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Green synthesis of Palladium nanoparticles by Soybean *(Glycin Max.)* leaf extract

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ABSTRACT

Palladium (Pd) nanoparticles were synthesized using protein rich soybean leaf extract based biological process. Reduction of palladium ions by soybean leaf extract was examined by UV-visible spectroscopic technique. It was believed that the proteins and some of the amino acids that are exist in soybean leaf extracts were actively involved in the reduction of palladium ions. Further it was confirmed by Fourier transformations infrared spectroscopic (FTIR) analysis. These amino acids are not only involving in the reduction of palladium ions but also acting as surfactants that inhibits the rapid agglomeration. The phase purity of the synthesized palladium nanoparticles was investigated through X-Ray Diffraction (XRD) analysis. Transmission electron microscopic (TEM) images of the palladium particles were recorded and the particle size was found to be ~13 nm.

Key words: Palladium Nanoparticles; soybean (Glycine max) leaf extract; characterization

INTRODUCTION

The synthesis of metal nanoparticles using bio inspired, ecofriendly greener methods is one of the most attractive aspects of current nanoscience and nanotechnology [1-3]. Extensive research effort has been made in utilizing various biological systems such as bacteria, fungus and plant extracts for the synthesis of metal nanoparticles. Among them plant extract mediated biological process is found to be simple and versatile process for the synthesis of different types of metal nanoparticles such as silver, gold and palladium, which has emerged as an alternate to conventional physical and chemical methods. Recently, we have successfully demonstrated the rapid synthesis of silver nanoparticles in aqueous solutions using soybean leaf extract [4-7]. The present work deals with biological (green) synthesis of palladium nanoparticles by soybean (*Glycine max)* leaf extract.

METHODOLOGY

The Glycine max (soybean) leaves of DKB 0099 variety were used to make extract. 20 gm of soybean (Glycine max*)* leaves were thoroughly washed with double distilled water and cut in to small pieces. Further they were boiled with in 100 ml deionised Water in conical flask for 5 minutes. Obtained soybean leaf extract was filtered and stored in refrigerator. Take 10 ml of plant extract and add 100 ml $PdCl_2$ Solution. Put this mixture on magnetic stirrer with hot plate at 60^oC with constant stirring for 30min. at the starting point of the reaction we observe the colour changes light orange to dark brown colour obtained.

RESULTS AND DISCUSSIONS

After completion of reaction, we observed the colour changes from light orange to dark brownish in comparison to the control solution. The colour change is the visual method of detection of synthesis of palladium nanoparticles. The palladium nanoparticles were characterized by using UV-Vis spectroscopy (Shimadzu UV 1800 UV-Visible spectrophotometer) reduction of palladium ions was monitored by measuring the UV-Vis range of the reaction mixture at 8 hour. FTIR spectroscopy analysis was carried out to identify the biomolecules responsible for the reduction of Pd^+ ions. FTIR spectroscopy analysis was carried out to find the biomolecules that were bound specifically on the palladium nanoparticles surface. The morphology of the obtained nanoparticles was characterized by using a high-resolution transmission electron microscopy (HR-TEM). Chemical compositions of the obtained nanoparticles were analyzed by EDAX technique. The crystallographic structure of palladium nanoparticles and the phase properties was examined by XRD measurements using Rigaku D/max 40 kV diffractometer. The average crystallite size was calculated by using debye Scherer's formula.

3.1 UV-Vis Spectra Analysis

UV-visible spectroscopy measurements (Shimadzu UV 1800) were carried out at room temperature in the region 800–300 nm as a function of time of the reaction. The UV–Visible absorption spectrum was used for the analysis of optical properties of green synthesized Palladium nanoparticles. The mono dispersed Palladium nanoparticles are shown in synthesis figure-2. The room temperature spectra exhibited strong excitonic absorption peaks at 420 nm for samples respectively. The observed peaks at 420 nm indicate the presence of the Pd2+ ions in reaction mixture.

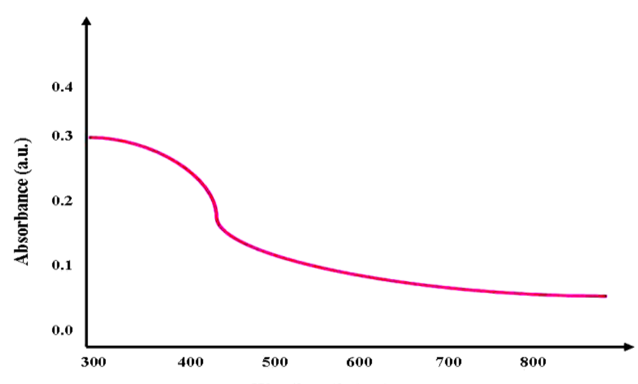

Fig. 2 UV-visible spectra of green synthesized Palladium nanoparticles.

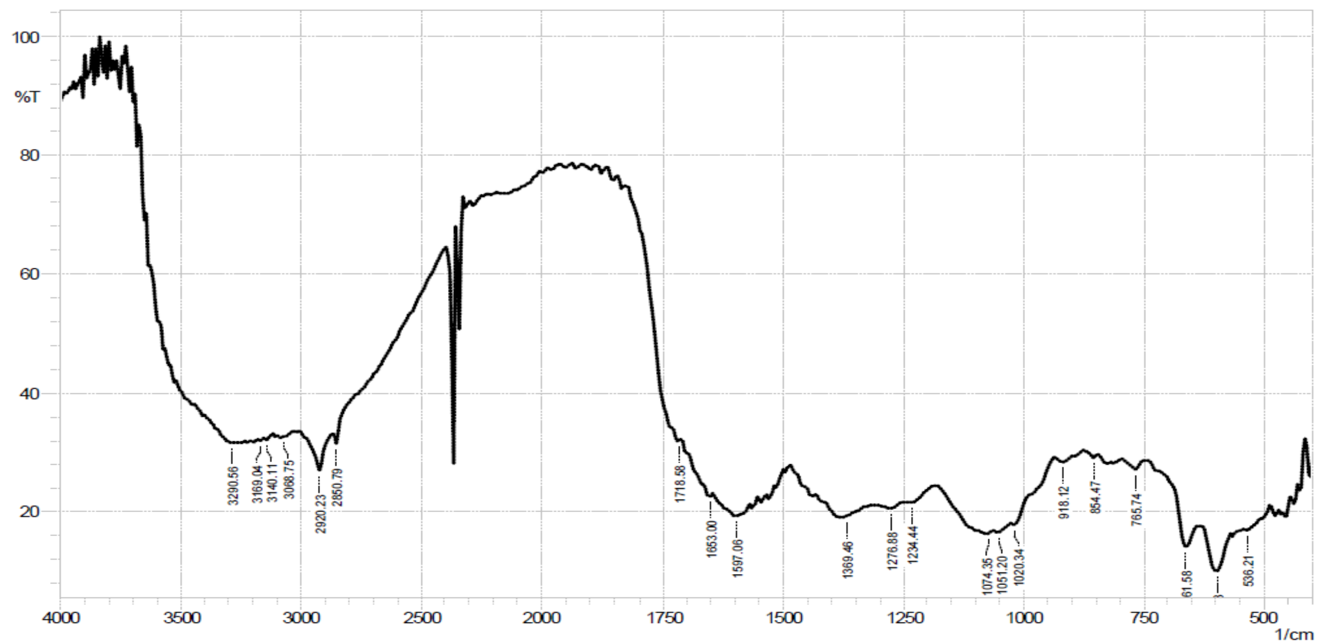

Fig3. FTIR spectrum of Palladium nanoparticles

FTIR spectroscopy analysis was carried out to identify the biomolecules responsible for the reduction of Pd^+ ions. Fig.3 shows the FTIR spectra of green synthesized palladium nanoparticles. The spectrum showed sharp bands at 854 cm^{-1} and 918 cm^{-1} corresponding to palladium nanoparticles. Strong bands were observed at 1234 cm^{-1}, 1276 cm^{-1} and 1369 cm^{-1} and have been referred to as C–N stretching and N=O stretching vibrations of aliphatic amines and nitro compound, respectively. The bands obtained at 1718 cm^{-1}, 2850 cm^{-1}, 2920 cm^{-1} and 3290 cm^{-1} have been representing to stretching vibrations of C=O stretching (Aldehyde), primary alkanes and water molecules.

3.3 X-RD analysis of Palladium Nanoparticles:

X-ray diffraction (XRD) measurement of the green synthesis of palladium nanoparticles carried out on a Rigaku D/max 40 kV diffractometer equipped with the graphite monochromator and cu target. Fig. 4 shows the XRD analysis of green synthesized palladium nanoparticles. This is used for further confirmation of palladium phase of nanoparticles. The observed intense peaks are 28.22^0, 33.61^0, 60.16^0 and 72.10^0 respectively representing the (100), (200), (220) and (311) reflections indicating the face centered cubic (fcc) structure of palladium nanoparticles XRD pattern reveals the face centered cubic structure indicating the crystalline nature of palladium NPs and the particle size calculated using Debye-Scherrer equation, $D = 0.9\lambda/\beta \cos\theta$ Where, D is average Particles size, λ is wavelength (1.5418 Å), θ is the Bragg's angle and β is full width half maximum (FWHM) of corresponding peek. The Scherer's formula was used to estimate the particles sizes and was found to around 13 nm.

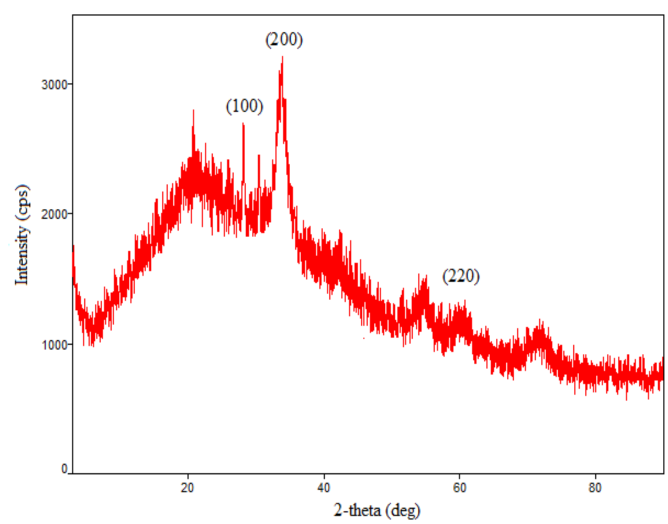

Fig. 4: XRD spectra of green synthesized Gold nanoparticles

3.4 HR-TEM and EDS analysis of Palladium Nanoparticles:

High-resolution Transmission electron microscope (HR-TEM) images were recorded on a Tecnai G2-F30 electron microscope. Fig. 5 shows the HR-TEM images of Palladium NPs prepared using *Glycine max* (soybean) leaf extract. High-resolution Transmission electron microscopy (HR-TEM) has been employed to characterize the size, shape and morphology of synthesized Palladium nanoparticles The composition of Palladium nanoparticles was further probed by energy-dispersive X-ray (EDS) analysis. Fig. 6 shows the EDS pattern of Palladium NPs prepared using green synthesis, which indicates the presence of Pd and small amount of oxygen. EDS spectrum of Palladium nanoparticles shows the peaks for Palladium and respective elements indicating the formation of Palladium nanoparticles.

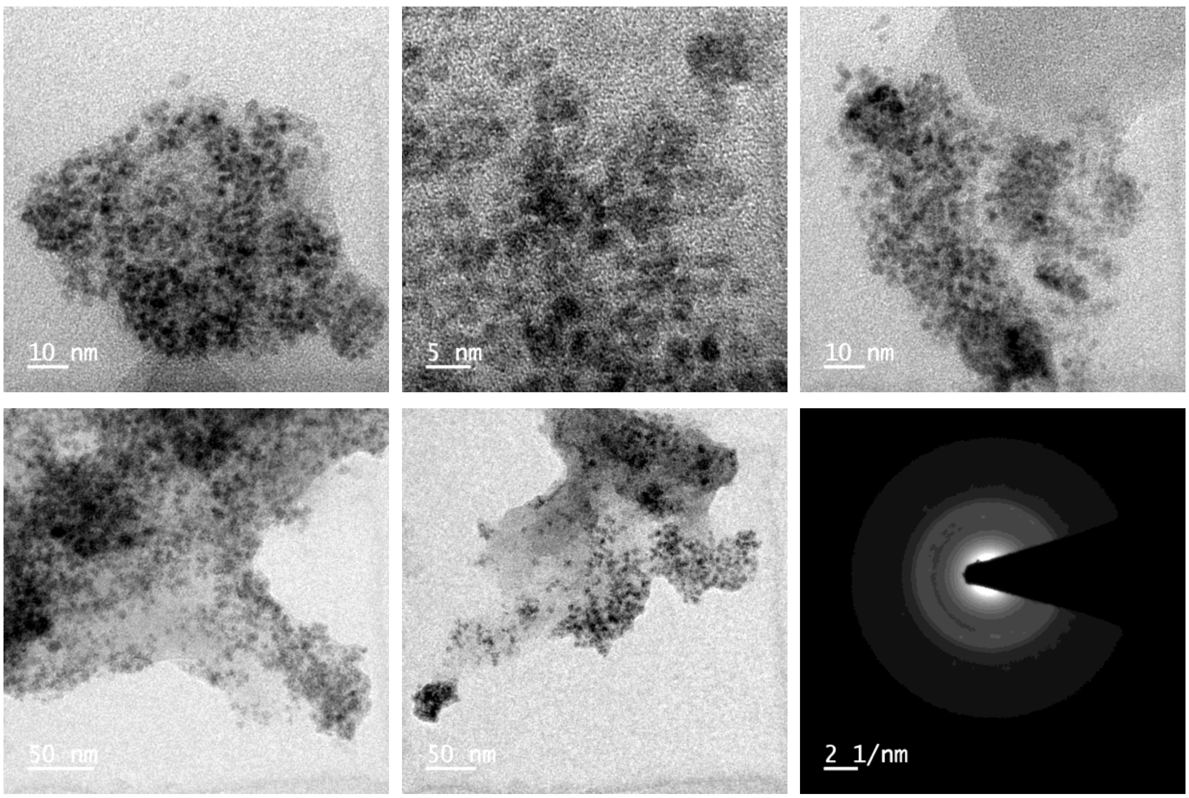

Fig. 5 HR-SEM spectra of Palladium nanoparticles

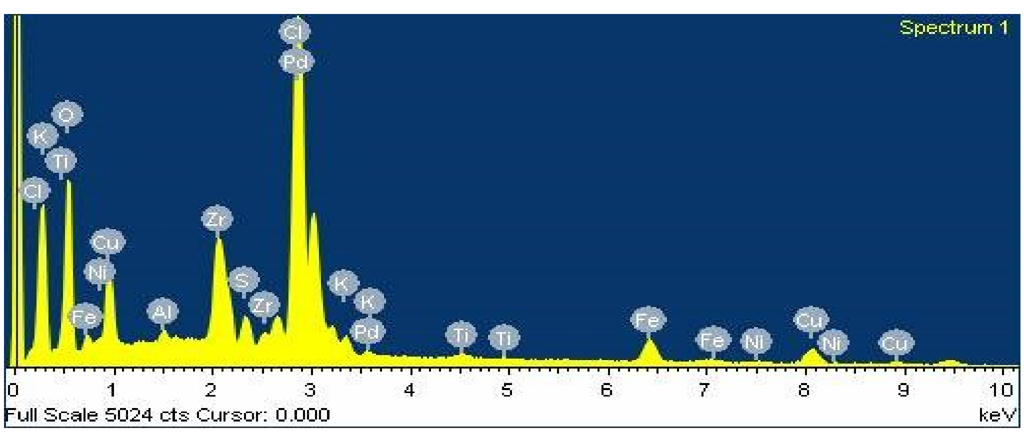

Fig. 6 EDS spectra of green synthesis of Palladium nanoparticles

CONCLUSION

Palladium nanoparticles were successfully synthesized using *Glycine max* (soybean) leaf extract mediated biosynthesis process. UV spectra shows absorption peak near 420 nm confirm that formation of palladium nanoparticles. Protein rich soybean leaf extract is acting as an effective reducing agent for palladium ions, which confirmed by FTIR analysis. The synthesized palladium nanoparticles were characterized using XRD and confirmed the fcc phase. HRTEM investigation results that the average size of synthesized palladium nanoparticles is around 13 nm. From this investigation we found that the soybean leaf mediated biosynthesis process can be cost effective and also alternate for conventional chemical and physical processes for the synthesis of palladium nanoparticles. Also these bio synthesized palladium nanoparticles can be used as catalysis especially in the degradation of azo dyes.

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