



**GREEN SYNTHESIS OF SILVER NANOPARTICLES USING AERIAL PARTS
EXTRACT OF ECHINOCHLOA COLONA AND THEIR CHARACTERIZATION**

Lakshman Kumar D.^{1*}, Siva Sankar S.², Dr. Venkatesh P.³, Dr. Hepty Kalarani D.³

¹Department of Pharmacognosy, PRRM College of Pharmacy, Kadapa, Andhra Pradesh, India.

²Department of Materials Science and Nanotechnology, Yogivemana University, Kadapa, Andhra Pradesh, India.

³Department of Pharmaceutical Chemistry, PRRM College of Pharmacy, Kadapa, Andhra Pradesh, India.

***Correspondence for Author: Lakshman Kumar D.**

Department of Pharmacognosy, PRRM College of Pharmacy, Kadapa, Andhra Pradesh, India.

Article Received on 13/02/2016

Article Revised on 04/03/2016

Article Accepted on 24/03/2016

ABSTRACT

In the present work, the silver nano particles (AgNPs) are synthesized by ecofriendly bio reduction method. The aqueous extract of Echinochloa colona plant aerial parts were used as reducing and stabilizing agent. The formation of AgNPs was initially identified by change in colour from light yellow to dark brown. The UV visible spectra showed the characteristic surface Plasmon resonance peak of synthesized AgNPs between 380 and 460 nm. X-ray diffraction analysis revealed the crystalline nature of AgNPs. The energy dispersive X-ray spectroscopy confirms the metallic nature of silver. Field emission scanning electron microscopy (FESEM) images showed the spherical nature of the particles where as size distribution was measured by Zeta sizer, which revealed that majority of size distribution of AgNPs were in the range of 50-70 nm.

KEYWORDS: Silver nano particles, FESEM, XRD, Green synthesis, Echinochloa colona.

1. INTRODUCTION

Nanoparticles are particles between 1-100 nanometers in size. In nanotechnology, a particle is defined as a small object that behaves as a whole unit with respect to its transport and properties. Nanoparticle research is currently an area of intense scientific interest due to a wide variety of potential applications in biomedical, optical and electronic fields. Ag was known only as a metal till the recent past and it is when the nano-era came into existence that people started to believe that silver could even be produced at the nano scale range. The development of techniques for the controlled synthesis of nanoparticles of well-defined size, shape and marked stability made its use possible in biomedical field. AgNPs have been reported in various applications as sensors^[1], DNA detection^[2], catalyst^[3]. From a therapeutic point of view biosynthesized AgNPs use as anti fungal gent^[4], batteries to increase the efficiency^[5], photovoltaic^[6], electronics^[7], nano heaters^[8], paint^[9,10] AgNPs prepared by various methods like chemical reduction method^[11], sonochemical method^[12], laser ablation^[13], lithography^[14], hydrothermal method^[15], gamma irradiation^[16], ultra sonic method^[17], thermal decomposition^[18], electrochemical method^[19], bacteria^[20,21], and fungi^[22]. On the other hand, green synthesis of AgNPs is rapid, low cost, and more eco-friendly; therefore, in recent time, scientists are looking forward to the possible biological methods for the synthesis of AgNPs. Along with chemical and biological methods AgNPs can be synthesized by using various

plant and fruit extracts like Grewia flaviscence, Murraya konigi, Punica granatum, Passiflora tripartite, Ferocactus echidne.^[23-26] On the basis of the available literature, we demonstrated green biological route for the synthesis of AgNPs using an extract derived from Echinochloa colona. The nanoparticles were characterized by UV-visible spectroscopy, FTIR, XRD, FESEM and DLS analysis.

EXPERIMENTAL

2. MATERIALS AND METHODS

Silver nitrate (AgNO₃) was purchased from Merck for this study. Echinochloa colona was collected from Tirumala hills. All glassware's were washed with HNO₃ and distilled water and dried in oven. Double distilled water (DDW) was used throughout the experiment. 10 g of dried powdered plant material was weighed and boiled for 20 min in 100 ml DDW in Erlenmeyer flask and cooled to room temperature and then the extracts were filtered through Whatman filter paper No. 1. The filtered extract was stored in refrigerator at 4^oC. This extracts were used as reducing as well as stabilizing agent. About 90 ml of 1mM aqueous solution of silver nitrate was taken in Erlenmeyer flask and 10 ml of Echinochloa colona extract was added to it at room temperature. After 6 hr the solution was turned yellow to dark brown indicating the formation of AgNPs.

Characterization of AgNPs

The reduction of pure silver ions (Ag^+ ions) into AgNPs can be identified by UV-Vis spectrum. Sample is prepared taking small amount of aliquot from the final reaction mixture (dark brown colored) and is further diluted with distilled water 1 in 10 dilutions. UV-VIS spectrum for this sample was recorded on UV-Vis spectrophotometer (Perkin-Elmer lambda 425) in the range of 300 to 600 nm. Sample for FTIR analysis was prepared by centrifuging the final reaction mixture at about 10000 rpm for about 15 min. The sediment was collected and the dried sample was directly placed on the potassium bromide crystals and the spectrum was recorded in Transmittance mode using FTIR (Model: Spectrum RXI). The spectrum was recorded in the mid IR region of $4000\text{-}400\text{ cm}^{-1}$. The spectrum was recorded using Attenuated Reflectance Technique (ATR). To find out the crystalline nature X-ray diffraction studies was performed on (RIGAKU, SMART LAB) operated at 30 kV/100 mA with $\text{Cu K}\alpha$ as a radiation source was used to record XRD patterns of dried AgNPs. FESEM image was observed on SUPRA 55 with co-relatively microscope at 20 kV along with Energy-dispersive X-ray (EDX) spectrum to find out the elemental composition of the synthesized AgNPs. Particle size distribution of the synthesized AgNPs was carried out on Zeta sizer S-90, Malvern, UK by taking dilute dispersion solution of AgNPs in Mill Q water.

3. RESULTS AND DISCUSSION

UV- Visible studies

In this present work, we observed the color change of the reaction mixture when *Echinochloa colona* aerial parts extract was mixed with silver nitrate solutions, after about 5 hr the reaction mixture finally turned into dark brownish colour and no further change in colour has been observed. The UV-Vis spectrum of the AgNPs has been shown in **Fig. 1**. It is evident that a strong and intense absorption peak at about 440 nm with high absorbance has been observed. It is confirmed from that formation of AgNPs.

FTIR studies

Fig. 2 Shows FTIR analysis of green synthesized AgNPs. The broad peak at 3283 cm^{-1} corresponds to the bounded hydroxyl (-OH) or amine groups of leaf extract. The absorption peak at 2925 cm^{-1} corresponds to the stretching vibrations of aldehydic -C-H groups present in leaf extract. The peak at 1646 cm^{-1} corresponds stretching of carboxyl groups (-C=O).^[26] Peaks at 1390 , 1457 cm^{-1} corresponds to C-O stretching of alcohols and tertiary amines. This analysis provides evidence for the presence of proteins as capping agent, which helps in increasing the stability of the synthesized AgNPs apart from acting as reducing agents in reducing silver ions into particles.

XRD Analysis

The XRD pattern of the synthesized AgNPs are shown in **Fig. 3**. The XRD pattern shows peaks at 2θ values of

37.88 , 43.96 , 64.18 and 77.08° correspond to 111, 200, 220 and 311 planes, respectively. This confirms that silver is in pure crystalline form. The data obtained was compared with the database of Joint Committee on Powder Diffraction Standards (JCPDS file No. 04-0783) which is in good agreement with standard values.

FESEM studies

FESEM will provide further insight into the morphology and size and shape of the nanoparticles. FESEM micrograph of the synthesized AgNPs using the *Echinochloa colona* aerial parts extract is shown in **Fig. 4**. The synthesized AgNPs were well dispersed without aggregation and also having nearly spherical shape. FESEM results confirmed that the morphology of synthesized AgNPs.

EDAX analysis

Fig. 5 shows EDX of AgNPs. The strong signal at the energy of 3 keV and also some of the weak signals are obtained for Cl, K, O and C elements. The major emission energy at 3 keV indicates the presence of AgNPs.

DLS analysis

Particle size distribution of green synthesized AgNPs were also measured using particle size analyzer and the results are displayed in **Fig. 6**. The histogram showed that most of the particles are in the range of 50-70 nm. However, the particles are ranging from 50- 70 nm. It supports the results showed in FESEM studies.

FIGURE CAPTIONS

Fig.1. UV-Vis spectra of green synthesized AgNPs from *Echinochloa colona* extract.

Fig.2. FTIR of Green synthesized AgNPs.

Fig.3. XRD pattern of the Green synthesized AgNPs.

Fig. 4. FESEM Micrograph AgNPs.

Fig.5. EDX Spectrum Green synthesized AgNPs.

Fig.6. Histogram of particle size distribution of Green synthesized AgNPs.

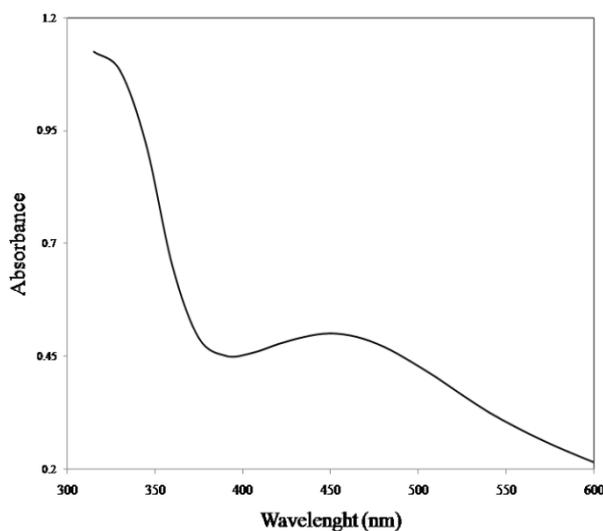


Fig: 1.

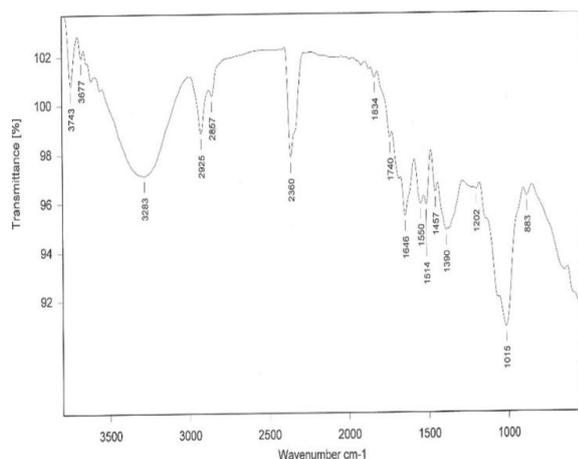


Fig: 2.

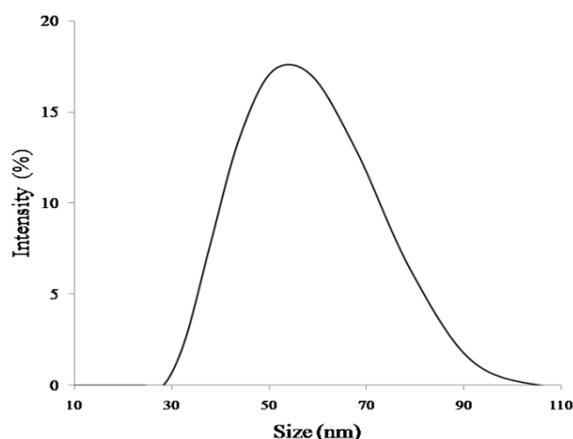


Fig: 6.

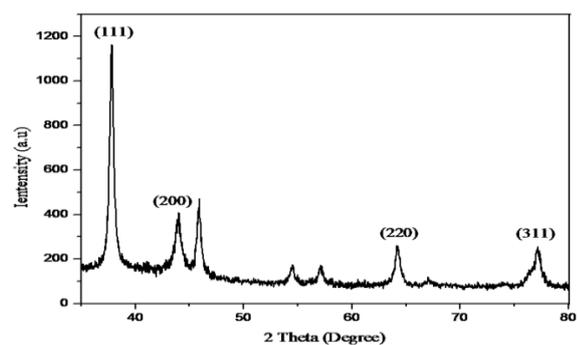


Fig: 3.

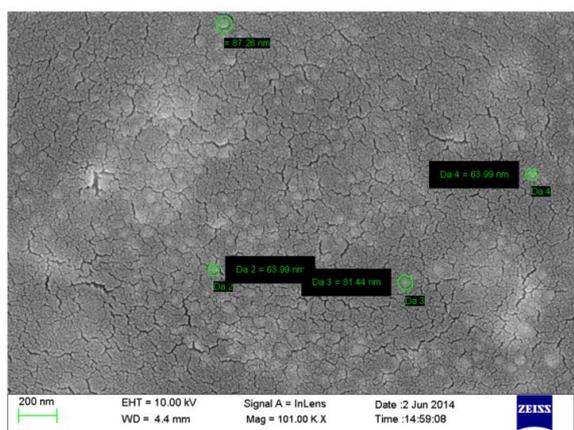


Fig: 4.

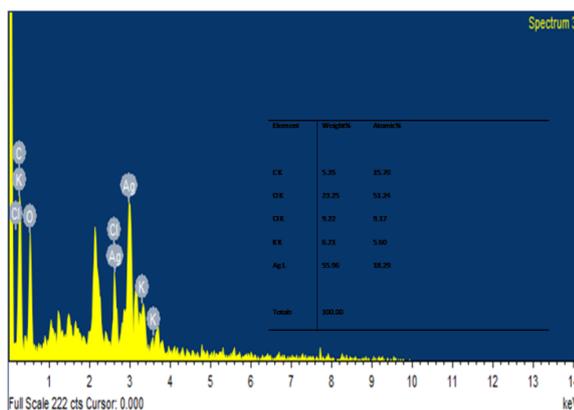


Fig: 5.

4. CONCLUSION

The present work, we describe synthesis and characterization of AgNPs using Echinochloa colona. Characteristic brown colour indicates the formation of AgNPs in the reaction mixture. UV-Vis spectroscopy showed absorption maxima at 440 nm, which further confirms the formation of AgNPs. FESEM image showed that the average particle size of AgNPs about 70 nm. FTIR analysis indicated the possible role of carboxyl (-C=O), hydroxyl (-OH) and amine (-NH) groups of leaf extract in fabrication of AgNPs. Use of Echinochloa colona extract offers an affordable, environment friendly technique for synthesis of large scale AgNPs

ACKNOWLEDGEMENT

We are thankful to the management of P. Rami Reddy Memorial College of Pharmacy, Kadapa, A. P. India for providing the all facilities for carry out this work.

REFERENCE

- Chandrakant, K T.; Sreekantha Reddy, D.; Aiyer, R.; Sungha, P.; Kulkarni, A.; Sabharwala, S.; Sensors and Actuators B, 2013; 183: 144–149. DOI:10.1016/j.snb.2013.03.106.
- Thompson, D G.; Enright, A.; Faulds, K.; Smith, W E.; Graham, D.; Anal. Chem., 2008; 80: 2805-2810. DOI: 10.1021/ac702403w.
- Bharat, B.; Gabriel, G J.; Akbashev, M. J.; Booher, M E. Langmuir, 2013; 29: 4225–4234. DOI: 10.1021/la305068p.
- Ganesh Kumar, C.; Poornachandra, Y.; Colloids and Surfaces B: Biointerfaces, 2015; 125: 110-119. DOI:10.1016/j.colsurfb.2014.11.025.
- Tanju, E.; Necip, A.; Mehmet, L.Y.; Karimi-Maleh, H.; Alper, T. C.; Asim, O.; Ionics, 2015. DOI 10.1007/s11581-015-1409-z.
- Qipeng, L.; Zhenda, L.; Yunzhang, L.; Longfeng, L.; Yu, N, Hongxia, Y.; Yanbing, H.; Yadong, Y.; Nano Lett., 2013; 13: 5698–5702. DOI: 10.1021/nl403430x.
- Jingqi, T.; Sen, L.; Yingwei, Z.; Li, H.; Lei, W.; Yonglan, L.; Asiri, A, M.; Al-Youbi, A. O.; Xuping, S.; Inorganic chemistry, 2012; 51: 4742–4746. DOI: 10.1021/ic300332x.

8. Li, Y.; Verbiest, T.; Strobbe, R.; Vankelecom Ivo F. J.; *J. Mater. Chem. A*, 2013. DOI: 10.1039/c3ta14406b.
9. Kumar, A.; Praveen kumar, V.; Ajayan, P, M.; John, G.; *Nature materials*, 2008; 7: 230-241. DOI: 10.1038/NMAT2099.
10. Holtz, R, D.; Lima, B, A.; Souza Filho, A, G.; Marcelo, B.; Alves, O. L.; *Nanomedicine: Nanotechnology, Biology, and Medicine*, 2012; 8: 935–940. DOI: <http://dx.doi.org/10.1016/j.nano.2015.09.004>.
11. Hongshui, W.; Xueliang, Q.; Jianguo, C.; Shiyuan, D.; *Colloids and Surfaces A*, 2005; 256: 111–115. DOI:10.1016/j.colsurfa.2004.12.058.
12. Zhu, J.; Liu, S.; Palchik, O.; Kolytyn, Y.; Gedanken, A.; *Langmuir*, 2000; 16: 6396-6399. DOI: 10.1021/la991507u.
13. Tsuji, T.; Thang, D H.; Okazaki, Y.; Nakanishi, M.; Tsuboi, Y.; Tsuji, M.; *Applied Surface Science*, 2008; 254: 5224–5230. DOI:10.1016/j.apsusc.2008.02.048.
14. Jensen, T. R.; Malinsky, M. D.; Haynes, C. L.; Van Duyne, R P.; *J. Phys. Chem., B*, 2000; 104: 10549-10556. DOI: 10.1021/jp002435e.
15. Zou, J.; Xuc, Y.; Bo, H.; Wu, D.; Sun, Y.; *China Particuology*, 2007; 5: 206–212. DOI: 10.1016/j.cpart.2007.03.006
16. Rao, Y.N., Banerjee, D.; Datta, A.; Das, S.K.; Guin, R.; Saha, A.; *Radiation Physics and Chemistry*, 2010; 79: 1240–1246. DOI:10.1016/j.radphyschem.2010.07.004
17. Byeon, J H.; Kim, Y W.; *Ultrasonics Sonochemistry* 2012; 19: 209–215. DOI:10.1016/j.ultsonch.2011.06.004.
18. Navaladian, S.; Viswanathan, B.; Viswanath, R. P.; Varadarajan, T. K.; *Nanoscale Res Lett.*, 2007; 2: 44–48. DOI 10.1007/s11671-006-9028-2.
19. Khaydarov, R, A.; Khaydarov, R, R. Olga, G.; Yuri, E.; Scheper, T.; *J Nanopart Res.*, 2009; 11: 1193–1200. DOI: 10.1007/s11051-008-9513-x.
20. Vidhya Lakshmi, D.; Roshmi, T.; Varghese, R T.; Soniya, E. V.; Mathew, J.; Radhakrishnan, E. K.; *3 Biotech*, 2014; 4: 121–126. DOI 10.1007/s13205-013-0130-8.
21. Shivaji, S.; Madhu, S; Singh, S.; *Process Biochemistry*, 2011; 46: 1800–1807. DOI:10.1016/j.procbio.2011.06.008.
22. Vigneshwaran, N.; Ashtaputre, N.M.; Varadarajan, P.V.; Nachane, R.P.; Paralikar, K.M., Balasubramanya, R.H.; *Mat. Lett.*, 2007; 61: 1413–141. DOI:10.1016/j.matlet.2006.07.042.
23. Siva Sankar, S.; Venkata Ramana, B.; Sai Kumar, A.; Vijaya Kumar N. B.; *Mat. Lett.*, 2015; 145: 347–350. DOI: <http://dx.doi.org/10.1016/j.matlet.2015.01.096>
24. Laura, C.; Singaravelu, V.; Manjusri, M.; Amar Kumar, M.; *Adv. Mat. Lett.*, 2011; 2(6): 429-434. DOI: 10.5185/amlett.2011.4256.
25. Naheed, A.; Seema, S.; Radheshyam, R.; *Adv. Mat. Lett.*, 2012; 3(5): 376-380. DOI: 10.5185/amlett.2012.6357.
26. Kumar, B.; Kumari, S.; Luis, C.; Alexis, D.; Javier, C.; Hernández-Gallegos, E.; Chávez-López, M G.; Grijalva, M.; Angulo, Y.; Rosero, G.; *Adv. Mater. Lett.*, 2015; 6(2): 127-132. DOI: 10.5185/amlett.2015.5697.