Synthesis and Characterization of Antimicrobial Silver Nanoparticles Using Marine Brown Seaweed Padina tetrastromatica

S. Rajeshkumar1,2, C. Kannan2, G. Annadurai1

1Environmental Nanotechnology Division, Sri Paramakalyani Centre for Environmental Sciences, Manonmaniam Sundaranar University, Alwarkurichi – 627 412, Tirunelveli, Tamil Nadu, India
2Department of Chemistry, Manonmaniam Sundaranar University, Abishekappati – 627 012, Tirunelveli, Tamil Nadu, India

Using green technology for the synthesis of silver nanoparticles developed dynamically now a day. In this report we focused on the green synthesis of silver nanoparticles by using marine brown seaweed Padina tetrastromatica. The synthesized nanoparticles were scrutinized by UV-visible spectrophotometer shows the crest at 460 nm. X-ray crystallography confirmed the silver nanoparticles crystalline personality. The structure and size distribution of the silver nanoparticles were examined by Transmission Electron Microscope (TEM) in that average size is 14 nm clearly shown and most of the nanoparticles were in spherical in shape. Finally the compounds responsible for the silver nanoparticles biosynthesis were studied using Fourier Transmittance-Infrared Spectroscopy (FT-IR). The AgNPs exhibited antimicrobial activity against Bacillus sps, Klebsiella planticola, Bacillus subtilis and Pseudomonas sps. Thus, the brown algae could be used for eco friendly and efficient synthesis of antimicrobial silver nanoparticles.

Key words: Biosynthesis, silver nanoparticles, Padina tetrastromatica, Antibacterial.

INTRODUCTION

Padina tetrastromatica is the family of Dictyotaceae one of most pertinent marine brown sea weed and it will contains the major component of fucopyranosyl residues containing sulfated fucans called as fucoids, Alginc acid and glucans were isolated from the seaweed and minor amount of gluconic acid and uronic acid are also found and they will play an important role in the field of Antiviral activities [1].

The application of nanosized materials and structures, usually ranging from 1 to 100 nanometers (nm), is a rising area of nanoscience and nanotechnology. The silver nanoparticles were prepared by various types of biological methods are bacteriological mediated like Bacillus licheniformis [2], fungal mediated Aspergillus fumigates [3], plant mediated nanoparticles are also growing vigorously now a day’s Persimmon (Dioptys kaki) [4], Parthenium hysterophorus [5], algae mediated nanoparticles synthesis are emerging in nanomaterials meadow Sargassum wightii Greville[6], were synthesized the silver nanoparticles and they involves in the numerous biomedical applications.

The silver nanoparticles are having key role in various applications are food processing applications [7], electrochemical biosensor [8], and also it used for various biomedical applications most one is antimicrobial activities especially antibacterial activities. The silver nanoparticles are having incredibly superior effect against in new resistant strains of bacteria which were causing health effect to human being and when compare to gram-positive organisms gram-negative bacteria vigorously affected by Silver nanomaterials [9]. Thereby, the present investigation was aimed to find out the efficiency of marine brown algae Padina tetrastromatica extract in reduction of the toxic compound silver nitrate (AgNO₃) into silver nanoparticles. The synthesized particles were characterized by UV-spectroscopic, diffraction assay, electron microscopic study and Fourier transmittance infrared spectroscopy. The antibacterial ability of the silver nanoparticles was tested against disease causing bacterial isolates.

MATERIALS AND METHODS

Preparation of Algal extract

The brown algae Padina tetrastromatica was collected from Tuticorin coastal area in south Tamilnadu, India. And the silver nitrate was purchased from Thomas baker India limited. The marine brown seaweed containing waste materials in its surface area was thoroughly washed by using fresh tap water for several times and washed three times using distilled water may remove metallic compounds. After washing of the seaweed it involved in the process of drying especially involves shade drying at room temperature for ten days. The dried Algal materials were collected and it will crushed by using mortar and pestle to get the powder form. One gram of crushed algal powder was taken and added with 100ml of distilled water containing 250 ml conical flask. The conical flask was placed in heating mantle and heated for five minutes at 60° to 80° C, and boiled extract collected and kept in a sample bottle and it known as pure algal extract.

Green synthesis and characterization of silver nanoparticles

In the pure algal extract solution 1mM of silver nitrate (AgNO₃) solution was added and the reaction of the colour change was observed. Colour changes of reacted solution was observed visually and from the colour changed solution absorbance was scrutinized from 340 to 580 nm at different time intervals using Double beam UV-Vis spectrophotometer (Perkin Elmer, Singapore) The synthesized nanoparticles involved for the morphological characterization by using the Transmission Electron Microscope. X-ray diffraction assay (Bruker, Germany, model D8 Advence) was performed for the

Corresponding Author:
Dr. G. Annadurai, Associate Professor, Sri Paramakalyani Centre for Environmental Sciences, Manonmaniam Sundaranar University, Alwarkurichi, Tirunelveli – 627 412, Tamil Nadu, India; e-mail:<gannadurai@hotmail.com>

Received 25-08-2012; Accepted 28-10-2012


511
determination of crystalline nature of the nanoparticle by this instrument using the lynx eye detector and silicon strip detector technology. Finally nanoparticles were involved for analysis of functional groups by FTIR Thermo (Nicolet Model: 6700). In that the interference pattern obtained from beam interferometer as the path difference between the two beams is altered, when transformed, gives rise to the spectrum.

**Antibacterial activity of Silver nanoparticles:**

The Nutrient broth and Muller Hinton agar purchased from Hi-media, India. The silver nanoparticles synthesized using Padina tetrastromatica was tested for antibacterial activity by agar well-diffusion method. The cultures used for the bactericidal activity were pathogenic isolates Pseudomonas sps, E.coli, and opportune pathogenic bacteria Bacillus subtilis and Klebsiella planticola. The three different concentration of silver nanoparticles samples (30 \( \mu l \), 60 \( \mu l \), 90 \( \mu l \)) solution was poured onto each well on all plates using a sterile micropipette and kept in incubator for 24 hours at 37°C. After incubation, the different levels of zone of inhibition of bacteria were observed and measured.

**RESULTS AND DISCUSSION**

The present study had shown the synthesis of silver nanoparticles. In that the toxic compound silver nitrate was reduced in to silver nanoparticles. Fig. 1 inside images (a) and (b) shown that the addition of the silver nitrate solution with the Padina tetrastromatica algal extract the colour changes were observed in that light green colour is found in the initial and colour was changed to light brown after the sixth hour only then after 24 hrs it was turns into dark brown in colour shown the reaction between the algae containing substances and silver nitrate. By using the UV-Vis spectrophotometer the colour changes were measured absorption was scanned at 320 nm to 580 nm in that 460 nm the high absorption was determined. The attribute surface plasmon absorption bands are noticed at 425 nm and rising of nanoparticles size can also affect the SPR band broadening. Based on the high intensity, we confirmed the surface plasmon resonance was eminent. In the different time intervals 24th hour only hit the highest point was determined.

![UV-Vis Absorption spectra of the silver nanoparticles biosynthesis](image1)

Fig.1. UV -Vis A bsorption spectra of the silver nanoparticles biosynthesis by Padina tetrastromatica and insect shows (a) is the initial stage of the algal extract with silver nitrate and (b) is after 24 hours reaction.

The pseudo spherical nanoparticles and plate like nanostructures was examined and size distributions of gold nanoparticles were clearly observed in the TEM analysis. Fig. 2 demonstrate the TEM ascertained morphology and size of the brown seaweed Padina tetrastromatica treated with 1mM silver nitrate solution for 24 hours, the nanoparticles in the optimized circumstance. The shape of the nanoparticles was clearly observed most of the spherical and some of in rounded rectangle like structures. The size distribution of the silver nanoparticles shown in that average size of the nanoparticles is 14 nm clearly mentioned.

![TEM images of silver nanoparticles formed by reduction of silver nitrate using Macro algae.](image2)

Fig. 2. TEM images of silver nanoparticles formed by reduction of silver nitrate using Macro algae. (a) 20 nm; (b) 40 nm; (c) 50 nm.

On the whole in the Padina tetrastromatica having a lot of polysaccharide compounds, using of carbohydrates for the synthesis of nanoparticles fabrication also proved. Fig. 3 Illustrated the FT-IR transmittance spectrum of the dried silver nanoparticles, after 24 hours of incubation with the pure algal extract. The sharp bands were occurred at 1650 cm\(^{-1}\), 1380 cm\(^{-1}\) and 1040 cm\(^{-1}\) were assigned to be strong nitro compounds in the asymmetric stretch, N-H amine and C-N amine maybe the nitro groups and broad spectrum in 3420 cm\(^{-1}\) were assigned to be stretching vibrations of Hydrogen-bonded O-H Stretch it maybe the alcoholic or phenolic compound and some medium absorption were obtained from 2930 cm\(^{-1}\), 2860 cm\(^{-1}\) were responsible for the carboxylic acid and 825 cm\(^{-1}\) is an vinyl bond trisubstituted alkanes and finally 555 cm\(^{-1}\) corresponds to the broalkanes engage in recreation the foremost role in the nanoparticles synthesis. FT-IR measurements were carried out to identify the possible biomolecule responsible for the reduction of the Ag+ ions and capping of the bioreduced silver nanoparticles synthesized by the seaweed S. wightii.  

![FT-IR spectrum of the algal mediated silver nanoparticles](image3)

Fig.3. FT-IR spectrum of the algal mediated silver nanoparticles

![XRD pattern of silver nanoparticles reduced from silver nitrate using algae Padina tetrastromatica](image4)

Fig. 4 Shows the XRD pattern of silver nanoparticles reduced from silver nitrate using algae Padina tetrastromatica. The 2θ values of the XRD pattern was ranging from 10 to 80 and four strong peaks were observed at 38.1°, 44.3°, 64.4° and 77.3° and...
it was compared with the original XRD pattern of silver nitrate crystals and pure silver which was published by Joint Committee on Powder Diffraction Standards (JCPDS file no. 84-0713 and 04-0763). The intense peaks at 38.1º, 44.3º, 64.4º and 77.3º were indexed with the (111), (200), (220) and (311) planes of silver respectively. The full width of half maximum was measured for 38.1º. From the XRD spectra of our experiment indicate the formation of silver nanoparticles is crystalline in nature and aggregation was formed due to the fewer action of stabilizing agents in the algal extract.

**Fig. 4.** XRD pattern for Algal mediated Silver nanoparticles

**Antibacterial Activity of the nanoparticles**

The antibacterial behaviors of silver nanoparticles from Padina tetrastromatica provide the great expectations in pathogenic microbe controlling in advance technology. The antibacterial activity conducted against the pathogenic bacteria Bacillus sps and Pseudomonas sps isolated form most contaminated area and opportune pathogenic bacteria Bacillus subtilis and Klebsiella planticola purchased from MTCC, India. The nanoparticles were reacted with the bacterial cell walls and inhibit the growth of the bacteria vigorously and formed the zone size were explained in the Fig. 5 shows the algal assisted synthesis of silver nanoparticles against the different bacterium explains Pseudomonas sps having towering inhibition and decreased gradually against Bacillus subtilis, klebsiella plantcula and Bacillus sps respectively. The particular mechanisms happened in the silver nanoparticles against the bacterial culture is clearly known and small surface area containing nanoparticles having interaction like large surface area it may attach with the cell membrane of the bacteria and involves the process of upsetting the respiration and permeability. The adsorption on bacterial surface and intracellular enzyme activity is the main reason for the antibacterial reactions.

**Fig. 5.** Illustrated the zone of inhibition of algal mediated Silver nanoparticles against Different bacterial strains.

**CONCLUSION**

Using of marine brown seaweed for the biosynthesis of silver nanoparticles is the greatest method because it’s an eco friendly and low cost effective. The biomolecules extracted from the algae Padina tetrastromatica having a lot of applications in the field of medical biochemistry. From the brown seaweed silver nanoparticles were synthesized and characterized using UV-Visible spectrophotometer shows the peak at 460 nm, the average size of the nanoparticles was 14 nm briefly examine by TEM, the crystalline nature was clearly in the XRD pattern and finally the biomolecules responsible for the formation of silver nanoparticles were proved using FT-IR. The interaction of the algae with the nanoparticles having lot of prospect application in advanced medicinal field. In the future for the medical and applicable biosciences these nanoparticles was dynamically act a role is long-established.

**REFERENCES**


**Source of support**: Nil,  
**Conflict of interest**: None Declared