Available online at
www.ijacskros.com

Indian
Journal of Advances in
Chemical Science

Indian Journal of Advances in Chemical Science 2(3) (2014) 190-193

Biosynthesis of Gold Nanoparticles from Aqueous Extract of *Dictyota Bartayresiana* and Their Antifungal Activity

S. Varun, S. Sudha* P. Senthil Kumar

Molecular Diagnosis and Drug Discovery Laboratory, Department of Biotechnology, Karpagam University, Coimbatore-641 021, Tamil Nadu, India

Received 27th March 2014; Revised 19th April 2014, Accepted 2nd May 2014.

ABSTRACT

The production, categorization and appliance of naturally synthesized nanomaterials are a key aspect in nanotechnology. The present study deals with the synthesis of gold nanoparticles (AuNPs) using aqueous extract of brown seaweed Dictyota bartayresiana as the reducing agent. Green synthesis of gold nanoparticles was preliminarily confirmed by color changing from yellow to dark pink in the reaction mixture and the broad surface plasmon resonance band was centered at 548 to 564 nm which indicates the polydispersed nanoparticles. Scanning electron microscopy showed the morphology and crystalline structure of green synthesized gold nanoparticles. The carboxylic, amine and polyphenolic groups were associated with the green synthesized gold nanoparticles which were confirmed by Fourier Transform Infra-Red (FT-IR) spectroscopy. The antifungal effects of the AuNPs were studied against Humiclo insulans and Fusarium dimerum. The present study indicates that AuNPs has considerable antifungal activity, in comparison with other antifungal drugs.

Keywords: *D. bartayresiana, Brown seaweed, Gold nanoparticles, Antifungal activity*

1. INTRODUCTION

In recent times, nanotechnology is lifting advanced technology from the past few decades, as of their uses in various areas. Commonly, metal nanoparticles are synthesized by means of chemical methods, electrochemical techniques and photochemical reactions [1]. Synthesis of nanoparticles through biological methods is a good, environment responsive and cost-effective method. The synthesis of gold nanoparticles (AuNPs) and their use in varied areas such as catalysis, drug delivery, bio diagnostics, medicine, and electronics have become an area of tremendous investigations because of their exclusive properties [2]. At present, there is a rising need to improve the environment friendly nanoparticle synthesis procedure that is free from toxic chemicals in the synthesis procedure [3]. Gold is one of the precious, inert, and less toxic metals, and it is utilized for curing various diseases. AuNPs have an important function in the delivery of nucleic acids, proteins, gene therapy, *in vivo* delivery and targeting [4]. Algae are the naturally accessible plant, which are main source of phytochemicals involved in the production of metallic nanoparticles. Recently, AuNPs synthesized using the extract of algae such as *Turbinaria conoides* [2], *Laminaria japonica* [5], and *Gelidiella sp.* [6] were reported.

*Corresponding Author:
Email: sudhasellappa@gmail.com

D. bartayresiana J.V. Lamouroux (Class*: Phaeophyceae*, Order: *Dictyotales*, Family: *Dictyotaceae*) is an abundantly growing brown seaweed in coastal of South India. It is commonly occurs in inter tidal region of Gulf of Mannar Southeast coast of India. We have recently reported that *D. bartayresiana* has antioxidant and antibacterial activity [1]. Here we deal with a simple, ecofriendly synthesis of gold nanoparticles by the reduction of aqueous $AuCl_4$ into nanoparticles using the extract of marine algae *D. bartayresiana*.

2. EXPERIMENTAL

2.1. Sample Collection

In the present study, *D. bartayresiana*, a brown seaweed was collected from Mandapam coastal region (78°8'E, 9°17'N), Gulf of Mannar, Tamilnadu, South India. Samples were brought to laboratory in polythene bags and cleaned thoroughly with fresh water to remove adhering debris and associated biota. The algae were cleaned using brush for the removal of the epiphytes with distilled water. After cleaning, algae were dried in shade at room temperature for one week.

2.2. Extraction

The whole plant of *D. bartayresiana* were initially rinsed thrice in distilled water and dried on paper toweling, and samples (25g) were cut into fine pieces and boiled with 100 ml of sterile distilled

water for 5 minutes. The crude extract was passed through Whatman No.1 filter paper and the filtrates were stored at 4°C for further use.

2.3. Synthesis of nanoparticles

To prepare gold nanoparticles, 10 mL of algae extract was added into 90 mL of 1 mM aqueous solution of gold chloride. The reduction was started at 10 min in room temperature, resulting in a color changing of solution indicating the formation of AuNPs.

2.4. UV-Vis spectral analysis

The colour change in reaction mixture (metal ion solution + seaweed extract) was recorded through visual observation. The bio reduction of Au ions in aqueous solution was monitored by periodic sampling of aliquots (0.5 ml) and subsequently measuring UV-vis spectra (200 to 800nm) of the solution. UV-vis spectra of these aliquots were monitored as a function of time of reaction on UV-2450 (Shimadzu).

2.5. Scanning electron microscopic analysis

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

2.6. Fourier Transform infra-red (FT-IR) spectroscopy analysis

To remove any free biomass residue or compound that is not the capping ligand of the nanoparticles, the residual solution of 100 ml after reaction was centrifuged at 5000 rpm for 10 min. The supernatant was again centrifuged at 10000 rpm for 60 min and the pellet was obtained. This is followed by redispersion of the pellet of AuNPs into 1 ml of deionized water. Thereafter, the purified suspension was freeze dried to obtain dried powder. Finally, the dried nanoparticles were analyzed by FTIR Nicolet Avatar 660 (Nicolet, USA).

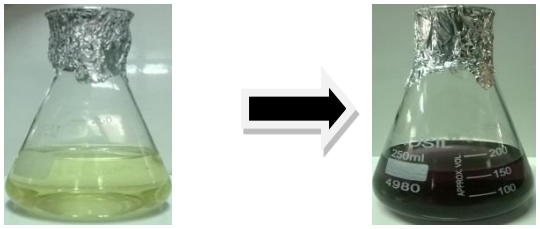
2.7. Antifungal activity

The antifungal effect of AuNPs was evaluated against *Humiclo insulans* (MTCC No. 4520) and *Fusarium dimerum* (MTCC No.6583). Cultures were maintained on potato dextrose agar (Hi Media, India) slants and they were subculture before use. The fungi studied were clinically important ones causing several infections and it is essential to overcome them through some active therapeutic agents.

Agar well diffusion assay was followed, which involves swabbing the cultures in pre-sterilized nutrient agar plates potato dextrose agar plates and three wells were cut in the same using sterile cork borer. Each well was loaded with 50 µl of solution in the following order: positive control, aqueous seaweed extract of *D. bartayresiana* solution of AuNPs, and test sample methanolic extract. Then the sample loaded in potato dextrose agar plates were incubated at 37 ºC for 48 hours. Then the formation of zone of inhibition was measured.

3. RESULTS AND DISCUSSION

The drop of gold ions into gold nanoparticles was visually recognized by color change from yellow to dark pink during the exposure of algae extract into the gold ion solution.



Before synthesis After synthesis

Figure 1: Synthesis of AuNPs Colour change at 1 h of incubation.

Normally, gold ion displays yellow color in distilled water. As the algae extract was added into the gold ion solution, it on track to change the color from yellow to pink which indicates the reduction of gold ions into gold nanoparticles. Difference in the color alteration was observed; it primarily depends on the reaction time and phytochemical components of the algae extract. In this observation, dark pink color was formed at 45 min time of incubation, and the end of reduction process that occurred at 24h was identified by the precipitation of nanoparticles at the bottom of the conical flask (Figure 1). These color change was happen due to the excitation of surface Plasmon vibrations with the gold nanoparticles [7].

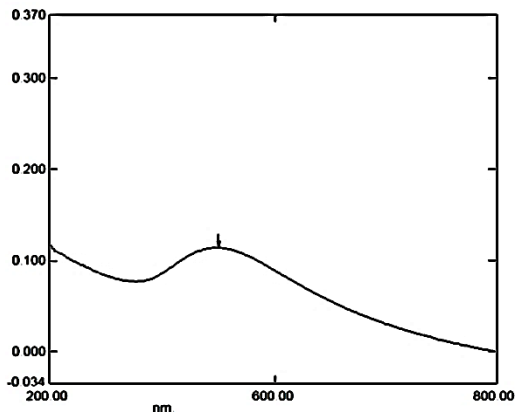


Figure 2: UV-Vis absorption spectra of gold nanoparticles synthesized by brown seaweed *Dictyota bartayresiana* extract.

Appropriate transfer interactions between metal and the chloro ligands of HAuCl4, the UV-visible spectrum showed single peak at 548nm (Figure 2). The variation of color of the AuNP colloids has been reported arising due to the change in size, shape, composition, crystallinity, etc. [8].

The SEM image (Figure 3) showed the spherical shape AuNPs, which was obtained by the aqueous extract of *D.bartayresiana*

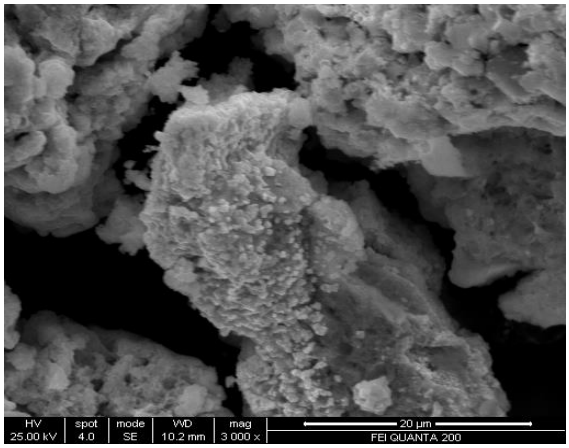


Figure 3: SEM micrograph of AuNPs synthesized by aqueous extract of *D. bartayresiana*.

FT-IR spectra was carried out for analysis of function group from green synthesized AuNPs FT-IR spectra of AuNPs showed in Figure 4.

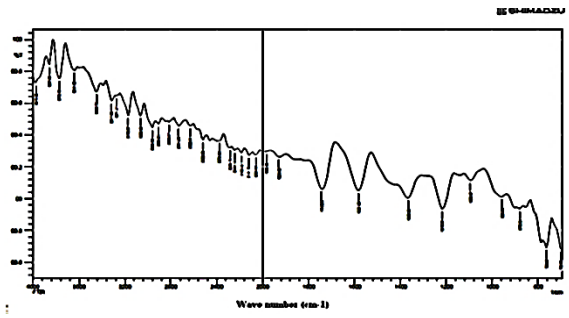


Figure 4: FTIR spectra of *D. bartayresiana* mediated gold nanoparticles.

The gold nanoparticles synthesized from *D.bartayresiana* revealed a set of biomolecules which were involved in the synthesis of AuNP process (Figure 4). The presence of carboxylic, amine, phosphate and hydroxyl functional groups is involved in the reduction of gold ions in the algae extract of *Sargassum polycystum* was previously reported by Thangaraju *et al*. [9]. Hydroxyl groups present in the brown algal polysaccharides were involved in the bio reduction of Au (III) ions into Au (0).

In addition the nanoparticles synthesis by using *D.bartayresiana* extract was found extremely toxic against clinically important fungal species at a concentration of 20 µl AuNPs shown high antifungal activity against *Fusarium dimerum* and an intermediary activity was shown against *D.bartayresiana* (Figure 5). Similarly our previous study proved that the AgNPs synthesized from *D.bartayresiana* a useful antifungal agent [1].

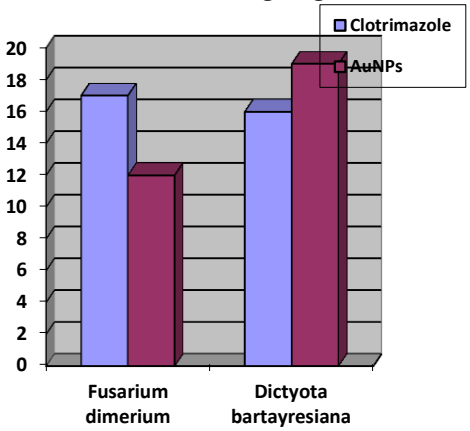


Figure 5: Antifungal activity of AuNPs synthesized by reduction of AuCl4 with *D. bartayresiana* extract against some selected fungal pathogens.

The inhibitory activities of AuNPs reported were comparable with standard antifungal agent Clotrimazole. The reduction of the metal ions through algal extracts leads to the formation of gold nanoparticles of fairly well-defined dimensions. This reduces the need of toxic chemicals for the synthesis of nanoparticles.

4. CONCLUSION

D.bartayresiana aqueous extract has tremendous medicinal significance and AuNPs are biocompatible. *D.bartayresiana* mediated AuNPs have very effective antifungal properties as compared to chemically synthesized antifungal drug.

Acknowledgments - The authors are thankful to the management of Karpagam University, Coimbatore, for provision of all necessary amenities for the work carried out.

5. REFERENCES

[1]. P. Senthil Kumar, S. Sudha, (2013) Biosynthesis of silver nanoparticles from *Dictyota bartayresiana* extract and their antifungal activity, ***Nano Biomedicine and Engineering,*** **5**: 72-75.

[2]. S. Rajeshkumar, C. Malarkodi, G. Gnanajobitha, K. Paulkumar, M. Vanaja, C. Kannan, G. Annadurai, (2013) Seaweed-mediated synthesis of gold nanoparticles using *Turbinaria conoides* and its characterization, ***Journal of Nanostructure in Chemistry,*** **3**:44.

[3]. B. Mahitha, B. Deva Prasad Raju, T. Madhavi,, CH. N. Durga mahalakshmi, N. John Sushma, (2013) Evaluation of antibacterial efficacy of phyto fabricated gold nanoparticles using *Bacopa Monniera* plant extract, ***Indian Journal of Advances in Chemical Science***,1, 94 -98.

[4]. P.M. Tiwari, K. Vig, V.A. Dennis, S.R. Singh, (2011) Functionalized gold nanoparticles and their biomedical applications, ***Nanomaterials,*** **1**: 31–63.

[5]. J.S. Devi, B.V. Bhimba, K. Ratnam, (2012) *In vitro* anticancer activity of silver nanoparticles synthesized using the extract of *Gelidiella Sp*., ***International Journal of Pharmacy and Pharmaceutical Sciences,*** **4**: 710–715.

[6]. S.S. Shankar, A. Ahmad, M. Sastry, (2003) *Geranium* leaf assisted biosynthesis of silver nanoparticles, ***Biotechnology Progress,*** **19**: 1627–1631.

[7]. A.M. Alkilany, S.E. Lohse, C.J. Murphy (2013) The gold standard: gold nanoparticle libraries to understand the nano bio interface, ***Accounts of Chemical Research,*** **46**: 650–661.

[8]. N. Thangaraju, R.P. Venkatalakshmi, C. Arulvasu, K. Pandian, (2012) Synthesis of silver nanoparticles and the antibacterial and anticancer activities of the crude extract of *Sargassum polycystum* C. Agardh, ***Nano Biomedicine and Engineering,*** **4**: 89–94.

****Bibliographical Sketch***

Dr. Sudha Sellappa, a doctorate in Zoology did doctoral research at Bharathiar University, India. Her research is in the area of cancer research, diabetes and occupational health and toxicity. She has authored more than 50 refereed journal publications. In recognition of her excellence and dedication in teaching and mentoring, she received the P K Das Memorial Best Faculty Award in 2011 and the Tamilnadu Young Woman Scientist Award in 2013. Her core research is in Cancer biology and genotoxicity.