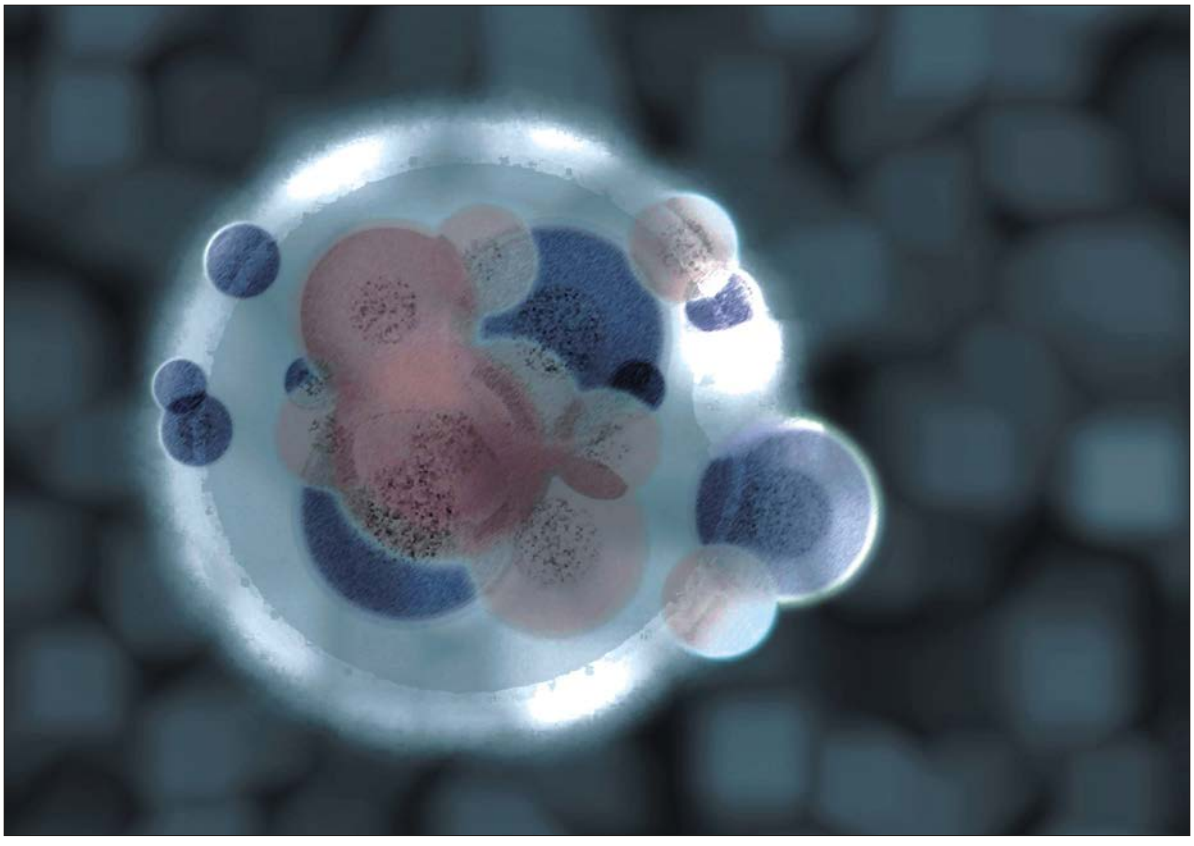

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Marine Algae Mediated Synthesis of Silver Nanopaticles using *Scaberia agardhii* Greville

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Abstract: Biosynthesis of silver nanoparticles (Ag NPs) has emerged as an important area is nanotechnology and biotechnology due to growing need to develop environmental benign technologies. Metallic nanoparticles are traditionally synthesized by wet chemical synthesis techniques where the chemicals used are quite often toxic and flammable. The present study deals with cost effective and environment friendly given synthesis from 1 mM $AgNO_3$ solution through the sea weed extract of *S. agardhii* as reducing as well as capping agent. The nanoparticles were characterized by surface plasmon absorbance measuring 409 nm. Scanning electron microscopy showed the formation of (Ag NPs) in the range of 40-50 nm and X-ray diffraction analysis of the freeze-dried powder confirmed the formation of metallic (Ag NPs). This study may be used in the development of value-added products from the sea weed for biomedical and nanotechnology based industries.

Key words: Nanoparticles, silver, marine algae, biosynthesis, *S. agardhii*

INTRODUCTION

Silver nanoparticles (Ag NPs) are widely investigated owing to their broad range of applications as antibacterial, catalyst and as a biosensor (Wang *et al*., 2008; Chen *et al*., 2007). For this purpose several researches have made attempts for synthesis of Ag nanoparticle using chemical reduction, electrochemical reduction and photochemical reduction (Yu, 2007; Liu and Lin, 2004). These methods employ harsh reducing and stabilizing agents making them unsuitable for biological applications. In the recent years, 'green synthesis' of the nanoparticles has paid much more attention in the rapidly growing area of nanoscience and nanotechnology (Korbekandi *et al*., 2009; Basu *et al*., 2008; Kim *et al*., 2010; Verma *et al*., 2010; Sharma *et al*., 2010).

Earlier reports cite the use of microorganism such as *Bacillus koriensis*, *B. subtilis*, etc., and fungi such as *A. fumigates*, *F. oxysporum*, etc. for the biosynthesis of Ag NPs (Bhainsa and D'Souza, 2006; Mohammadian *et al*., 2007; Prasad and Elumalai, 2011). *Scaberia agardhii* Greville (Sargassaceae) is an endemic species in southern Australia. It's belonging to the order of algae. Here in, we report for the first time synthesis of silver nanoparticles, reducing the silver ions present in the solution of silver nitrate by the aqueous extract of *S. agardhii*.

MATERIALS AND METHODS

Plant material and synthesis of silver nanoparticles: *S. agardhii* Greville was collected from Glenelg beach, Adelaide, South Australia. The algae were air dried for 30 days then were kept in the hot air oven at 60°C for 24-48 h. The marine algae were ground to a fine powder. 1 mM silver nitrate was added to plant extract to make up a final solution 200 mL and centrifuged at 18000 rpm for 25 min. The collected pellet stored at-4°C. The supernatant was heated at 50°C to 95°C. A change in the color of solution was observed during the heating process.

UV-VIS Spectra analysis: The reduction of pure Ag^+ ions was monitored by measuring the UV-Vis spectrum of the reaction medium at 3 h after diluting a small aliquot of the sample into distilled water. UV-vis spectral analysis was done by using uv-vis spectrophotometer UV-2450 (Shimadzu).

SEM analysis of silver nanoparticles: Scanning Electron Microscopic (SEM) analysis was done using Hitachi S-4500 SEM machine. Thin films of the sample were prepared on a carbon coated copper grid by just dropping

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a very small amount of the sample on the grid, extra solution was removed using a blotting paper and then the film on the SEM grid were allowed to dry by putting it under a mercury lamp for 5 min.

EDAX measurements: In order to carry out EDAX analysis, the weed extracts reduced silver nanoparticles were dried and drop coated on to carbon film and performed on Hitachi S-3400 N SEM instrument equipped with a Thermo EDAX attachments.

RESULTS

UV-VIS Spectra analysis: It is well known that silver nanoparticles exhibit yellowish brown color in aqueous solution due to excitation of surface plasmon vibrations in silver nanoparticles. As the *S. agardhii* extract was mixed in the aqueous solution of the silver ion complex, it started to change the color from watery to yellowish brown due to reduction of silver ion; which indicated formation of silver nanoparticles (Fig. 1).

The result obtained in this investigation is very interesting in terms of identification of potential marine algae for synthesizing the silver nanoparticles. UV-VIS spectrograph of the colloidal solution of silver nanoparticles has been recorded as a function of time. Absorption spectra of silver nanoparticles formed in the reaction media at 10 min has absorbance peak at 409 nm and the broadening of peak indicated that the particles are polydispersed (Fig. 2).

SEM and EDX: The Scanning Electron Micrograph (SEM) of the Ag NPs synthesized after the treatment of 1 mM silver nitrate solution with an aqueous extract of *S. agardhii* for 20 min is shown in Fig. 3a, which obviously illustrates the presence of Ag NPs.

Figure 3b shows the EDAX (energy dispersive analysis of X-rays) spectrum recorded in the spot-profile mode from one of the densely populated silver nanoparticle regions on the surface of film. The vertical axis shows the counts of the x- ray and the horizontal axis

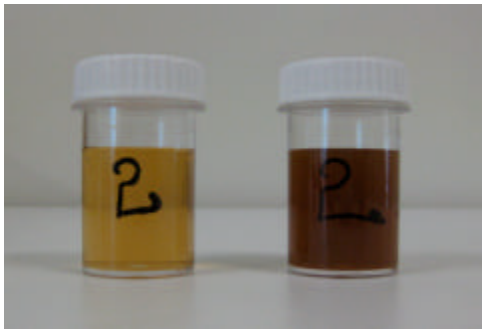


Fig. 1: Colour change of *S. agardhii* extracts containing silver before and after synthesis of silver nanoparticles

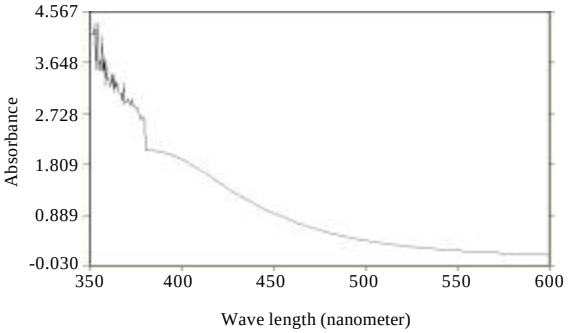
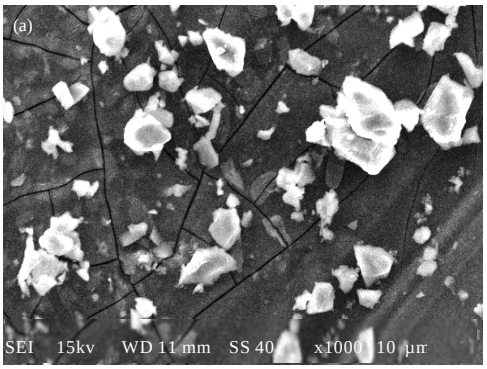


Fig. 2: Uv-vis absorption spectra of silver nanoparticle synthesized from *S. agardhii* at 1 mM silver nitrate



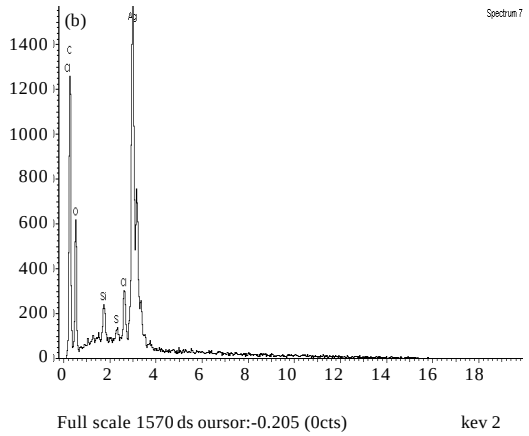


Fig. 3(a-b): (a) SEM and (b) EDAX image of silver nanoparticles formed by *S. agardhii*

shows energy in kev. Strong signals from the silver atoms in the nanoparticles are observed, while weaker signals from C, O, S, P, Na, Mg and Ca atoms were also recorded. The C, O, S, P, Na, Mg and Na signals are likely to be due to X-ray emission from proteins/enzymes present in the cell wall of the biomass.

DISCUSSION

Development of easy, reliable and eco-friendly methods helps in endorsing extra interest in the synthesis and application of nanoparticles which are good for mankind (Bhattacharya and Gupta, 2005). In this context the utilization of biological systems for nanoparticle synthesis is notable alternative for the advancement of multifaceted approach. Biological systems have shown the ability to interact with metal ions and reduce them to form metallic nanoparticles (Raut *et al*., 2010).

The SEM image showed relatively polydispersed shape nanoparticle formed with diameter range 40-50 nm Silver nanoparticles has been characterized using SEM by various investigators (Kalimuthu *et al*., 2008; Shahverdi *et al*., 2007). The Energy-Dispersive Spectroscopy analysis of x-rays (EDS) shows the presence of elemental silver in the sample. The EDS profile shows strong silver signals, along with weak oxygen and carbon peaks, which might originate from the *S. agardhii* extract that is bound to the surface of the Ag NPs. These obtained results compare well with previous reports of silver nanoparticle preparations using biomaterial extracts, like plant and microorganisms (Gardea-Torresdey *et al*., 2002, Twu *et al*.,2008).

CONCLUSION

It has been demonstrated that the marine algae is capable of producing silver nanoparticles extracellularly and the silver nanoparticles are quite stable in solution. And this is an efficient, eco-friendly and simple process. This report will also lead to the development of a rational biosynthetic procedure for other metal nanomaterials with the *Scaberia agardhii*. Studies on assessment of the effect of these silver nanoparticles on soil microbial community are in progress.

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