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Biological Synthesis of Gold Nanowires by *Pseudomonas aeruginosa*

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The present and fast-growing demands of the synthesis of nanoparticles with various areas such as medicine and energy, catalysis, electronics and chemistry increased day to day. In the past decade, nanoparticles are prepared from wet chemical method, where chemicals used are quiet flammable and often toxic. In this report, we are going to synthesize gold nanowires from bacterium Pseudomonas aeruginosa. Gold nanowires were synthesized through the reduction of aqueous Au3+ ion using the growth culture supernatants. Gold nanowires were formed within 1 h of gold ion coming in contact with the cell filtrate. The synthesized gold nanowires were characterized from TEM, UV-Vis and DLS. An absorption peak at 550 nm in Uv–Vis spectrophotometer was detected indicating the presence of gold nanowires. The DLS analysis showed gold nanowires with size of 90±15 nm.

Keywords: gold, Nanowires, *Pseudomonas aeruginosa*.

In modern sciences, the field of nanotechnology is one of the most active area of research which suddenly bring brigh through amongs all sciences. Then field of nanoparticles exhabits completely a new and improved properties based which comes with totally new characteristics such as morphology and distribution and size. Here the question arises why we reduce the size of a material and why we are interested to study small size materials[1, 2]. The excellent biocompatibility of GNPs is due to the ease of conjugation to various biomolecules, i.e. peptides, proteins, enzymes, aptamers and antibodies[3]. Biomolecules secreted by bacteria are involved in the synthesis of GNPs, and they play a role as capping agents absorbed on the surfaces of GNPs[4]. GNPs have many biomedical applications, such as detectors of disease biomarkers, immunosensors, diagnostic imaging agents, drug or gene delivery vectors, and side-directed biosensors in the photothermal destruction of tumors[5, 6]. Moreover, in biomedical applications of GNPs, their physicochemical and optical properties with regard to surface plasmon light absorption and scattering are important; these properties depend on the GNP's size and shape[7, 8]. Thus, providing for the controlled biosynthesis of GNPs of proper size and shape is of great importance for such applications. For synthesis of gold NPs, a number of synthesis approaches are available for example photochemical and chemical reactions[4], gold NPs thermal decomposition[5], reduction in solution[6], electrochemical[7], sonochemical[8], microwave assisted process[9] and recently via green synthesis

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[10]. gold NPs attracted much attention in in the field of medicine and biology due to its fascinating physicochemical properties. It has been known that gold product has bacterial and strong inhibitory effects as well as broad spectrum of antimicrobial activity which is used to treat and prevent many diseases notably infections[11]. However, the reported gold NPs possess antiflammatory[12], and antifungal [13, 14].

However, the biological synthesis of gold nanowires using microorganism has been seldom reported. This study demonstrated the extracellular synthesis of stable gold nanowires.

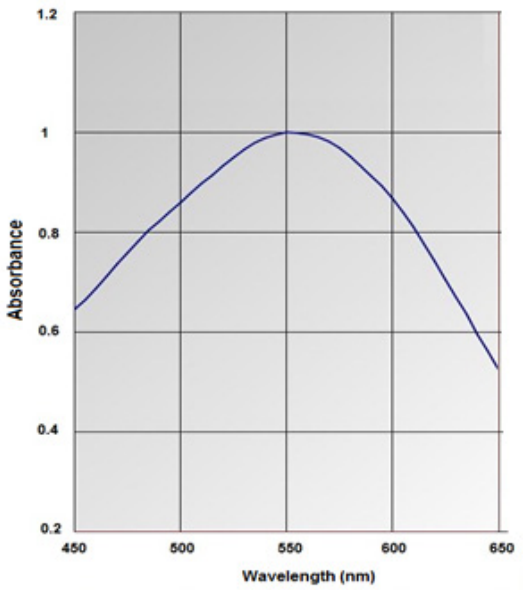

Fig. 1. UV–Visible spectrum of gold nanowires

EXPERIMENTAL

The mixed culture of Pseudomonas aeruginosa was cultured in a medium containing pyruvate, yeast extract, NaCl, NH_4Cl, and K_2HPO_4 at pH 7 and 30 °C. After 72 h of fermentation, the cells were separated from the culture broth by centrifugation (8000 rpm) at 15 °C for 30 min and washed three times with deionized water to obtain about 1 g wet weight of cells. The harvested cells were then resuspended in 10 mL of deionized water for 15 days. The cells were then removed by centrifugation, and the aqueous supernatant obtained was cell-free extract (CFE). The CFE solution thus prepared was a light yellow liquid and was used for the reduction of $HAuCl_4$. To test tubes containing 10 mL of CFE solution was added 50-100 mL of 0.001 M aqueous HAuCl4 solution. All experiments were conducted at 30 °C and pH 6 for 48 h, during which time reduction of Au^{3+} in all of the reaction mixtures had occurred. The reduction of the Au^{3+} ions in the solutions was monitored by sampling the aqueous component and measuring the UV–Vis spectrum of solutions. Particle-size distributions of the samples were also obtained using dynamic light scattering (DLS). Furthermore, the gold nanoparticles were characterized by transmission electron microscopy (TEM).

RESULTS AND DISCUSSIONS

One of the useful techniques for structural characterization and stability of the gold NPs in

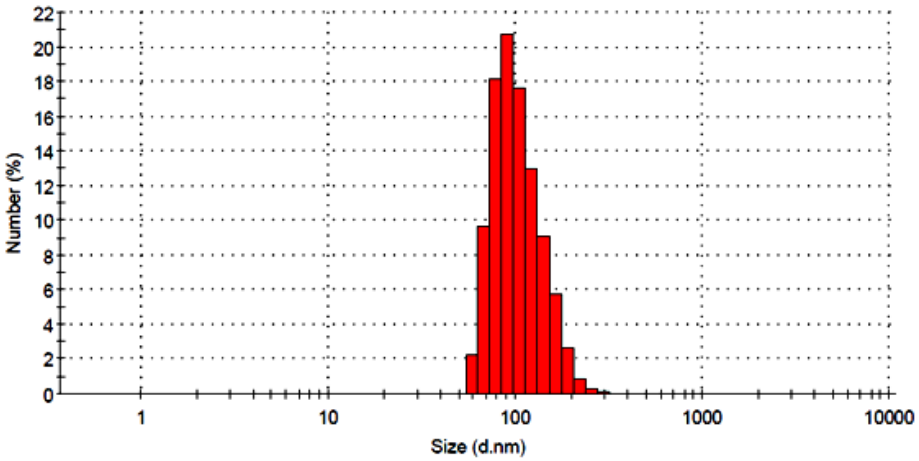

Fig. 2. A particle size distribution histogram of gold nanowires

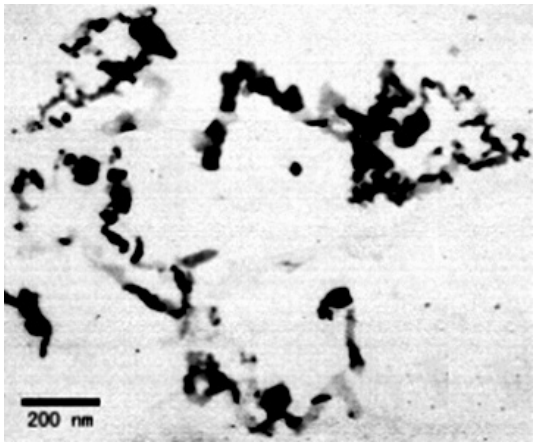

Fig. 3. TEM micrograph of gold nanowires

the aqueous solution is UV-Vis spectroscopy. It is well known that gold can be reduced from Au3+ to Au0 by a cell-free extract (CFE) of Pseudomonas aeruginosa. The appearances of the peaks indicate the characteristics of surface plasmon resonance of nano gold particles. Fig (1) indicates the UV-Vis spectra recorded from aqueous solution of gold ions. The absorption band at about 550 nm is known to be due to surface plasmon resonance in nano-gold solutions.

Dynamic light scattering is a used method for the determination of nanoparticle size. The gold particles' size histograms show that the nanoparticles size is 90±15 nm (Fig. 2). The shape and morphology of the synthesized gold nanowires were elucidated with the help of transmission electron microscopy (TEM) further confirming the formation of gold nanowires (Fig. 3).

CONCLUSIONS

In the field of nanotechnology, an urgent need to the development of ecofriendly and reliable process for the synthesis of metallic nanoparticles. We demonstrated that, the low cost, natural biological reduction of pseudomonas aeruginosa produce metal nanostructures with an efficient green protocol which avoids toxic and hazardous waste and solvents presence. This study showed an economical, simple and rapid route to synthesize gold nanowires.

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