks at 38.29°, 46.36°, 66.5°, and 76.8°, which corresponded to the crystal planes (111), (200), (220), and (311), respectively. XRD patterns also show some unknown peaks (marked with stars) at 28.4, 32.37, 40.64, 50.31, 55.34, and 73.83 which differs from the result of Harsita in I.cairica leaf extract. Noginov reported that the unknown peaks observed may be due to the crystallization of the bioorganic phase on the AgNPs surface originating from the leaf extract. [Noginov et al., 2006]

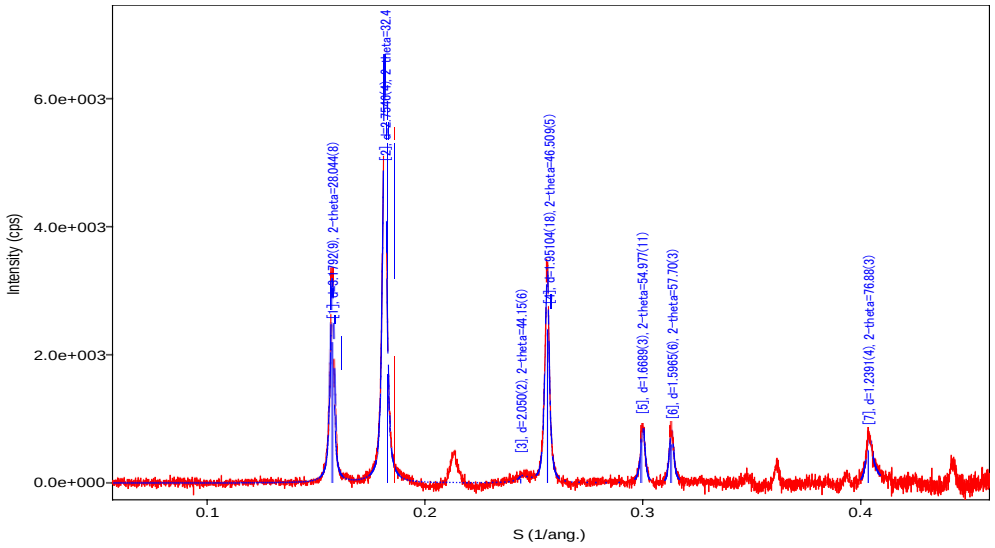

Fig 4: XRD spectra of synthesized silver nanoparticles.

Compositional and morphological study:

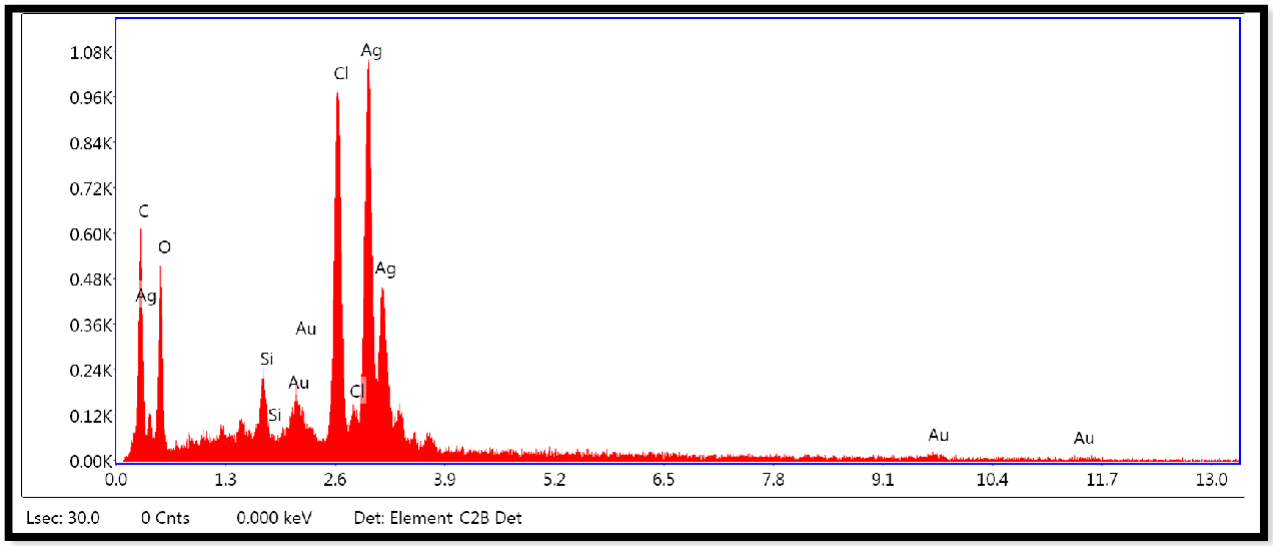

Fig 5: EDAX spectra of synthesized silver nanoparticles.

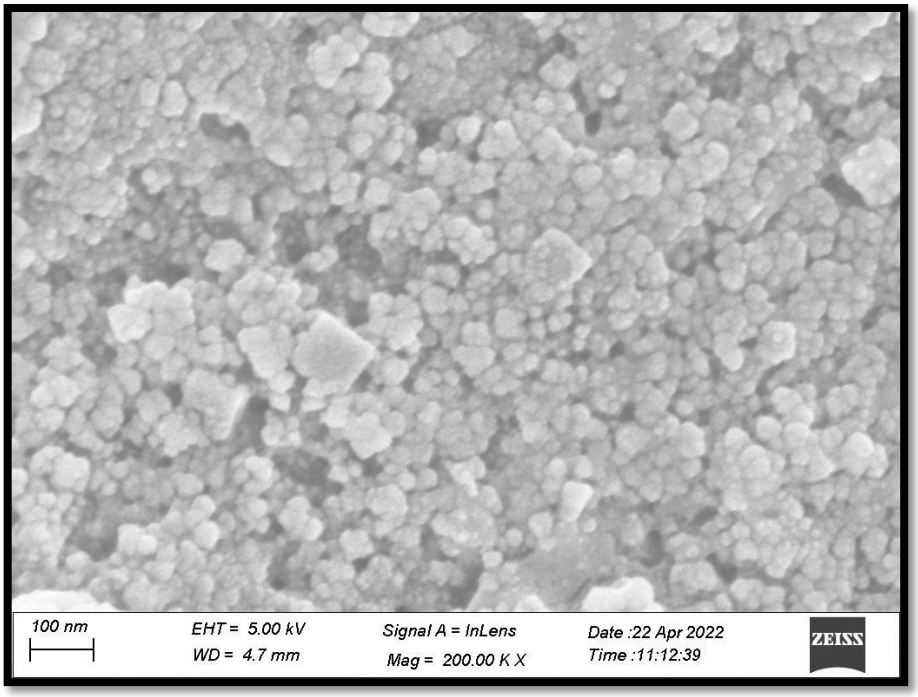

Fig 6: FESEM spectra of synthesized silver nanoparticles.

FESEM analysis report shows the formation of spherical-shaped silver nanoparticles with size varying between 12-25 nm and the average size was 18 nm. A spherical 5.8mm size was reported by Harsita using SEM. The EDX analysis attached with FESEM showed elements like carbon, chlorine, silica, oxygen, and gold with silver peaks. The peak of silver is greater than the other peaks similar results observed by previous researchers [Mollick et al., 2015, Magudapathy et al., 2001].

Conclusion

The green chemistry approach has proven that silver nanoparticles can be synthesized by using dried leaf powder of *Ipomoea palmata*. The synthesis of AgNPs from fresh leaf extract of *Ipomoea cairica* was previously reported by Harshita et al. Here the biomolecules act as effective capping as well as reducing agents, which was observed by FTIR analysis. The present study involving the use of aqueous leaf extract can prove to be a very effective, economical, sustainable, and eco-friendly approach for the biosynthesis of silver nanoparticles which was confirmed by XRD analysis and can be further used for drug preparation.

Acknowledgment

I Shweta Kashyap want to acknowledge the HOD of the University Department of Botany Dr. Kunul Kandir for providing me with the lab facility. I want to thank Dr. S.K. Dey of ARCTC, University Department of Physics and Dr. Hui Tag and Dr. Niranjan of Rajiv Gandhi University, Department of Physics, and Mr. Manav of Rajiv Gandhi University for supporting me in the

characterization of synthesized AgNPs. Last but not least I want to thank Mr. Deepak Gupta, and his family members for giving me moral support during my work and I want to thank God for giving me the opportunity and strength for doing my work.

References

- Nanda A, Saravanan M. Biosynthesis of silver nanoparticles from Staphylococcus aureus and its antimicrobial activity against MRSA and MRSE. Nanomedicine: Nanotechnology, Biology, and Medicine 2009; 5(4): 452-456.
- Leela A, Vivekanandan M. Tapping the unexploited plant resources for the synthesis of silver nanoparticles. Afr J Biotechnol 2008;7(17):3162
- Krishnaraj C, Jagan EG, Rajasekar S, Selvakumar P, Kalaichelvan PT, Mohan N. Synthesis of silver nanoparticles using Acalypha indica leaf extracts and its antibacterial activity against water borne pathogens. Colloids Surf B Biointerfaces 2010;76(1):50-6.
- Noginov MA, Zhu G, Bahoura M, Adegoke J, Small C, Ritzo BA, et al. The effect of gain and absorption on surface plasmon in metal nanoparticles. Appl Phys B 2006;86(3):455-60.
- Shrivastava S, Dash D. Applying nanotechnology to human health. J Nanotechnol 2009;12:240-3.
- Sathyavathi R, Krishna MB, Rao SV, Saritha R, Rao DN. Biosynthesis of silver nanoparticles using Coriandrum sativum leaf extract and their application in nonlinear optics. Adv Sci Lett 2010;3(2):1-6.
- Shameli K, Ahmad MB, Yunus WM, Ibrahim NA. Synthesis and characterization of silver/talc nanocomposites using the wet chemical reduction method. Int J Nanomedicine 2010;5:743-51.
- Khanna PK, Sing N, Charon S, Subbrarao VV, Gokhole R, Mulik UP. Synthesis and characterization of Ag/PVA nanocomposite by chemical reduction method. Mater Chem Phys 2005;93(1):113-7.
- Mahdieh M, Zolanvari A, Azimee AS, Mahdieh M. Green biosynthesis of silver nanoparticles by Spirulina platensis. Sci Iran 2012;19(3):926-9
- Nanda Anima and Shahnaz Majeed. Enhanced antibacterial efficacy of biosynthesized AgNPs from Penicillium glabrum (MTCC1985) pooled with different drugs. International Journal of PharmTech Research 2014; 6(1): 217-223.
- Seema S, Naheed A, Anuradha P, Vidya NS, Ashok KG, Bodh AM. Synthesis of crystalline Silver Nanoparticles from microorganisms. Mater Sci Appl 2010; 1:1-7.
- Deepa Srivastava. Medicinal plants of genus Ipomoea: present scenario, challenges and future prospective. Research journal of recent sciences; vol6(10),23-26, October 2017.
- Marilena Meira et al., Review on genus Ipomoea; traditional uses, chemistry, and biological activities. Brazilian Journal of Pharmacognosy,22(3), 682-713, May June 2012.
- Subha V et. al, Asian J Pharm Clin Res, Vol 8, Issue 5, 2015, 103-106

- Krishnaraj C, Jagan EG, Rajasekar S, Selvakumar P, Kalaichelvan PT, Mohan N. Synthesis of silver nanoparticles using Acalypha indica leaf extracts and its antibacterial activity against water borne pathogens. Colloids Surf B Biointerfaces 2010;76(1):50‑ 6.
- Noginov MA, Zhu G, Bahoura M, Adegoke J, Small C, Ritzo BA, et al. The effect of gain and absorption on surface plasmon in metal nanoparticles. Appl Phys B 2006;86(3):455‑ 60.
- Shrivastava S, Dash D. Applying nanotechnology to human health. J Nanotechnol 2009;12:240‑ 3.
- Gorzalczany S, Acevedo C, Muschietti L, Martino V, Ferraro G 1996. Search foranti-inflammatory activity in Argentine medicinal plants. *Phytomedicine 3*: 181-184.
- Ferreira AA, Amaral FA, Duarte IDG, Oliveira PM, Alves RB, Silveira D, Azevedo AO, Raslan DS, Castro MSA 2006. The antinociceptive effect from *Ipomoea cairica* extract. *J Ethnopharmacol 105*: 148-153.
- Lima OOA, Braz-Filho R 1997. Dibenzylbutyrolactone lignans and coumarins from *Ipomoea cairica. J Braz Chem Soc* 8: 235-238.
- Eich E, Pertz H, Kaloga M, Schulz J, Fesen MR, Mazumder A, Pommier Y 1996. (-)-Arctigenin as a lead structure for inhibitors of human immunodeficiency virus type-1 integrase. *J Med Chem 39*: 86-95.
- Krishnaraj C, Jagan EG, Rajasekar S, Selvakumar P, Kalaichelvan PT, Mohan N. Synthesis of silver nanoparticles using Acalypha indica leaf extracts and its antibacterial activity against water borne pathogens. Colloids Surf B Biointerfaces 2010;76(1):50-6.
- Noginov MA, Zhu G, Bahoura M, Adegoke J, Small C, Ritzo BA, et al. The effect of gain and absorption on surface plasmon in metal nanoparticles. Appl Phys B 2006;86(3):455-60.
- A. Henglein. Physicochemical properties of small metal particles in solutions: microelectrode reactions, chemisoption, composite metal particles, and the atom-to-metal transition. J. Phys Chem.
(1993)
- Krishanan R, Maru GB. Isolation and analyses of polymeric polyphenols fractions from black tea. Food Chem 2006;94(3):331-40.
- Saranyaadevi K, Subha V, Ernest Ravindran RS, Renganathan S. Synthesis and characterisation of copper nanoparticle using Capparis zeylanica leaf extract. Int J Chem Tech Res 2014b;6(10):4533-41
- Kumar R, Mohana Roopan S, Prabhakarn A, Khanna VG, Chakroborty S (2012) Agricultural waste Annona squamosa peel extract: Biosynthesis of silver nanoparticles. Spectrochim Acta Part A 90: 173-176.