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Synthesis and Spectroscopic Characterization of Palladium Nanoparticles by Using Broth of Edible Mushroom Extract

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***Abstract*—Reliable and eco-friendly process for the synthesis of metallic nanoparticles is an important step in the field of Nanoscience and Technology. In the present study we fabricate the palladium nanoparticles by using mushroom extract as a reducing and capping agent. It was observed that the synthesis procedure was quite simple and in a single step benign palladium nanoparticles were formed. UV-visible spectrum of the aqueous medium containing palladium ions demonstrated a peak corresponding to the plasmon absorbance of palladium nanoparticles. X-Ray diffraction (XRD) spectrum reveals the crystalline structure of palladium nanoparticles. The morphology of the biomolecules-stabilized palladium nanoparticles were determined by the atomic force microscopy (AFM) image. Energy dispersive X-ray analysis (EDS) evidences the presence of palladium nanoparticles in the aquatic solution of mushroom extract. FTIR analysis of the nanoparticles likewise indicated the possible presence of functional groups in biomolecules, which may be acting as capping agents around the nanoparticles.**

Keywords- Mushroom extract; green synthesis; AFM; FTIR

I. INTRODUCTION

In the recent years, naturally motivated, environmentally benign investigational practice for the green synthesis of metal nanoparticles has been established as an emerging area of nanoscience and nanotechnology research [1]. The immobilization of metal complexes in water for application to aqueous catalysis including biphase and supported phase catalysis is a technique that can address many issues of green chemistry [2], [3].

Nature provides a clue in the form of biomolecules that can be effectively utilized in capping nanostructures. This served as an inspiration for green chemistry and bioprocesses Biological sources such as micro organisms and plant leaf extracts were used in the synthesis of biomolecules that hosted nanoparticles [4]-[9]. Green chemistry is all about reducing or eliminating the use and generation of substances hazardous to human health and the environment. Strategies of addressing the mounting environmental concerns with current the approaches include the use of environmentally benign solvents, biodegradable polymers and non toxic chemicals [10], [11].

Mushrooms are important in the ecosystem because they biodegrade substrates and thereby use the wastes generated in agriculture. They include a number of subclasses such as flavonoids, phenolic acids, hydroxyl benzoic acids, hydroxycinnamic acids, stilbenes, lignans, tannins and oxidized polyphenols and display a great diversity of structure. The mushrooms have been shown to have food nutrition value and have also been proved to be effective against inflammation, tumors, bacteria, viruses, allergies. Further besides being antioxidents then have too anti- atherogenic, hyperglycemic and hematological properties and are involved in immunomodulating therapies. Mushrooms are not only nutritions but can prevent diseases like hypertension, hypercholesterolemia and cancer [12], [13].

A. Atomic force microscope studies

The morphology of the nanoparticles was studied with an atomic force microscope (AFM). The AFM samples of the aqueous suspension of palladium nanoparticles were diluted to 1:2 ratios with deionized water, dropping the suspension onto a clean glass plate allowing the water to completely evaporate. The AFM image that provides more detailed information about the surface morphology of the palladium nanoparticles is spherical in shape as shown in Fig.2.

B. EDAX measurements s

In order to carry out energy dispersive X-ray analysis (EDS), a thin film of the sample was taken onto a clean glass plate and dropped a very small amount of the sample on the grid of the instrument equipped with a thermo EDAX attachment. The EDS revealed the formation of a strong signal in the palladium region and confirmed the formation of palladium nanoparticles as shown in Fig. 3.

C. Crystalline structural analysis of palladium nanoparticles

An X-ray diffraction (XRD) measurement of a thin film of the biomolecules stabilized palladium nanoparticles aqueous solution was drop coated onto a glass slide and tested on an X-ray diffractometer. The diffraction pattern was recorded by Co-kα_1 radiation with λ of 1.78A^o in the region of 2θ from 25^o to 110^o at 0.02^o/ min. and the time constant was 2 sec. The crystalline nature of palladium nanoparticles was studied with the aid of an XRD (Fig. 4).

II. EXPERIMENTAL

A. Preparation of mushroom extract

The mushroom extract used for the reduction of palladium ions was prepared by taking 20gm of thoroughly washed, finely cut pieces of it in 500ml Erlenmeyer flask along with 100ml of deionized water and then boiling the mixture for 2min before decanting it. Further, the extract was filtered and stored at 4°C and used for further experiments.

B. Synthesis of palladium nanoparticles

In a typical synthesis of palladium nanoparticles, a 0.5ml extract 10ml of deionized water with the appropriate amount of palladium chloride (1mM) were taken in 50ml round bottom flask and stirred vigorously. The bioreduced aqueous component (0.5ml) was used to measure the UV-Vis spectrum of the solution. The particle suspension was diluted to 1:10 ratio with ultrapure water to avoid errors that could occur due to high optical density of the solution.

III. RESULTS AND DISCUSSION

A. UV-Visible absorption spectroscopy

Define The UV-Vis spectroscopy was used to study the palladium ions during their reaction with the mushroom extract. The color of the solution gradually turned from brownish color into black precipitate, indicating the generation of palladium nanoparticles. Figure 1 shows the UV-VIS spectrum recorded from the aqueous palladium chloride–mushroom extract reaction at room temperature on UV-VIS spectrometer.

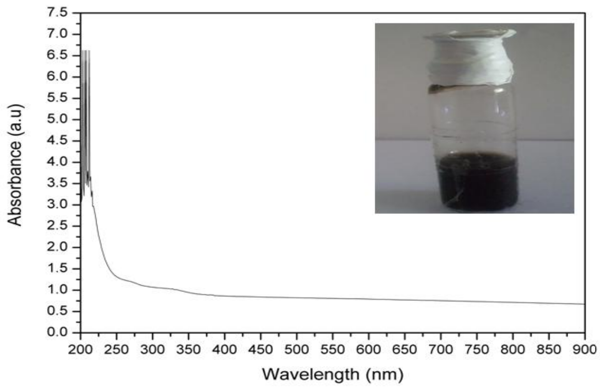

Figure 1. UV-Vis absorption spectrum of mushroom extract fabricated palladium nanoparticles.

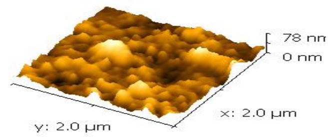

Figure 2. Three dimensional AFM image of biomolecules hosted palladium nanoparticles.

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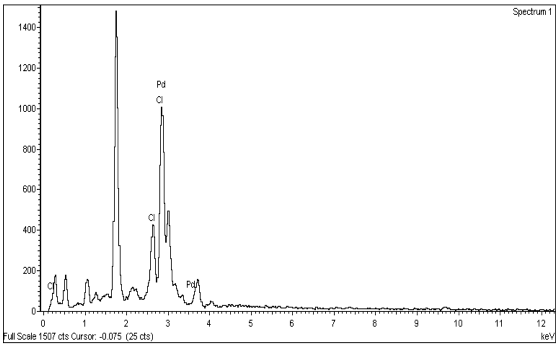

Figure 3.

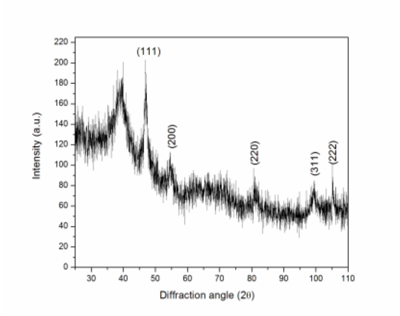

Figure 4. X-Ray diffraction spectrum of synthesized palladium nanoparticles

The number of strong Bragg's diffracted peaks was observed at 46.7º, 54.4º, 80.6º, 98.7º and 104.9º corresponding to the (111), (200), (220), (311), (222) and facets of the face-centered cubic lattice of palladium were obtained. Using the width of the (111) Bragg's reflection the average domain size of the phytofabricated palladium nanoparticles was found to be 1.7 nm [15].

E. Fourier transforms infra-red spectroscopy

FTIR has emerged as a valuable tool for understanding the involvement of surface functional biological groups in metal interactions. The FTIR spectrum of synthesized palladium nanoparticles by using mushroom extract is shown in Fig. 5.

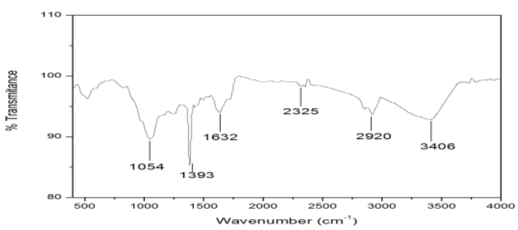

Figure 5. Fig. 5 FTIR spectrum of mushroom derivatized palladium nanoparticles.

It confirms the fact that the biomolecules act as reducing agents and efficient stabilizers of the palladium nanoparticles. The band at 3406 cm^{-1} corresponds to O-H, as also the H-bonded alcohols and phenols. The peak at 2920 cm^{-1} indicates carboxylic acid. The band at 2325 cm^{-1} represents the C≡N stretch nitriles. The band at 1632 cm^{-1} states primary amines. The band at 1393 cm^{-1} corresponds to C-C stretching aromatics and 1054 cm^{-1} indicates that C-O stretching alcohols, carboxylic acids, esters and ethers. Therefore, the synthesized nanoparticles were encapsulated by some proteins and metabolites such as terpenoids that have the functional groups of alcohols, ketons, aldehydes and carboxylic acids.

IV. CONCLUSIONS

We developed a single-step method for the synthesis of palladium nanoparticles by mushroom extract offers a valuable contribution in the area of eco-friendly, nanoscience and technology without adding different physical and chemical methods. The greener methodology has advantages like facile synthesis of palladium nanoparticles, easy processing, economical viable, non-toxic and eco-friendly method for development of palladium nanoparticles may be valuable in environmental benign, biotechnological, catalysis and sensor applications. From a technical point of view, the palladium nanoparticles thus obtained may have potential applications not only in catalysis, but also in the fields of biosensors and medicine.

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