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Research Article

BIOLOGICAL SYNTHESIS AND CHARACTERIZATION OF GOLD NANOPARTICLES USING *LEMNA MINOR*

K. SARITHA[1], U.SARASWATHI[2*], G. SINGARAVELU[3], S.REVATHI[2], V.JAYANTHI[2]

[1]PG and Research Department of Biochemistry, K.M.G. College of Arts and Science, Gudiyattam, TamilNadu, India, [2] Department of Biochemistry, PSG College of Arts & Science, Coimbatore, TamilNadu, India, [3] Department of Zoology, Thiruvalluvar University, Serkadu, Vellore, TamilNadu, India. Email: sarasbiochem@yahoo.co.in

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ABSTRACT

Bio molecular synthesis of metal nanoparticles is an intensifying research area due to its impending applications for the development of advanced novel technologies which includes therapeutic and diagnostic devices.

Objective: The present study was aimed on the synthesis and characterization of gold nanoparticles using *Lemna minor*.

Methods: Gold nanoparticles were synthesized using auric chloride and were characterized by UV, XRD, SEM and TEM analysis.

Results: UV spectrum exhibited an absorption peak at 526 nm. X-ray diffraction pattern displayed typical peak of crystalline gold at (111), (200) and (220). The transmission electron microscopy results indicate that the gold nanoparticles were spherical in nature.

Conclusion: Environment friendly gold nanoparticles were synthesized by green chemistry using *Lemna minor* and was characterized by spectroscopy and microscopy

Keywords: *Lemna minor,* gold nanoparticles, Auric chloride.

INTRODUCTION

Nano science is one of the most promising areas of research in properties based on physico-chemical nature than larger particles of the bulk materials from which the nanoparticles are made. The surface to volume ratio of nanoparticles is inversely proportional to their size. The biological effectiveness of nanoparticles can increase proportionately with an increase in the surface area due to the increase in their surface energy and catalytic reactivity. Although there are many routes available for the synthesis of nanoparticles, there is an increasing need to develop high-yield, low cost, non-toxic, biocompatible and environmentally benign procedures. Hence, the biological approach for the synthesis of nanoparticles becomes imperative. Biological molecules have qualities by which they can undergo highly controlled and hierarchical assembly, which makes them suitable for the development of a reliable and eco – friendly process for metal nanoparticle synthesis. Their emerging applications in various fields like biosensors, bioremediation of radioactive wastes, functional electrical coating, synthesis of enzyme electrodes and particularly in medicine such as delivery of antigen for vaccination, gene delivery for treatment or prevention of genetic disorder, inspired the scientists to develop environmentally benign technologies for the synthesis of gold nanoparticles and to avoid use of hazardous chemicals, which are in use. Synthesis methods using biological resources, both unicellular and multicellular like yeast, fungi and bacteria come into the practice, which are able to synthesize inorganic materials either extracellularly or intracellularly. The results addressed herein disclose the synthesis of gold nanoparticles by the reduction of aqueous Au^{3+ions} with the aqueous extract of *Lemna minor.* The approach established appears to be cost efficient alternative to conventional methods and completely biogenic method of synthesis of gold nanoparticles.

MATERIALS AND METHODS

Chemicals and plant material

The leaves of *Lemna minor* were collected from Vellore, Tamilnadu, India. *Lemna minor* leaves were washed with deionized water and then shade dried, powdered using electronic blender. The dried coarse powder of *Lemna minor* was extracted using deionized water. Auric Chloride ($HAuCl_4$) was obtained from Loba Chem.

Synthesis of gold nanoparticles

1mM solution of 100ml Auric Chloride at a concentration of 10^{-3}M was prepared by dissolving it in double distilled water. Different reaction concentrations of *Lemna minor* extract and $HAuCl_4$ solution (49:1, 48:2, 47:3, 46:4, and 45:5) was subjected respectively. The reduction of gold ions to gold nanoparticles was completed within 1 hour. The formation of the ruby red coloured solution indicates the formation of gold nanoparticles.

Characterization of gold nanoparticles

Aliquots of the reaction solution were measured using UV-2300 TECHCOMP spectrophotometer containing double beam in identifying compartments, each for reference and test solution fitted with 1 cm path length quartz cuvettes. For FTIR measurements, the newly synthesized gold nanoparticles were centrifuged at 8000 rpm for 10 minutes and the obtained pellet was washed with deionized water. A purified pellet was dried and smirks with KBr pellets and analyzed by Thermo Nicolet Qatar instrument in the diffuse reflectance mode operating at the resolution of 4 cm^{-1}. X-ray diffraction of bio reduced gold nanoparticles carried out using Siefert X-ray diffractometer, operated at a voltage of 40Kv and tube current of 30 mA with Cu – Kα, radiation. For TEM studies newly synthesized gold nanoparticles were prepared by placing a drop of nanoparticle solution on carbon coated copper grids and allowing water to evaporate. The observations of TEM were performed on a JEOL 3010 operated on accelerating voltage of 120 KV. The surface morphology of newly formed gold nanoparticles was determined using Scanning Electron Microscope (FEI Quanta 200 SEM).

RESULTS

Generation of nanomaterial with unique physico-chemical and optoelectronic features is a corner stone in Nano science. The present report discloses ethno pharmacologically important of *Lemna minor* extract bio reduction property of gold ions into gold

nanoparticles. The synthesis of gold nanoparticles has been achieved in 1 hour reaction of 1 ml aqueous extract of Lemna minor extract with 49 ml of 10^{-3} M auric chloride solution. The change of colour was noted in different time intervals. The solution was subjected to UV-vis spectral analysis. Fig.1 shows band at 526 nm, which confirms the formation of a gold nanoparticles.

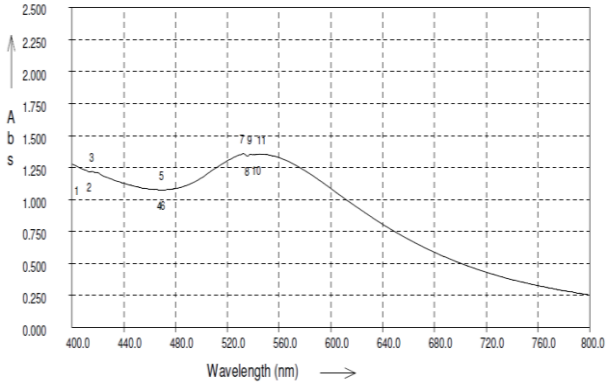

Fig.1: UV–Vis spectra of gold nanoparticles synthesized using *Lemna minor*

In fig-2, the crystalline nature of the gold nanoparticles was confirmed and the characteristic XRD peaks at 2θ of 38.29º, 44.46º, 64.71º are indexed to the (111), (200) and (220), crystallographic planes of the gold nanoparticles respectively.

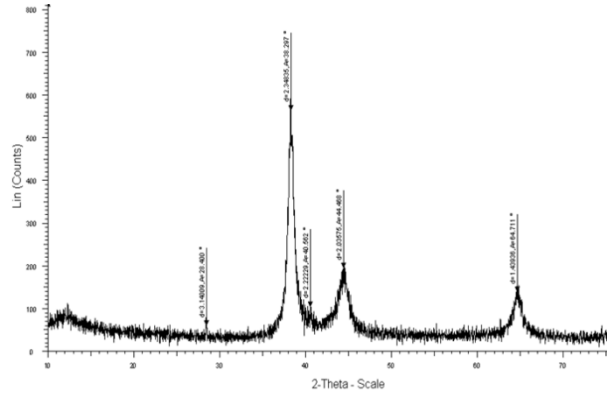

Fig.2: XRD pattern of gold nanoparticles synthesized using aqueous extract of *Lemna minor*

Scanning Electron Microscopy (SEM) was used to investigate the morphology and size of the newly synthesized gold nanoparticles. The image showed the presence of spherical, triangular and hexagonal nanoparticles (Fig.3).

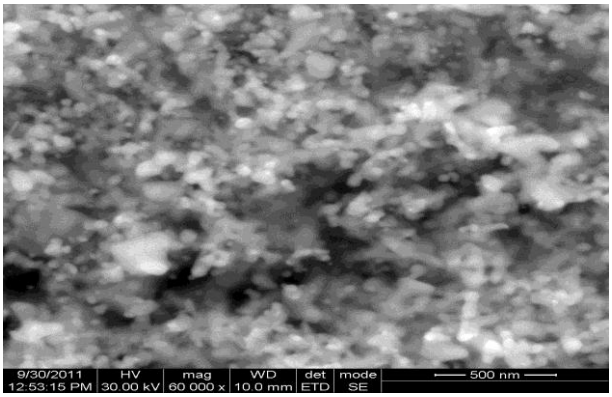

Fig.3: SEM image of gold nanoparticles synthesized using aqueous extract of *Lemna minor.*

The size and shape of the particles were determined by TEM. The gold nanoparticles synthesized using *Lemna minor,* are well dispersed with spherical, triangular and hexagonal in shape. The nanoparticles size in diameter ranging from 11 to 52 mm.

Fourier Transform Infrared (FTIR) was made in order to identify the possible biomolecules responsible for the reduction of the gold ions capping of the bio reduced gold nanoparticles

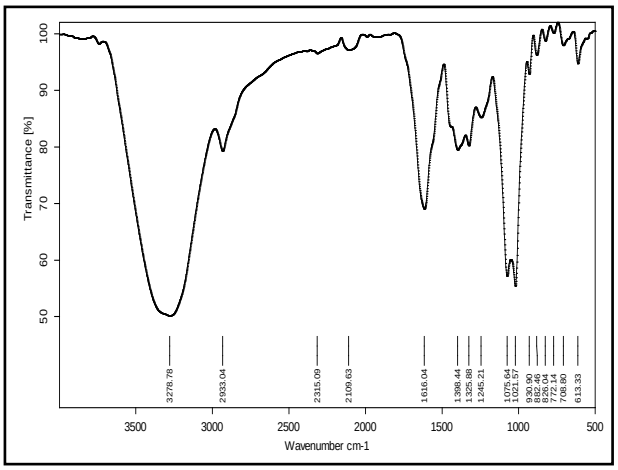

Fig.4: FTIR absorption spectrum of (a) aqueous extract of *Lemna minor*

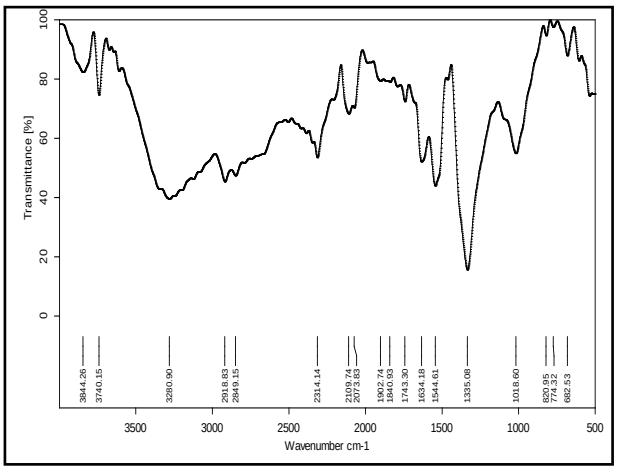

Fig. 4(b): Gold nanoparticles synthesized using aqueous extract of *Lemna minor.*

The FTIR spectrum of the aqueous extract of *Lemna minor* extract (Fig 4a) showed peaks at 3278 (O–H stretch, H–bonded of alcohols/phenols), 2933 (-C-H, alkenes), 2109 (–C (triple bond) C–stretch of alkynes), 1616 (N-H, amines), 1075 C=O stretch of carboxylic acids). The FTIR spectrum of the gold nanoparticles (Fig 4b) showed peaks at 3280 (O–H stretch, H–bonded of alcohols/phenols), 2933 (-C-H, alkenes), 1634 (N-H, amines), 1335 (C–N stretching vibration of aliphatic amines). Comparing both FT-IR spectra it can be identified that the changes C-H alkenes group shitted higher wavelength to lower wavelength which is responsible for the reduction of the gold ions to gold nanoparticles. Amines and the C-O carboxylic acid group's are also responsible for the reduction and capping of the nanoparticles.

DISCUSSION

Over the past few decades, inorganic nanoparticles, whose structures exhibit significantly novel and distinct physical, chemical and biological properties and functionality due to their nano scale size, have elicited much interest. Nanostructure materials are attracting a great deal of attention because of their potential for achieving specific processes and selectivity, especially in biological and biomedical applications [1][2] [3][4] [5] [6]. On the nano scale,

the physical, chemical, and biological functionalization of materials differs fundamentally and often unexpectedly from their corresponding counterpart because of the quantum size effect.

Discoveries in the past decade have demonstrated that the electromagnetic, optical and catalytic properties of noble-metal Nano crystals are strongly influenced by the shape and size [7][8]. This has motivated an upsurge in research on the synthesis routes that allow better control of shape and size for various nano technological applications. In medicine, nanotechnology has been explored for early detection, diagnosis and treatment of diseases [9][10][11][12]. Nanoparticles are the building blocks of nanotechnology. Although physico -chemical characteristics of nanoparticles are well studied, their biological characteristics largely remain unexplored.

Targeted delivery of therapeutic agents to disease sites is one of most challenging research areas in pharmaceutical sciences. Nanoparticles – based drug – delivery systems provide an advantage over free drugs, improving delivery efficiency, solubility, *in vivo* stability and bio distribution[13][14]. Therapeutics based on nanoparticles has been successfully introduced for the treatment of several pathological conditions, including cancer, pain and infectious disease. The unique properties of noble metal nanoparticles make these nanoparticles very promising as drug carriers and this area of noble metal nanoparticles applications is a rapidly expanding field.

In the present study, gold particles were synthesized using *Lemna mino*r and were characterized by UV-VIS spectroscopy. The broadening of the peak in the UV- spectrum revealed the reduction of gold ions and the formation of stable nanoparticles. The synthesized nanoparticles were spherical, triangular and hexagonal in shape. The XRD analysis revealed the crystalline nature of gold nanoparticles. The size of the nanoparticles (11 to 52mm) was determined by SEM image. FTIR analysis proved that the amines and the C-O are responsible for the bio reduction of gold ions.

CONCLUSION

In conclusion gold nanoparticles were synthesized using *Lemna mino*r. Bio reduction property of gold ions into gold nanoparticles was studied by UV-Vis spectra, FTIR, TEM and SEM.

CONFLICT OF INTEREST

Conflict of interest declared none.

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