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ORIGINAL ARTICLE **OPEN ACCESS**

Synthesis, Characterization and antioxidant/anti-cancer activity of palladium Nanoparticles using *Cassia absus* seed extract

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ABSTRACT

The current study describes an eco-friendly, biogenic production of palladium nanoparticles (PdNPs) using Cassia absus seed extract. UV-visible spectroscopy, Fourier transform infrared spectroscopy were used to analyse the produced PdNPs (FTIR). The production of PdNPs was confirmed using a UV-visible spectrophotometer and spherical PdNPs.The functional groups present in Cassia absus may have been involved in the bio-reduction reaction for PdNPs synthesis, as revealed by the functional groups present in the FT-IR spectrum, which revealed the functional groups present in Cassia absus may have been involved in the bio-reduction reaction for PdNPs synthesis. PdNPs that have been prepared had anticancer and antioxidant properties. It could be used as a non-toxic reducing agent for the production of PdNPs, and the resulting PdNPs could be used in biological applications.

Keywords: Pd Nps, Cassia absus, Antioxidant, Anti-cancer activity.

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INTRODUCTION

Noble metal nanoparticles have gotten a lot of attention recently because of their outstanding optical qualities, small size, and unusual physiochemical properties. These nanoparticles can be used in electronics, sensing, photochemistry, energy storage devices, and pharmaceuticals [1]. In the literature, different forms of metal nanoparticles have been documented, including gold (Au), silver (Ag), titanium, and zirconium. All of these metal nanoparticles have varied applications, including biomedical and catalytic [2,3].

Palladium nanoparticles (PdNPs) catalysts have sparked a lot of interest due to their potential applications in biotechnology, biomedical research, and medicine. Because of their high surface-to-volume proportion and high surface vitality, improvements in the manufacturing of palladium nanoparticles (PdNPs) have gained outstanding relevance because of their applicability in both heterogeneous and homogeneous catalysis [4]. Chemical [5-7], electrochemical, laser pulse ablation [9], and sonochemical reduction [10] are some of the common manufacturing processes for delivering PdNPs. Because chemical methods for producing palladium nanoparticles induce a harsh reaction that reduces palladium's catalytic activity, new synthetic methods for producing palladium nanoparticles with regulated size and shape are needed to suit a wide range of future uses. Methods such as physical, chemical, enzymatic, and biological can be used to reduce metal ions into nanoparticles. Physical and chemical procedures rely on high levels of radiation and concentrated reducing agents, both of which harm the environment and endanger human health. The enzymatic technique to nanoparticle creation, on the other hand, is safer but more expensive [11-12].

Cassia absus seeds are the most widely utilised medicinally, but the roots have also been examined. The leaves are sour and pungent. Seeds were once used to heal eye problems. It is known as chakshu, Chakusya, because it is used to treat eye disorders (eye, in the Sanskrit language). It's mostly found in wastelands up to 1500 metres in India and Sri Lanka. It can be found in every tropical location on the planet [14]. It can also be found on the Australian, Central American, and African continents [15]. It is traditionally used for the treatment of hypertension, irritable bowel syndrome, dysentery, conjunctivitis, trachoma, dacryocystitis, hemorrhoids bronchitis, asthma, cough, constipation, tumors, venereal ulcer, renal stones, , leucoderma, and hepatic diseases.

Palladium (PdNPs) is produced in this chapter utilising a biosynthetic technique with *Cassia absus* as a reducing agent. UV-Visible Spectroscopy, Fourier Transformed Infrared Spectroscopy, and scanning electron microscopy are used to characterise the nanoparticles that have been created.

MATERIAL AND METHODS

BIOSYNTHESIS OF NANOPARTICLES

In an Erlenmeyer flask, 50 ml of *Cassia absus* seed aqueous extract was added to 90 ml of (1mM) Palladium acetate solution. At room temperature, the reaction mixture was thoroughly agitated, and the development of a brown colour indicated the synthesis of PdNPs. To separate the colloidal suspension of metal nanoparticles, the solution was centrifuged at 2500 rpm for 15 minutes and rinsed twice with deionized water to eliminate contaminants.

CHARACTERIZATION OF NANOPARTICLES

UV-Visible Spectroscopy (Jasco V670 Spectrophotometer), Fourier Transformed Infrared Spectroscopy (FTIR SHIMADZU), and microscopic techniques such as scanning electron microscopy were used to investigate the biosynthesised metal nanoparticles (SEM ZEISS EVO18).

BIOLOGICAL POTENTIAL OF THE NANOPARTICLES

ANTI-OXIDANT ACTIVITY

The PdNPs' ability to scavenge free radicals was demonstrated using the DPPH radical scavenging assay. Various concentrations of NPs (10-50 g/ml) were combined with 500 l of DPPH solution (0.01 mM) and methanol solution to make up to 3 ml. The mixture was thoroughly mixed and maintained at 28°C for 30 minutes in the dark. A UV-Visible spectrophotometer was used to measure the absorbance of the solutions at 517 nm. As a control, ascorbic acid was employed.

IN VITRO MCF CELL LINE STUDIES

The MCF-7 (Michigan Cancer Foundation-7) breast cancer cell line culture, which is a breast ductal carcinoma, was used in the cell line investigations. Absorbance was examined before the medicine was incubated, and the cells were found to be 100 percent alive. The produced nanoparticles were injected into the cell line at the appropriate timings, and the absorbance and vitality of the cells were evaluated [16-19].

RESULTS AND DISCUSSION

CHARACTERIZATION OF METAL NANOPARTICLES

UV-VISIBLE ANALYSIS

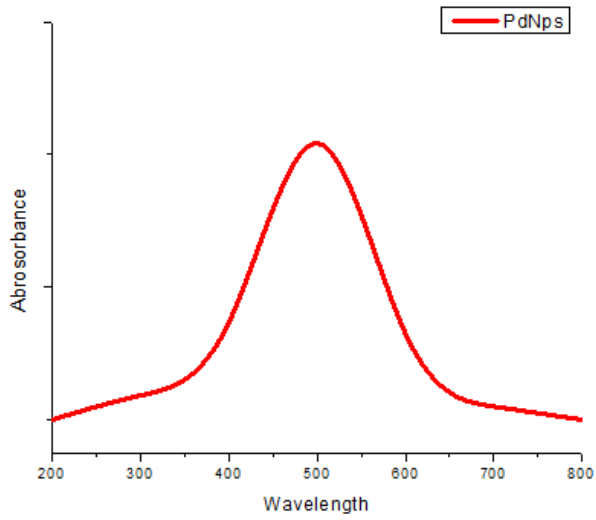

Fig.1. UV-Visible analysis of *Cassia absus* mediated synthesis PdNPs

UV-Visible spectroscopy was used to investigate how *Cassia absus* aqueous extract facilitated PdNP production. After 24 hours of incubation, the solution's colour changed from brownish yellow to dark brown. Surface plasmon resonance (SPR), an intrinsic feature of metal nanoparticles, is responsible for the colour shift in the produced solution. The UV-Vis spectra for the production of PdNPs is shown in Figure 1. Due to its SPR, PdNPs did not show this distinctive peak.In this study no significant peaks appeared after 24 h which revealed the formation $Pd^{(2+)}$ of Pd ions and similar results were reported for the UV vis analysis for PdNPs.

FTIR ANALYSIS

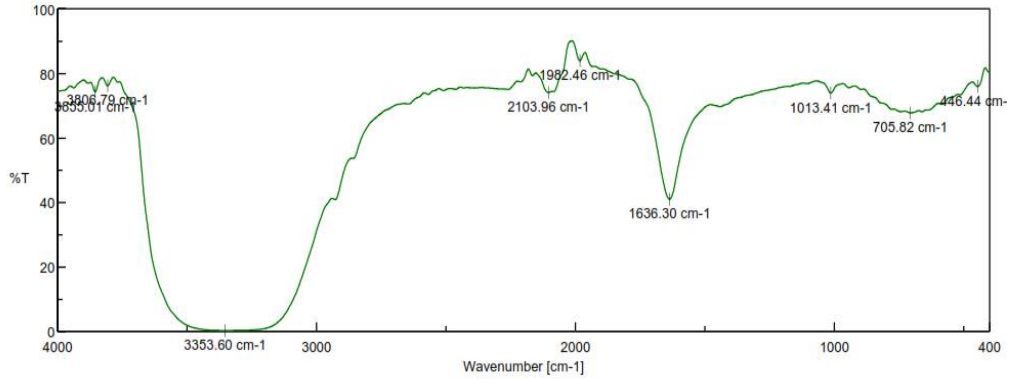

Fig.2 FTIR analysis of *Cassia absus* mediated PdNPs

The *Cassia absus* extract and manufactured PdNPs IR spectra were analysed in order to determine the essential chemicals involved in the bio reduction process. (Fig.2). The spectra of aqueous extract showed intense signals at 3353cm^{-1} (hydroxyl group); 1636 cm^{-1} (amide I band) and 1013 cm^{-1} (polysaccarides). Minor peaks at 2103 cm^{-1} corresponding to alkyl and amide were also observed. The IR spectra of *Cassia absus* assited PdNPs, on the other hand, show a decrease in peak intensity of functional moities such as phenolic compounds, which are involved in the reduction process during PdNP formation. In the absence of any strong ligating agents for the conversion of PdNPs, the fluctuations in peak intensity could be attributed to polyphenlos adsorption on the surface of metallic nanoparticles via the interaction of -electrons.

SEM ANALYSIS

The existence of triangle-shaped particles was revealed by microscopic investigation of *Cassia absus* assisted PdNPs detected by SEM (Fig. 3). The average particle size of the PdNPs was determined from the histogram to be 11.8 nm.

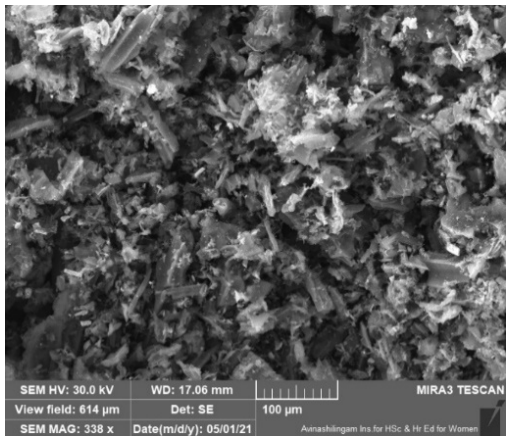

Fig.3. SEM analysis of synthesized pdNPs

ZETA POTENTIAL AND DYNAMIC LIGHT SCATTERING ANALYSIS

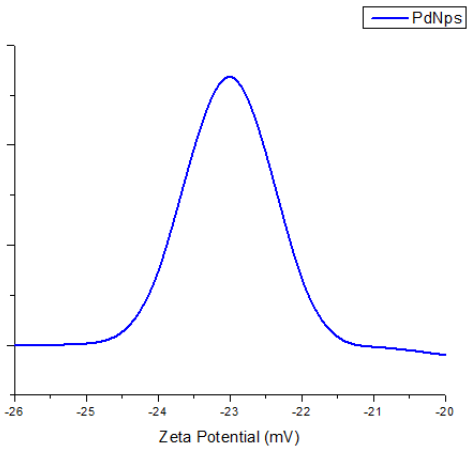

Fig.4. Zeta potential and DLS analysis of *Cassia absus* mediated PdNPs

The zeta potential was used to investigate the stability and surface charge of the produced PdNPs. -23.2 mV was discovered to be the zeta potential (Fig. 4). The discovered zeta potential value ranges from -26 to -20 mV, indicating that the nanoparticles are stable and acceptable for biological applications. PdNPs have a particle size of 12 nm, according to DLS (Fig.6). The particle sizes determined by these various methods are equivalent. *Cassia absus*-mediated biosynthesised PdNPs were clearly nanosized.

BIOLOGICAL APPLICATIONS:
ANTI-OXIDANT ACTIVITY

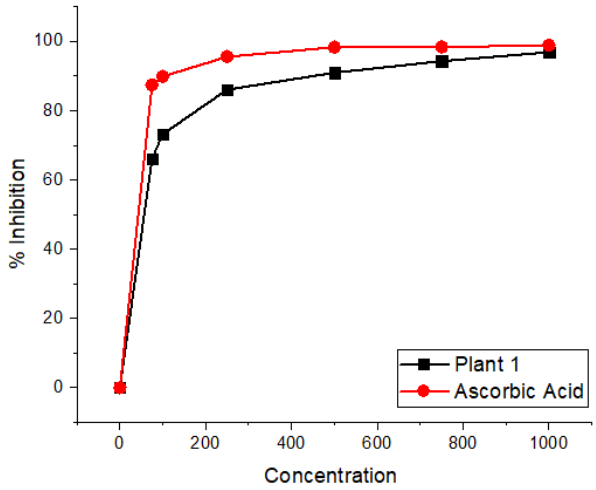

Fig.5. Antioxidant activity of *Cassia absus* mediated PdNPs

DPPH was used to assess the anti-oxidant effects of the NPs generated using *Cassia absus*; that is, an increase in NP concentration leads to an increase in anti-oxidant activities (Fig. 8). The exertion of radical scavenging effects varied significantly among the anti-oxidant assays, according to a comparative analysis. PdNPs' antioxidant activity on DPPH free radicals was investigated in a dose-dependent manner (Fig. 5). At high concentrations of PdNPs (1000 g/ml), maximum radical inhibition (88%) was observed. However, ascorbic acid (standard) showed slightly lesser inhibition effect (89%) at 1000 µg/ml concentration compared to the biogenic PdNPs. Its showed the *Cassia absus*also similar anti-oxidant activity compared to ascorbic acid.

ANTICANCER ACTIVITY

MCF7 cell line studies

MCF-7 (Michigan Cancer Foundation-7) cell line tests were used to culture a breast cancer cell line that is a breast ductal carcinoma. When the absorbance was checked without the drug incubation, the cells were found to be 100 percent viable. The produced nanoparticles were injected into the cell line at appropriate periods, and their absorbance and viability were assessed. The lethal ability of PdNps at various concentrations Figure 6 . At 50 g / ml cells, cells that could survive PdNps effects at lower doses were entirely destroyed.

Fig. 6. Representation of cell morphology at 50 µg concentration of Nanoparticles

CONCLUSION

Cassia absus seed extract was used to make PdNPs. The colour change and UV-Vis spectrophotometery confirmed the production of PdNPs. SEM analysis validated the size distribution of spherical-shaped PdNPs. The zeta potential was used to investigate the stability and surface charge of the produced PdNPs. -23.2 mV was discovered to be the zeta potential. The PdNPs demonstrated considerable anti-oxidant and anti-cancer activity in biological testing. The researchers discovered that *Cassia absus* seed extract is a low-cost and efficient source of PdNPs, and that PdNPs generated from it can be employed as an effective antibacterial agent in biological applications.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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