Synthesis and characterization of silver nanoparticles using seaweed *Sargassam tennerimum* and their antioxidant activity

Parthiban[1], Chandra Lekha[*2], Kalarani[2], Divya[3]
[1]*Research Scholar, Reg.No.18212102031009, Department of Chemistry, Kamaraj College, Thoothukudi.*
(Affiliated to M.S University, Tirunelveli)
[2]*Department of Chemistry, Kamaraj College, Thoothukudi.*
[3]*Department of Chemistry, St.Mary's College, Tuticorin,*
*****Corresponding author**:** *Email: chandralekha1978@yahoo.com,*

Abstract

Green synthesis of nanoparticle prevents the atmosphere from pollution and its application in various fields has become the favourite pursuit of all researchers. Recent studies have shown that several marine plants have the ability to perform as bio-factories for the production of nanoparticles. Green synthesis of (AgNPs) was achieved by using the aqueous extract of Sargassam tenerrimum and AgNO3. Reduction of silver ions into silver nanoparticles was observed as a result of the colour change from pale brown to dark brown. The synthesized nanoparticles have been characterized by UV-Vis spectroscopy, FTIR and AFM techniques. UV-Visible spectrophotometer showed absorbance peak in range of 406 nm. Infrared spectrometer (FTIR) analysis was carried out to determine the nature of the capping agents in leaf extracts. The synthesized silver nanoparticles of aqueous extract of Sargassam tenerrimum have shown good potential source of antioxidant.

Keywords: Green synthesis, *Sargassam tenerrimum*, Silver nanoparticles, UV, FTIR, AFM etc.

1. Introduction

The silver nanoparticles are the most concentrated interest for research due to its potential in applications like antibacterial [1,2], antioxidant [3], antifungal [4], anticancer [5,6], catalysis [7], drug delivery [8] and photo sensors [9]. This has promoted research in the good known activity of silver ions and silver-based compounds, including silver nanoparticles. The biological methods are now widely being used because in case of chemical methods, the chemicals used can be highly toxic and the products are not eco-friendly.

Seaweeds are large algae (macro algae) that grow in saltwater or marine environment. Recent works have proved that extracts from seaweeds species exhibit activity against human, animal and plant pathogens [10]. As, seaweeds are rich in various secondary metabolites including quinones, flavonoids, saponins, and terpenoids, which are involved in the stabilization or reduction of the nanoparticles [11]. The green synthesis of

metal nanoparticles using several species of seaweeds have been reported [12-17]. Current study discusses the silver nanoparticles were synthesised by the aqueous extract of sea weed *Sargassum tenerrimum* and its merits towards antioxidant activity.

2. Materials and methods

2.1 Preparation of aqueous seaweed extract

Sargassum tenerrimum was collected by hand picking method at a depth of 1 – 2 meter in Gulf of Mannar, Tuticorin, India. The seaweed was surface sterilized with twice time tap water to remove extraneous substances followed by thrice time distilled water. The seaweed is identified aqueous extract was prepared by dissolving 10 gm of fresh seaweed in 100 ml of sterile distilled water. The extract was heated at 60°C for 20 minutes with hot plate, the extract was passed through Whatmann no1 filter paper, and the extract was stored at 4˚C in the refrigerator for further use.

2.2 Synthesis and characterization of silver nano-particles (AgNPs)

In an Erlenmeyer's flask, 80 ml of 0.01M silver nitrate (AgNO3) solution was prepared using deionized water and 20 ml of aqueous seaweed extract was added and the colour change from pale brown to dark brown indicated the formation of silver nanoparticles.

Characterization of silver nanoparticles was performed in sequence using UV-Visible spectrophotometer in the different wavelength range of 200- 600 nm (JASCO UV-Visible spectrophotometer). It is one of the important techniques to verify the formation of metal nanoparticles provided surface plasmon resonance exists for the metal. Appearance of colour arises from the property of the coloured material to absorb selectively within the visible region of the electromagnetic spectrum. To discern silver nanoparticles at the absorption range of 400-406 nm. The presence of bioactive functional groups responsible in seaweed extracts and synthesized Ag-NPs recorded by using FTIR spectrometer at a resolution of 4.0 cm^{-1} range from 400 to 4000 cm^{-1} in KBr pellet.

The total antioxidant activity was assessed by phosphomolybdenum method described by Prieto et al. 1.0 ml of the seaweed extract was mixed with 1.0 ml of the standard reagent solution (0.6M sulphuric acid, 28mM sodium phosphate and 4 mM ammonium molybdate). The tubes were capped and incubated in a thermal block at 95°C for 90 min. After cooling to room temperature, the absorbance was measured at 695 nm against a reagent blank. The total antioxidant capacity was expressed as milligram of Ascorbic Acid Equivalence (AAE) per gram of extract.

3. Results and discussion:-

3.1 Visual analysis

The silver nitrate bio-reduction to silver nanoparticles using the seaweed extract was observed. The silver nanoparticles

gave a characteristic band of absorbance under the UV region, they undergo either to blue shift or red shift depending upon the size effects of nanoparticles. The UV-Visible spectrophotometer was used to store the absorbance for wavelength in the range of 200 to 600 nm. The reduction of Ag+ ion was observed by measuring the UV/Vis spectrum of the reaction medium. Fig.1 demonstrates the maximum peak observed in 406 nm wavelength. Also, seen in *Sargassum tenerrimum seaweed* extract, the absorbance peak for the visible colour change was seen at 406 nm when silver nitrate solution was added to the seaweed extract.

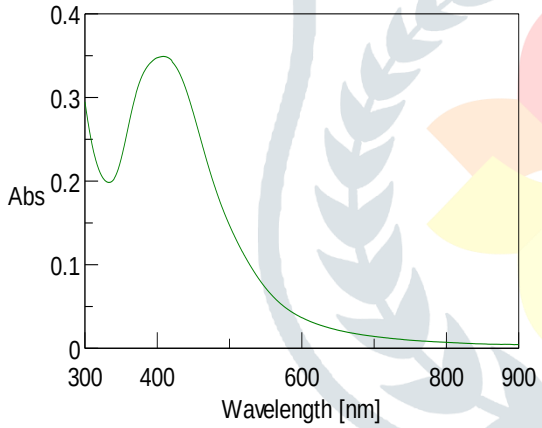


Figure: 1 UV spectra of Silver nanoparticles synthesized from *Sargassum tenerrimum* extract

3.2 Fourier transform infrared spectroscopy (FTIR) analysis

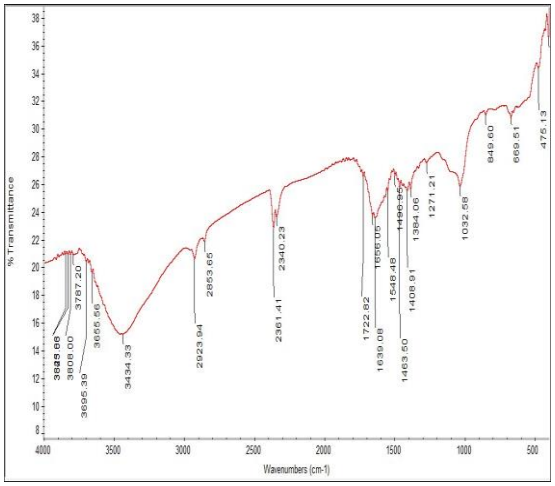


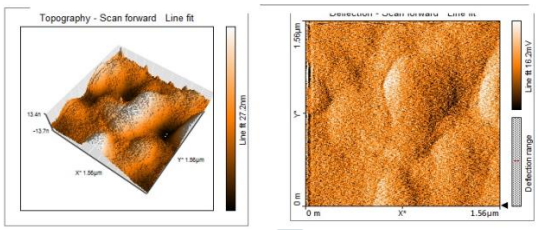
Figure: 2 FTIR spectra of Silver nanoparticles synthesized from *Sargassum tenerrimum* extract

The fig. 2 shows the presence of functional groups due to phytochemicals of the brown seaweed extract, the broad absorbance peak at 3825.88 cm^{-1} - 3655.56 cm^{-1} the presence of alcohol (O-H stretching). 3434.33 cm^{-1} the presence of primary amine (N-H stretching).2923.94 - 2853.65 cm^{-1} as amine salt (N-H stretching).2361.41 - 2340.23 cm^{-1} as carbon dioxide (O=C=O Stretching). 1722.82 cm^{-1} as aliphatic ketone (C=O stretching). 1656.05 cm^{-1} as conjugated alkene (C=C stretching), 1639.08 cm^{-1} as alkene (C=C stretching), 1548.48 cm^{-1} - 1496.95 cm^{-1} as nitro compound (N-O stretching) and 1463.50 cm^{-1} as alkane (C-H bending). 1408.91 cm^{-1} - 1384.06 cm^{-1} as sulfate (S=O stretching). 1271.21 cm^{-1} - 1032.58 cm^{-1} as alkyl, aryl, ether (C-O stretching). 849.60 cm^{-1} - 669.51 cm^{-1} as halo compound (C-Cl Stretching) and 475.13 cm^{-1} as alkyl halides (C-I bend).

3.3. AFM studies

AFM images were taken using NanoSurfeasyscan 2 AFM (BT02218).

Topography of the silver nanoparticles synthesized from *Sargassum tenerrimum seaweed* extract was given in the Fig.4. Triangular shapes of different sizes were seen in the topography.



(a) (b)

Figure: 3 Topography of AgNps from *Sargassum tenerrimum* in a) normal view and b) 3D view

3.4 Antioxidant Studies

Phytochemicals are non-nutritive seaweed chemicals that have protective or disease preventive properties. Medicinal seaweeds are a source for a wide variety of natural products, such as the phenolic acids which are very interesting for their antioxidant properties. The total antioxidant activity of the seaweed extracts was measured spectrophotometrically through phosphomolybdenum method, which is based on the subsequent formation of Mo (IV) to Mo (V) with a maximum absorption at 695 nm. The higher the absorbance, stronger is the antioxidant activity. The total antioxidant activity was found to be in aqueous extract (22.0 mg of TAA/g of seaweed silver nanoparticle).

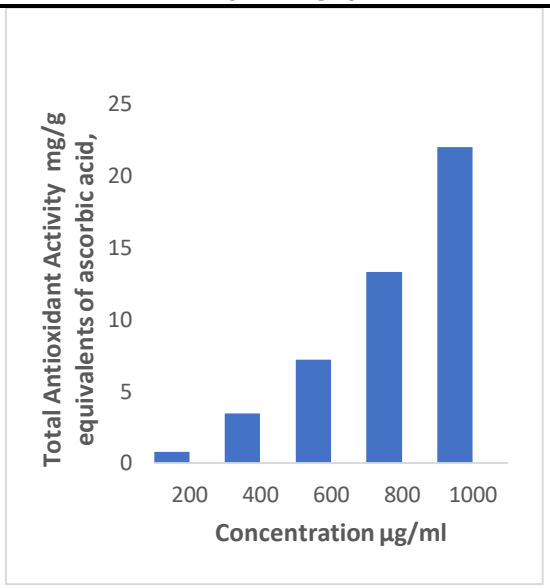


Figure: 4 Antioxidantchart of Silver nanoparticles synthesized from *Sargassum tenerrimum* extract

4. Conclusion

In the reported research work, AgNPs have been synthesized using *Sargassum tenerrimum seaweed* extract. The UV–visible spectroscopy and AFM confirm the existence of elemental silver and its spherical form. The synthesized AgNPs have been confirmed to show antioxidant activity. The present research is a simple, rapid, eco-friendly and non-toxic method for the synthesis of silver nanoparticles.

References

1. G. A. Sotiriou and S. E. Pratsinis, "Engineering nanosilver as an antibacterial, biosensor and bioimaging material," *Current Opinion in Chemical Engineering*, vol. 1, no. 1, pp. 3–10, 2011.

2. Y. Zhao, Y. Tian, Y. Cui, W. Liu, W. Ma, and X. Jiang, "Small molecule-capped gold nanoparticles as potent antibacterial agents that target gram-

negative bacteria," *Journal of the American Chemical Society*, vol. 132, no. 35, pp. 12349–12356, 2010.

3.B. Sharma, D. D. Purkayastha, S. Hazra et al., "Biosynthesis of fluorescent gold nanoparticles using an edible freshwater red alga, Lemanea fluviatilis (L.) C.Ag. and antioxidant activity of biomatrix loaded nanoparticles," *Bioprocess and Biosystems Engineering*, vol. 37, no. 12, pp. 2559–2565, 2014.

4.M. Vivek, P. Senthil Kumar, S. Steffi, and S. Sudha, "Biogenic silver nanoparticles by *Gelidiella acerosa* extract and their antifungal effects," *Avicenna Journal of Medical Biotechnology*, vol. 3, no. 3, pp. 143–148, 2011.

5. W. Cai, T. Gao, H. Hong, and J. Sun, "Applications of gold nanoparticles in cancer nanotechnology," *Nanotechnology, Science and Applications*, vol. 1, pp. 17–32, 2008.

6. R. Van Horssen, T. L. M. Ten Hagen, and A. M. M. Eggermont, "TNF-α in cancer treatment: molecular insights, antitumor effects, and clinical utility," *Oncologist*, vol. 11, no. 4, pp. 397–408, 2006.

7.Y. Mikami, A. Dhakshinamoorthy, M. Alvaro, and H. García, "Catalytic activity of unsupported gold nanoparticles," *Catalysis Science and Technology*, vol. 3, no. 1, pp. 58–69, 2013.

8. P. Ghosh, G. Han, M. De, C. K. Kim, and V. M. Rotello, "Gold nanoparticles in delivery applications," *Advanced Drug Delivery Reviews*, vol. 60, no. 11, pp. 1307–1315, 2008.

9. T. Zhai, X. Fang, M. Liao et al., "A comprehensive review of one-dimensional metal-oxide nanostructure photodetectors," *Sensors*, vol. 9, no. 8, pp. 6504–6529, 2009.

10. A. J. Smit, "Medicinal and pharmaceutical uses of seaweed natural products: a review," *Journal of Applied Phycology*, vol. 16, no. 4, pp. 245–262, 2004.

11.B. A. P. Da Gama, R. C. Pereira, A. G. V. Carvalho, and R. Coutinho, "The effects of seaweed secondary metabolites on biofouling," *Biofouling*, vol. 18, no. 1, pp. 13–20, 2002.

12. R. R. R. Kannan, W. A. Stirk, and J. Van Staden, "Synthesis of silver nanoparticles using the seaweed *Codium capitatum* P.C. Silva (Chlorophyceae)," *South African Journal of Botany*, vol. 86, pp. 1–4, 2013.

13. F. Arockiya Aarthi Rajathi, C. Parthiban, V. Ganesh Kumar, and P. Anantharaman, "Biosynthesis of antibacterial gold nanoparticles using

brown alga, Stoechospermum marginatum (kützing)," *Spectrochimica Acta—Part A: Molecular and Biomolecular Spectroscopy*, vol. 99, pp. 166–173, 2012.

14. P. Kumar, S. Senthamil Selvi, and M. Govindaraju, "Seaweed-mediated biosynthesis of silver nanoparticles using *Gracilaria corticata* for its antifungal activity against *Candida* spp.," *Applied Nanoscience*, vol. 3, no. 6, pp. 495–500, 2013.

15. S. Nagarajan and K. A. Kuppusamy, "Extracellular synthesis of zinc oxide nanoparticle using seaweeds of Gulf of Mannar, India," *Journal of Nanobiotechnology*, vol. 11, article 39, 2013.

16. S. Rajeshkumar, C. Malarkodi, G. Gananajobitha et al., "Seaweed-mediated synthesis of gold nanoparticles using Turbinaria conoides and its characterization," *Journal of Nanostructure in Chemistry*, vol. 3, no. 44, pp. 1–7, 2013.

17. T. Ashokkumar and K. Vijayaraghavan, "Brown seaweed-mediated biosynthesis of gold nanoparticles," *Journal of Environment and Biotechnology Research*, vol. 2, no. 1, pp. 45–50, 2016.