WORLD JOURNAL OF PHARMACY AND PHARMACEUTICAL SCIENCES
SJIF Impact Factor 6.041
Volume 5, Issue 6, 1712-1717 Research Article ISSN 2278 – 4357

AMARANTHUS OLERACEA LEAF EXTRACT MEDIATED SYNTHESIS OF SILVER NANOPARTICLES AND ITS ANTIBACTERIAL ACTIVITY

Nilesh Paul[1,2*], Pratik Sharma[1], Pooja Gaikwad[1], Rahul Dhangare[1], Archana Panche[1], Sanjay Harke[1]

[1]Department of Biotechnology, MGM's Institute of Biosciences and Technology, Aurangabad-431003, Maharashtra, India.

[2]Department of Biotechnology, MGM's Jawaharlal Nehru Engineering College, Aurangabad-431003, Maharashtra, India.

Article Received on
07 April 2016,

Revised on 27 April 2016,
Accepted on 17 May 2016

DOI: 10.20959/wjpps20166-6961

***Corresponding Author**
Nilesh Paul
Department of Biotechnology, MGM's Institute of Biosciences and Technology, Aurangabad-431003, Maharashtra, India.

ABSTRACT

Metallic nanoparticles have an increasing commercial demand due to their wide applicability in various areas. The present study explores the *Amaranthus oleracea* plant for the simple, rapid and ecofriendly synthesis of silver nanoparticles. These biosynthesized nanoparticles were characterized by Transmission Electron Microscopy (TEM). It was observed that *Amaranthus oleracea* leaf extract can reduce silver ions into silver nanoparticles in the size range 5-20 nm and it is spherical in shape. Further, the antibacterial activity of synthesized silver nanoparticles showed effective inhibitory activity against *Escherichia coli*.

KEYWORDS: Biosynthesis; Silver nanoparticles; Antibacterial activity; TEM.

INTRODUCTION

Nanotechnology provides technology platform for the exploration of biological systems and applications. Nanomaterials showed many features of interesting characteristics such as optical, catalytic, that significantly depends on the size and shape of nanoparticles (Gericke and Pinches, 2006). Metal is a poor catalyst in bulk form, nanoparticles can exhibit excellent

properties, which significantly differ from those of the bulk material (Mubarak Ali et al., 2011; Paul and Yadav, 2014).

Today, nanoparticle research is unavoidable not only because of its application but also methods of synthesis (Gopinath et al., 2012). Various routes are available for the synthesis of nanoparticles such as physical, chemical and biological routes (Panigrahi et al., 2004). Physical and chemical approaches may have considerable environmental effect and economically expensive. Chemical methods require toxic chemicals such as capping, reducing and stabilizing agents, which increases the cost and toxicity (Paul et al., 2016). Therefore, researchers are attracted towards the biological methods as these methods are simple and ecofriendly.

Plants provide a better platform over microorganisms for the synthesis of nanoparticles, as they are free from toxic chemicals. Moreover, use of plant extracts provides natural reducing and capping agents, also it reduces the cost of microorganisms isolation, subculture and maintenance (Paul and Yadav, 2015; Singhal et al., 2011).

Silver is most extensively studied materials. There is an increasing interest in silver nanoparticles because of their antimicrobial properties (Paul et al., 2015). Silver nanoparticles possess unique electrical, optical as well as biological properties and are thus applied in catalysis, biosensing, imaging, drug delivery, nanodevice fabrication and in medicine (Ibrahim, 2015).

Here in, we report for the synthesis of silver nanoparticles using aqueous extract of *Amaranthus oleracea* leaf. Further, these biologically synthesized nanoparticles were found potential antibacterial activity against *Escherichia coli*.

MATERIALS AND METHODS

Materials

Fresh leaves of *Amaranthus oleracea* were collected from local area of Aurangabad, Maharashtra, India. Silver nitrate ($AgNO_3$) was purchased from Merck Ltd Mumbai.

Preparation of extract

Leaves were washed thoroughly twice with sterile distilled water and cut into small pieces. The chopped leaves were homogenized in 100 mL of sterile distilled water. The leaf broth

was filtered with Whatman filter paper No-1 and stored in a refrigerator for further experimental use.

Synthesis of silver nanoparticles

10 ml extract of *Amaranthus oleracea* was added in 190 ml of silver nitrate solution for reduction Ag^+ ions. It was kept in water bath at 60^{o}C for 10 minutes, colour change was observed in reaction mixture. Then it was centrifuged at 15,000 rpm for 20 minutes and used for further characterization.

TEM analysis

Characterization of generated nanoparticles was performed using TEM for the identification of size and shape of nanoparticles. Sonication of sample was done for 10 min. The TEM analysis was performed on a PHILIPS- Model No- CM200 instrument at IIT-SAIF, Bombay.

Antibacterial Assay

Antibacterial activity of the synthesized nanoparticles was performed against *E. coli* using well diffusion method. Wells were created in the LB agar using a cork borer. 25 µl, 50 µl, 75 µl and 100 µl of nanoparticle solution were added to the wells and leaf extract as a control. Petri plate was incubated at 37^{o}C for 24 hours and zone of inhibition was measured.

RESULTS AND DISCUSSION

Visual observation

In this investigation, when leaf extract of *Amaranthus oleracea* was exposed to 1 mM silver nitrate solution, colour change was observed after incubation at 60^{o}C. The reduction of silver nitrate to silver nanoparticles is followed by change in greenish to brown color in the reaction mixture due to excitation of surface plasmon vibration in silver nanoparticle (Fig 1). The appearance of color change in reaction mixture indicates synthesis of silver nanoparticles. Hence, solution was further analyzed using TEM to understand the size and shape of nanoparticles.

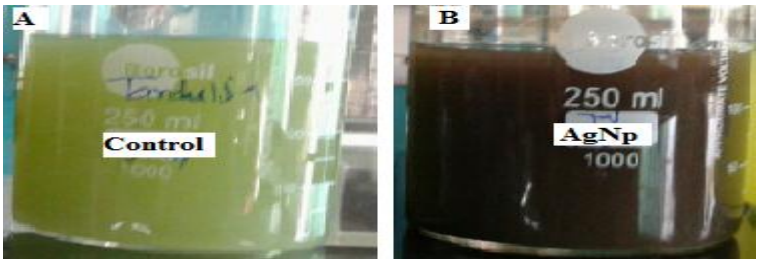

Figure 1: Visual observation of silver nanoparticles synthesized using *Amaranthus oleracea* leaf extract. A- Leaf extract of *Amaranthus oleracea* as a control, B- Reaction mixture of silver nitrate and leaf extract indicates the color change due to nanoparticle synthesis (brown color).

TEM Analysis

The TEM micrograph showing the silver nanoparticles synthesized by the *Amaranthus oleracea* leaf extract further confirmed the structural morphology and crystallinity of silver nanoparticles. The TEM images were recorded at different magnification to study the particles size and shape. Synthesized silver nanoparticles were observed in spherical shape and average size of the particles was 5-20 nm (Fig 2).

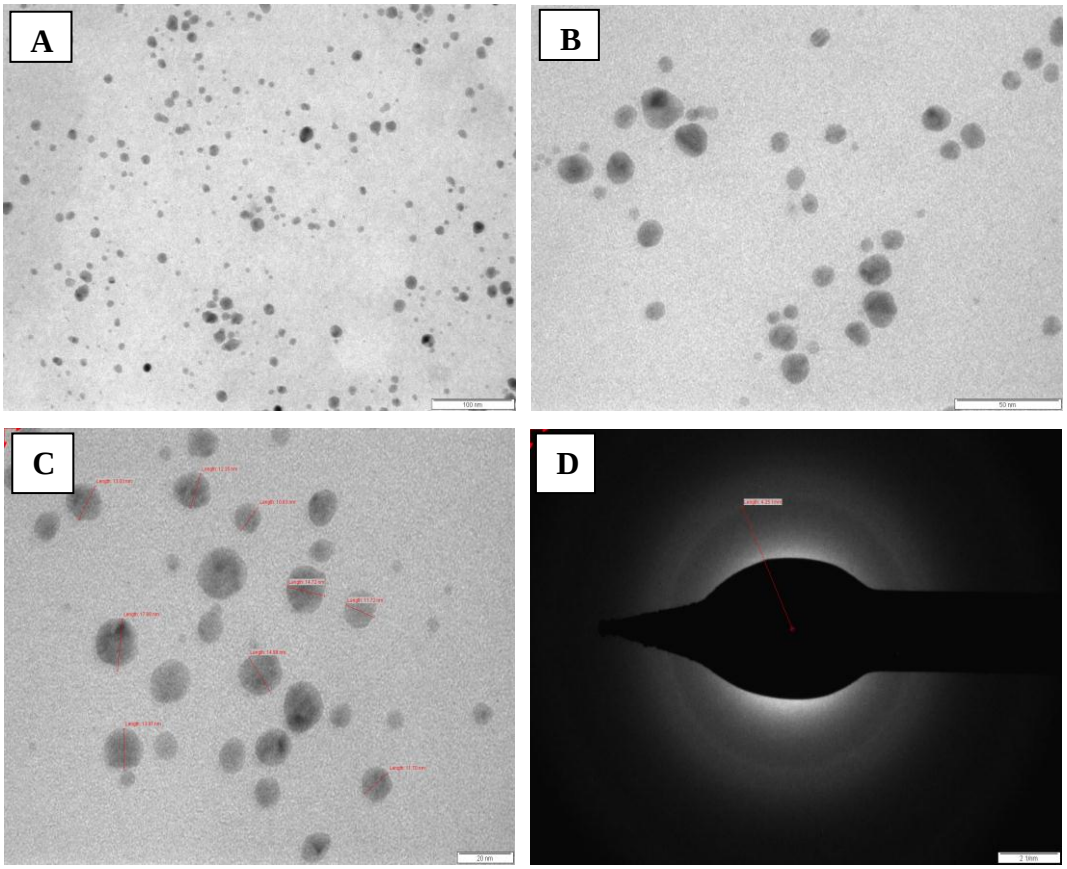

Figure 2: TEM analysis of generated silver nanoparticle using *Amaranthus oleracea* extract. A: Scale at 100 nm, B: Scale at 50 nm, C: Scale at 20 nm, D: SAD Pattern

Antibacterial Assay

The antibacterial effect of synthesized silver nanoparticles was examined against *E. coli*. Different concentrations of nanoparticles solution were showed zone of inhibitions against *E. coli* (Fig 3).

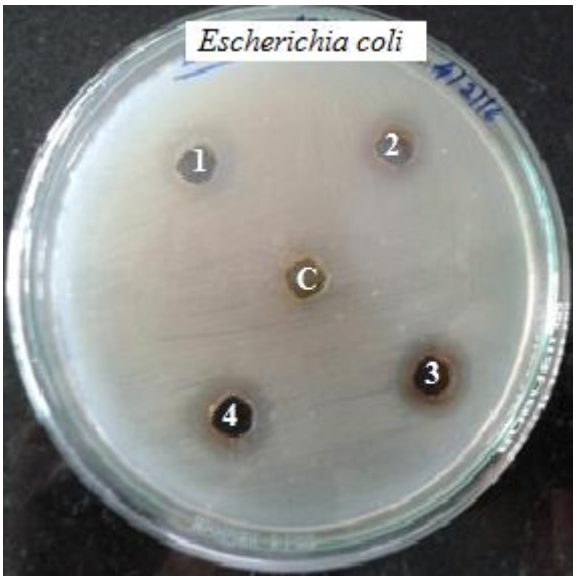

Figure 3: Antibacterial activity of generated silver nanoparticles against *E. coli*. C- Control. Concentrations of nanoparticles: 1- 25 µl, 2- 50 µl, 3- 75 µl, 4- 100 µl.

The zone of inhibition at different concentrations of the nanoparticles solution was measured as shown in Table 1.

Table 1: Antibacterial activity of silver nanoparticles against *E. coli*

Nanoparticles	Zone of inhibition (mm)				
	Control	25 µl	50 µl	75 µl	100 µl
Silver nanoparticles	-	10	11	12	13

A maximum zone of inhibition was found to be 13 mm for *E coli*. The result indicates that the synthesized AgNPs has potential antibacterial activity against *E. coli*.

CONCLUSION

In this investigation, the bioreduction of aqueous Ag+ ions has been demonstrated using *Amaranthus oleracea* leaf extract as a reducing agent. Reduction of the metal ions through leaf extracts leading to the formation of silver nanoparticles followed by the ecofriendly approach. In the present study, we found that *Amaranthus oleracea* leaf can also be a good source for synthesis of silver nanoparticles. This method is cost effective and suitable for large-scale production of silver nanoparticles. The synthesized silver nanoparticles showed good antibacterial activity against *E. coli*.

Conflict of interest statement

The authors declare that they have no conflict of interest.

ACKNOWLEDGEMENTS

Authors are thankful to SAIF, IIT Bombay to provide facility of Transmission Electron Microscopy for the characterization of nanoparticles.

REFERENCES

1. Gericke M, Pinches A. Biological synthesis of metal nanoparticles. Hydrometallurgy, 2006; 83(1): 132-140.
2. MubarakAli D, Thajuddin N, Jeganathan K, Gunasekaran M. Plant extract mediated synthesis of silver and gold nanoparticles and its antibacterial activity against clinically isolated pathogens. Colloids and Surfaces B: Biointerfaces, 2011; 85: 360-365.
3. Paul NS, Yadav RP. Green chemistry: An approach for synthesis of silver nanoparticles and their antimicrobial activity. J Med Pharm Innov, 2014; 1: 10-14.
4. Gopinath V, Mubarak Ali D, Priyadarshini S, Meera Priyadharsshini N, Thajuddin N, Velusamy P. Biosynthesis of silver nanoparticles from *Tribulus terrestris* and its antimicrobial activity: A novel biological approach. Colloids and Surfaces B: Biointerfaces, 2012; 96: 69-74.
5. Panigrahi S, Kundu S, Ghosh SK, Nath S, Pal T. General method of synthesis for metal nanoparticles. J Nanopart Res, 2004; 6: 411-414.
6. Paul N, Khole E, Jagtap S, Tribhuvan H, Kakde G, Kuwar P, Panche A, Harke S. *Eleusine coracana*: Ecofriendly approach for the synthesis of silver nanoparticles. World Journal of Pharmaceutical Research, 2016; 5(5): 1026-1032.
7. Paul NS, Yadav RP. Biosynthesis of silver nanoparticles using plant seeds and their antimicrobial activity. Asian Journal of Biomedical and Pharmaceutical Sciences, 2015; 5: 26-28.
8. Singhal G, Bhavesh R, Kasariya K, Sharma AR, Singh R. Biosynthesis of silver nanoparticles using *Ocimum sanctum* (Tulsi) leaf extract and screening its antimicrobial activity. J Nanopart Res, 2011; 13: 2981–2988.
9. Paul NS, Sharma R, Yadav RP. Biological synthesis of antimicrobial silver nanoparticles by *Phaseolus vulgaris* Seed Extract. MGM Journal of Medical Sciences, 2015; 2: 1-6.
10. Ibrahim HMM. Green synthesis and characterization of silver nanoparticles using banana peel extract and their antimicrobial activity against representative microorganisms. Journal of Radiation Research and Applied Sciences, 2015; 8: 265-275.