Seaweed (*Sargassum ilicifolium*) assisted green synthesis of palladium nanoparticles

B.S.Naveen Prasad[#] and TV.N. Padmesh[$*]

Abstract:

In the present work, a green route for the synthesis of palladium nanoparticles (PdNPs) has been described. Aqeous extract of the seaweed *Sargassum ilicifolium* has been used for the reduction of Pd^{2+} ions to Pd^{0}. The synthesized PdNPs were characterized using UV-vis spectroscopy and Scanning Electron Microscopy (SEM). The particles were well dispersed and spherical in shape. The average size of the PdNPs was found to be 60-80 nm.

Keywords: *Sargassum ilicifolium, green synthesis, palladium nanoparticles, spherical, SEM*

1. Introduction

Nanoscience and nanotechnology represents one of the major breakthroughs of modern science and engineering, enabling materials of distinctive size, shape and composition to be formed. Nanoparticles of noble metals, such as silver, gold, palladium and platinum, are widely used in consumer products, medical and pharmaceutical applications [1]. Palladium nanoparticles exhibits unique physical, chemical, optical and thermo dynamical properties at nano regime [2,3] which lead them in to application in heterogeneous and homogeneous catalysis due to their high surface to volume ratio [4,5]. Recent day's synthesis of palladium nanoparticles using bio-inspired, eco-friendly green chemistry approach is one of the most important aspects of current nanoscience and nanotechnology [6]. Research effort has been made using various biological systems such as bacteria [7] and plant extracts [8] for the synthesis of palladium nanoparticles. Literature revealed that synthesis of palladium nanoparticles using marine algae has been unexplored, which stimulate our interest in the present work.

[#]*Department of Chemical Engineering, Sathyabama University, Chennai-600119, India, E-mail:bsnaveenprasad@gmail.com*
[$]*Department of Chemical Engineering, Taylors University, Malaysia, E-mail: tirunelveli.padmesh@taylors.edu.my*

Presently seaweeds constitute commercially important marine renewable resources which provide valuable idea for the development of new drugs against cancer, microbial infections and inflammations [9]. Sargassum species are commercially valuable for their uses in several food and non-food sector industries. The present study was undertaken to investigate on the green synthesis of palladium nanoparticles using pharmacological potent seaweed *Sargassum ilicifolium.*

2. Materials and methods

2.1. Materials

Palladium chloride ($PdCl_2$) was purchased from SRL Pvt. Ltd., India and used as received. All other reagents used were of analytical grade with maximum purity. Fresh *Sargassum ilicifolium* seaweed was collected from Mandapam (Latitude 9.2800° N, Longitude79.1200° E), Rameswaram, East Coast of India. The collected seaweed was cleaned with double distilled water, shade dried, and ground to powder and stored for further studies.

2.2. Synthesis of palladium nanoparticles

The seaweed extract was prepared by adding 1g of dried *Sargassum ilicifolium* powder to 20 mL of distilled water and placed in an orbital of PdNPs, about 100 mL of seaweed extract shaker for 24 h. After 24 h, the extract was filtered and stored for further experiments. For the synthesis was mixed with 1 mL $PdCl_2$ (1M) and incubated at room temperature for 5 days.

2.3. Characterization of PdNPs

The solution was monitored for the formation of PdNPs at different time intervals by an UV-vis spectrophotometer (Schimadzu-UV1800).Scanning electron microscopy (SEM) analysis was carried out to study the morphology of PdNPs using HITACHI-S3400N equipment. The sample was prepared by drop coating the PdNPs onto a carbon tape mounted on an aluminium stub, dried in a controlled environment and the images were captured.

3. Results

The appearance of blackish brown colour indicates the formation of PdNPs. The peak at 280 nm indicates the presence of Pd^{2+} ions and the gradual disappearance of the peak with time indicates the formation of PdNPs (Fig.1). The morphology of the palladium nanoparticles in the colloidal solution and their distribution was analysed by scanning electron microscope. SEM images clearly indicate the morphology of palladium nanoparticles which shows well dispersed and spherical shaped particles of size 60-80 nm (Fig. 2a&b).

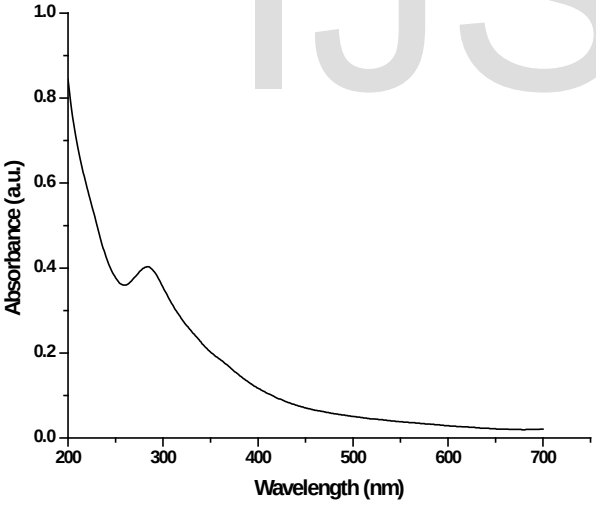
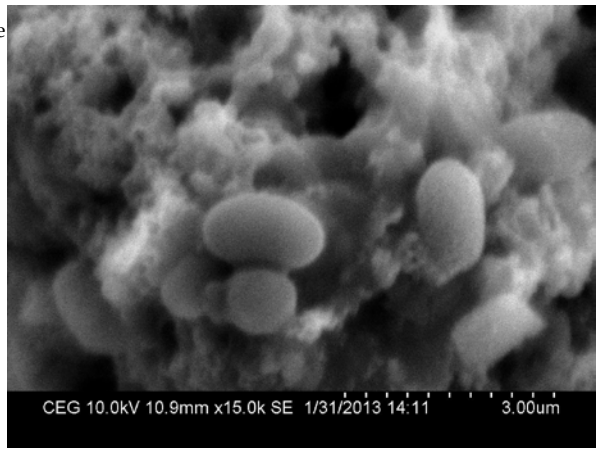


Figure 1. UV-vis spectra of PdNPs synthesized using seaweed *Sargassum ilicifolium*



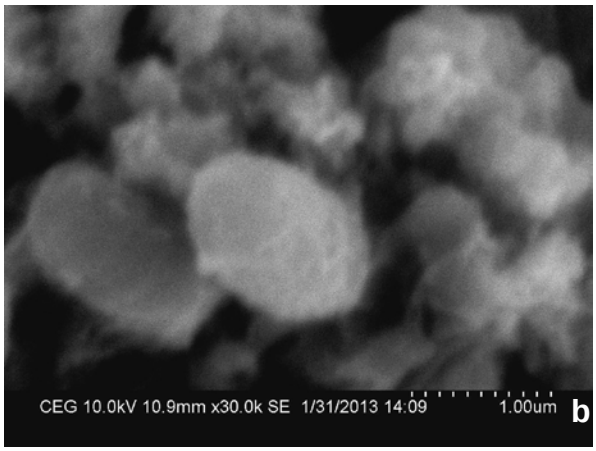


Figure 2. SEM image of *Sargassum ilicifolium* synthesized PdNPs

4. Discussion

The greener method employing natural sources have drawn attention for an easy and viable alternative to physical and chemical methods [10,11]. Such dependable and environmentally friendly green chemistry approach help in endorsing extra interest in the synthesis and application of nanoparticles which are good for mankind. In green synthesis, it is believed that natural material extract act as reducing agent for the generation of metal nanoparticles. It has been reported that addition of soybean leaf extract to $PdCl_2$ has exhibited a gradual colour change from transparent orange to dark brown over a period of time. Also, the UV-vis spectra showed a gradual disappearance of the peak at 420 nm with time indicating the formation of PdNPs [12]. TEM images of PdNPs stabilized by lignin showed well dispersed spherical shaped particles [13]. PdNPs synthesized from the aqeous extract of *Annona squamosa* peel showed spherical shaped particles with an average size of 100 nm [14]. Song et al. [1] have demonstrated first ecofriendly synthesis of platinum nanoparticles using plant extract *Diopyros kaki*. An almost 100% conversion of platinum ions to platinum nanoparticles was achieved with a reaction temperature of 95^{o}C. The average particle size was in the range of 2–12 nm. The controlled via changes in reaction temperature and in

the concentrations of leaf broth and $PtCl_6^{2-}$.

4. Conclusion

In the present study, synthesis of PdNPs was achieved from the seaweed *Sargassum ilicifolium* at room temperature in 5 days. The synthesized PdNPs were spherical in shape with an approximate size of 60-80 nm. From the investigation, it is found that the present route for the synthesis of PdNPs can serve as a better alternative for the other conventional methods practiced for the synthesis of palladium nanoparticles.

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