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Research Article

Biosynthesis and characterization of gold nanoparticle using antiparkinsonian drug *Mucuna pruriens* plant extract

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ABSTRACT

The process of development of reliable and eco-friendly metallic nanoparticles is an important step in the field of nanotechnology. To achieve this use of natural sources like biological systems becomes essential. Parkinson's disease is a degenerative neurological disorder that is prevalent throughout the world. The plant *Mucuna pruriens* has been used as a nerve tonic for nervous system disorders including Parkinsonism. It contains high concentration of L-dopa in the seeds, so that it has been studied for its possible use in Parkinson's disease. In the present, work we have synthesized the gold nanoparticles using the plant extract *Mucuna pruriens* and have achieved rapid formation of gold nanoparticles in a short duration. The nanoparticles were examined using UV-Visible Spectroscopy, FT – IR, Transmission Electron Microscopy (TEM), and X-ray diffraction (XRD) spectrum of the gold nanoparticles analyses. No toxic chemicals are needed for this preparation and also it is stable for several months. This is a good alternate for other methods.

Keywords: Nanoparticle; Parkinson disease; *Mucuna pruriens*; biosynthesis; Transmission Electron microscopy.

INTRODUCTION

Nanotechnology, is the powerful tool for the creation of new objects in nanoscale dimensions, is a cutting edge technology having important applications in modern biomedical research (Parak, 2003; Gao, 2005; Alivisatos ,2004; Salata, 2004). Because of the dimension of nanoscale devices is similar to cellular components such as DNA and proteins (Prescher,2005; Thrall,2004) the tools developed through nanotechnology may be utilized to detect several diseases at the molecular level (El-Sayed , 2005).Conventional synthetic methods of gold nanoparticles have involved a number of chemical methods (Sun,2002; Selvakannan,2002). To avoid toxic, it is necessary to develop clean, nontoxic and environmentally benign synthetic technologies. Microbial resistance against heavy metal ions has been exploited for biological metal recovery via reduction or formation of the metal ions (Stephen,1999) . So the attractive procedure is using plants to synthesize gold nanoparticles recently.

The unique optical, electrical, and photothermal properties of metal nanoparticles such as gold (Au) and silver (Ag) have recognized importance in chemistry, physics, and biology (Li , 2007; Huang,2006), Such nanoparticles have potential applications in the colorimetric detection for proteins and DNA molecules (Lee, 2008). Furthermore, Au nanoparticles have photothermal properties that can be exploited for localized heating resulting in drug release, thus, increasing their potential for therapeutic applications (Pissuwan, 2006).Gold nanoparticles with various morphologies have been routinely synthesized by chemical and physical methods. However, these methods usually involve more elaborate processing steps and many sophisticated apparatus, and easily cause environmental pollution due to the toxic reagents used. Biosynthesis of nanoparticles by using plant extract and microorganisms is currently considered as an eco-friendly and exciting approach (Shankar,2004; Ahmad,2003). Parkinson's disease (PD) is the most common disease of motor system degeneration and this is the second most common neurodegenerative disease affecting about 4 million people worldwide (Saunders, 2003). The plant *M. pruriens* has been used as a nerve tonic for nervous system disorders. Because of the high concentration of L-dopa in the seeds, it has been studied for its possible use in Parkinson's disease. Numerous in vivo studies also have been conducted in rats and humans (Vaidya,1978) **.** In this report, *Mucuna pruriens*, a medicinal plant which is used for antiparkinsonian drug, has been shown effective in the reduction of Au (III) to Au (0) and extracellular synthesis of nanoparticles. *M. pruriens* seed extract found to successfully produce gold nanoparticles of different sizes and shapes.

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MATERIALS AND METHODS

Chemicals

All the experiments were conducted at room temperature. Material used for the synthesis of gold nanoparticles are chloroauric acid ($HAuCl_4$) (Loba Chemicals).

Preparation of extract

M. pruriens seeds were used (purchased from recognized medical shop). Deionised, Double Distilled Water was used. *M. pruriens* seeds cleaned thoroughly in fresh water followed by distilled water and then shade dried for 3–5 days. Dried seeds were ground to powder. The methanolic extract was prepared by Soxhlet apparatus. The extract was kept in deep freezer until use.

Formation of gold nanoparticle

1 mM solution of 100ml Chloroauric acid (0.034 g) at concentration of 10^{-3} M was prepared by dissolving DDW (100ml), kept in a 250 m L Erlenmeyer flask. 100ml of *M. pruriens* (0.060 g) supernatant was added to the chloroauric acid solution. The 95% of the bioreduction of $AuCl_4$ − ions occurred within 10min. The yellow colored solution which it turned purple red slowly, indicating the formation of gold nanoparticles.

Instruments

The UV–visible spectra of gold nanoparticles synthesized were measured on a Shimadzu spectrophotometer (model UV- 1601) operated at a resolution of 1 nm.

Samples for high resolution transmission electron microscopic (HR-TEM) analysis were prepared by drop coating Au nanoparticles solutions onto carbon coated copper TEM grids. The films on the TEM grids were allowed to stand for 2 min following which the extra solution was removed using a blotting paper and the grid is allowed to dry, prior to the measurement. HR-TEM measurements were performed on a JEOL TEMSCAN2000EX instrument operated at an accelerating voltage at 80keV.

X-ray diffraction (XRD) measurement of the *Mucuna pruriens* gold nanoparticles was carried out on films of the respective solutions drop coated onto glass substrates on a Rich Seifert P3000 instrument operating at a voltage of 40 kV and a current of 30mA with Cu Kα1 radiations.

The Fourier transform infrared (FTIR) spectroscopy measurements were carried out to identify the biomolecules for synthesis of silver nanoparticles. Dry powders of the extract and gold nanoparticles solutions were centrifuged at 5000 rpm for 15 min and resulting suspensions was redispersed in sterile distilled water. The purified pellets were dried and analyzed by Thermo Nicolet Avator 300 instrument in the diffuse reflectance mode at a resolution of 4cm $^{-1}$ in KBr pellets.

RESULTS AND DISCUSSIONS

The biosynthesis of gold nanoparticle from the antiparkinsonian medicinal plant *M. pruriens* was carried out in this work. The addition of seed extract to 10^{-3} M aqueous $HAuCl_4$ resulted in the color change to pink-ruby red after 10min of reaction due to the production of gold nanoparticles. These color changes arise because of the excitation of surface plasmon vibrations with the gold nanoparticles (Mulvaney, 1996) .

UV visible spectrophotometer

Fig.1. shows UV-visible spectrum of nanoparticle measured at the time of reaction of *M. pruriens* seed extract. The UV visible light absorption pattern of *M. pruriens* was kinetically monitored in the range of 300–800 nm. UV–visible spectra were recorded from the aqueous chloroauric acid and *M. pruriens* seed extract reaction medium. In the case of gold ions reduction, the bands corresponding to the surface plasmon resonance (SPR) occurred at 537 nm . The surface plasmon resonance (SPR) band of gold occurs initially at ca. 537 nm after 5min. This increases in intensity as a function of time of reaction. It is observed that the gold SPR band is centered at about 537 nm. The plasmon bands of nano-Au are broad with an absorption tail in the longer wavelength that extends well into the near infrared region attributing the excitation of the in-plane SPR and indicates significant anisotropy in the shape of gold nanoparticle.

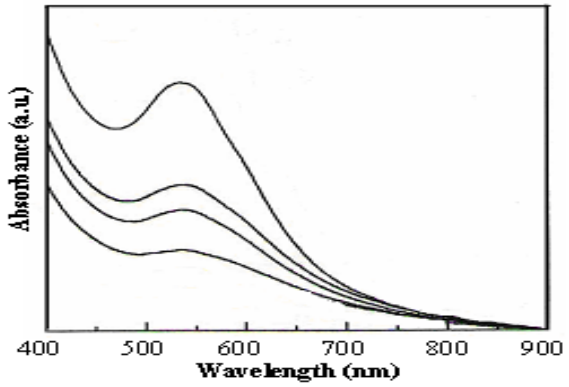

Figure 1: UV-vis spectrum of gold nanoparticle measured at the time of reaction of Mucuna pruriens seed extract with aqueous solution of 10^{-3} mol/L $HAuCl_4$

TEM images

Figure 2 a, b show the TEM images of the gold nanoparticles formed predominantly monodisperse with diameter ranging from 6 to 17.7 nm. Various magnifications of TEM images of gold nanoparticles is noted that the particles are of uniformed size ca. around 12.5 nm. TEM analysis revealed that the synthesized nanoparticles are stable in solution over a period of one month at room temperature.

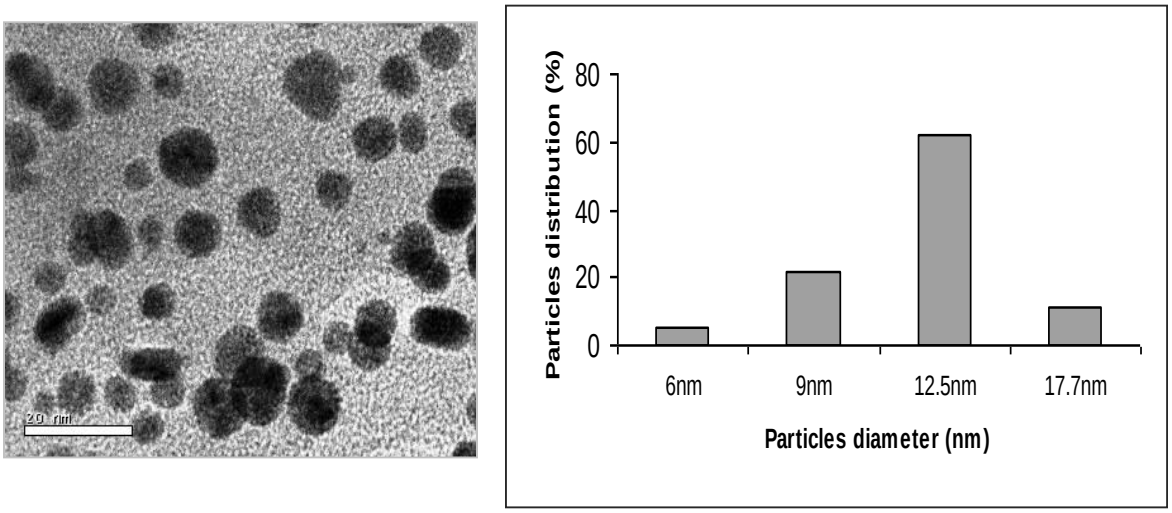

Figure 2: a, b Show the TEM images of gold nanoparticles by Mucuna pruriens seed extract

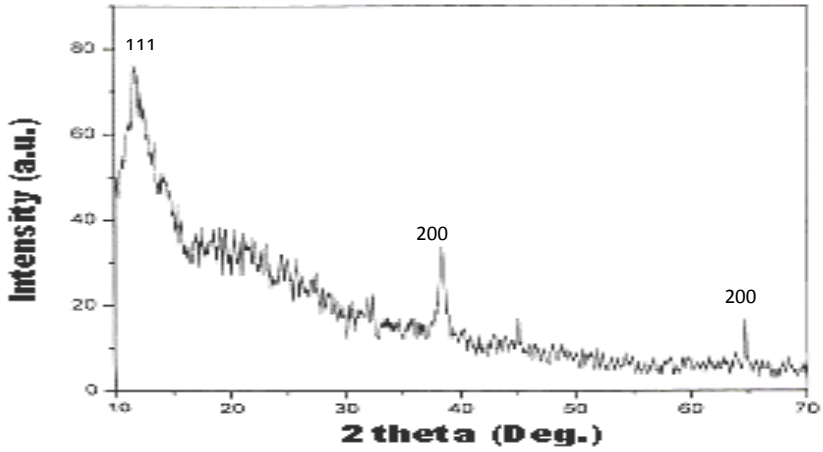

Figure 3: shows XRD spectrum of gold nanoparticles synthesized by Mucuna pruriens seed extract

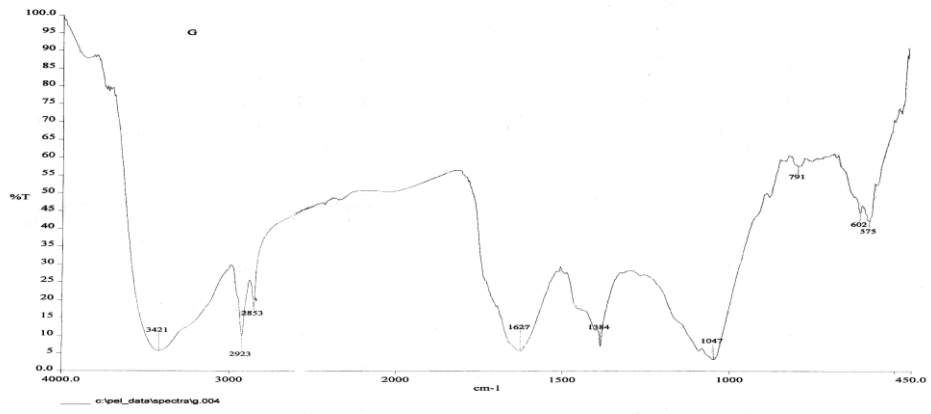

Figure 4: Shows FT-IR spectrum of gold nanoparticles synthesized by reacting $HAuCl_4$ with Mucuna pruriens seed extract

XRD results

XRD pattern obtained has been represented in Fig. 3. X-ray diffraction study was used to confirm the crystalline nature of the particle . The XRD patterns thus clearly show that the gold nanoparticles formed by the bioreduction of *M. pruriens* seed extract. The XRD analysis showed intense peaks corresponding to (111), (200) and (220) Bragg's reflection based on the fcc structure of gold nanoparticles. The broadening of Bragg's peaks indicates the formation of nanoparticle. The size of the nanoparticles was thus determined to be about 12.5 nm for gold nanoparticles. The mean

size of gold nanoparticles was calculated using the Debye–Scherrer's equation by determining the width of the (111) Bragg reflection (Borchert, 2005).

FT-IR analysis

Fig. 4 shows the FTIR spectrum recorded from the chloroauric acid solution after reaction with *M. pruriens* seed extract . FT-IR analysis revealed the strong bands at 1627, 1384 and 1047 cm−1. The band at 1627cm^{-1} corresponds to C=O stretching vibrations. The band at 1384 cm^{-1} corresponds to C=C stretching of aromatic amine group and 1047 cm−1 is characteristic of C-N. The weaker band at 1047 cm^{-1} arisen due to carbonyl stretch in proteins. These bands may be assigned to the amide I and II bands of proteins, respectively. It is well known that proteins can bind to gold nanoparticles either through free amine groups or cysteine residues in the proteins (Gole,2001) and therefore, stabilization of the gold nanoparticles by surface-bound proteins is a possibility. We believe that one or more of these proteins may be enzymes that reduce chloroaurate ions and cap the gold nanoparticles formed by the reduction process. It is also possible that the capping and stabilization of the gold nanoparticles is effected by a different protein.

In the present investigation, a green chemistry approach based biosynthesis of gold nanoparticles by *Mucuna* seed extract was demonstrated.

CONCLUSIONS

In conclusion, we proposed an ecofriendly method for gold nanoparticle synthesis using plant extracts. The proposed method requires only a few minutes for >90% conversion by using *M. pruriens* seed extract, the reaction rate thus obtained was higher or comparable to the rate of gold nanoparticle synthesis by chemical methods. This environmentally friendly method of biological gold nanoparticle synthesis can potentially useful in many applications including medicine. We , the authors proudly say that this the first report to synthesis the gold nanoparticle from the antiparkinsonian medicinal plant *M. pruriens* seed.

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