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Ecofriendly Synthesis of Gold Nanoparticles using Fresh Water Spirogyra sp. algae and its Antioxidant Study

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ABSTRACT

In the present study, simple, low cost and ecofriendly method is described for the synthesis of gold nanoparticles (GNPs) using fresh water Spirogyra sp. algae. The formations of gold nanoparticles were characterized by the peak obtained at 535.0 nm in UV- spectroscopy and further confirmed by Scanning electron microscope (SEM) analysis of size range from 40-50 nm. Then antioxidant study was carried out using ascorbic acid as standard and free radical scavenging activity of the GNPs was determined with hydrogen peroxide.

Keywords : Ecofriendly Synthesis, Gold Nanoparticles, Spirogyra Sp. Algae, Antioxidant Study.

I. INTRODUCTION

Gold nanoparticles have unique optoelectronic properties when compare to the bulk materials, molecules and atoms [1]. They have huge application in the fields of cancer therapy[2], diagnosis[3], biomedical imaging[4], biological and chemical sensors [5]. Synthesis of gold nanoparticles are most commonly carried out by chemical reduction methods in which reducing agents such as tri sodium citrate and sodium borohydride used to prepare gold nanoparticles by reducing Chloroauricacid (HAuCl4)[6,7]. These kinds of preparation methods are high cost, harmful and required high temperature. So that researchers found that green methods to prepare gold nanoparticles using plants extract [8], microbes [9], enzymes [10] etc. But the literature survey showed that limited works have been carried out using algae extracts for the synthesis of gold nanoparticles [11].

Algae are generally known as “aquatic plant” and classified into different categories based on presence of different pigments. Chlorophyta or Charophyta (green algae) occurs in fresh water, consists of 7000 species which contains chlorophyll pigment. Algae are multicellular plant like organism which contains different pigments to trap sunlight and convert the light into carbohydrate by photosynthesis process. They are found in fresh water as well as salt water and also in moist soil, on rocks. They are lacks of true root, leaves and stem. They are also called as “bionanofactories” because of its application in both live and dead dried condition of biomass for the synthesis of nanoparticles. It has major advantages compare to other biological sources due to its high capacity of metal uptake.

This investigation reported that ecofriendly fabrication of gold nanoparticles using Spirogyra sp. aqueous extract by controlling time and temperature. The synthesized GNPs was characterized by UV-Visible spectrophotometer and morphology structure was characterized by scanning electron microscopy (SEM). The antioxidant study was done by using ascorbic acid as standard.

II. METHODS AND MATERIAL

A. Chemicals

Analytical chemical of Chloroauric acid and deionised water are used for the synthesis of gold nanoparticles. Hydrogen peroxide solution is used for the antioxidant study. The chemicals were obtained from Loba chemical Pvt limited (Chennai, T. N, India).

B. Collection of algae:

The Fresh water green algae were collected from the wells of Kanchipuram District located in Tamil Nadu, India. The Samples were collected in sterile plastic bags and taken to the laboratory under normal live condition. The samples were initially rinsed thoroughly with fresh water to remove epiphytes, necrotic parts and dust particles attached to it and finally washed with distilled water. The water was removed by using filter paper. The algal species were identified based on their morphological characters under microscopic image. The algae were dried for three weeks to remove moisture content and stored for further process.

C. Preparation of algae extract:

5 gms of the dried algae (Spirogyra sp.) was weighed and grounded into powder form with the help of blender. Then 50mL of double distilled water was added to the powdered algae and boiled at 70- 80oC for 15- 20 minutes to extract crude solution. After boiling, the crude solution was filtered using Whatman filter paper No.1 and stored under the frozen condition for the further investigation.

D. Ecofriendly synthesis of gold nanoparticles:

The Chloroauricacid solution was prepared by dissolving 1mg of HAuCl4 into 100mL of deionised water. 10mL of algae extract was added to 90mL of 1mM Chloroauric solution by continuous stirring and the mixture was kept under the room temperature for 24 hours. A colour change from yellowish green to purplish red was observed which indicates the bio reduction of gold ions to nanoparticles. The colour change of the solution was observed under the UV-Visible spectrometer (Shimadzu UV-1700 model) at wavelength range from 400 to 800 nm.

E. Purification and characterization of synthesized gold nanoparticles:

The bio reduced solution containing gold nanoparticles were centrifuged at 2000 rpm for 20minutes. After centrifugation, the pellet were obtained and dried at hot plate. The powdered form of gold nanoparticles were collected and analysed under the Scanning electron microscopy (SEM) (JEOL JSM-5600LV instrument with operation of 25kV).

F. Hydrogen peroxide scavenging activity:

The Dehpour method was used to determine the scavenging action of the alage mediated synthesised gold nanoparticles towards Hydrogen peroxide using standard ascorbic acid. The solution of hydrogen peroxide (40mM) was prepared in phosphate buffer (pH=7.4). The gold nanoparticles of different concentration were taken in test tubes. The hydrogen peroxide prepared with phosphate buffer solution was added to it and incubate for 10 minutes. The absorbance was measured at 560 nm using UV spectrophotometer against blank solution containing phosphate buffer without hydrogen peroxide. The percentage of hydrogen peroxide scavenging activity of the nano materials was calculated by using the formula:

$$\% \text{ Scavenging} = \frac{\text{Absorbance Control} - \text{Absorbance Sample}}{\text{Absorbance Control}} \times 100$$

described.

III. RESULTS AND DISCUSSION

UV- Visible spectrophotometer analysis:

The bio-reduction of gold ions into gold nanoparticles was visually observed by colour change from greenish brown to purplish red. Further incubation of solution mixture shows red wine colour due to oscillation of free electrons in solution mixture. The algae mediated formation of gold nanoparticles was confirmed by UV- Visible spectrophotometer analysis at the range of 400 to 800 nm. The surface Plasmon resonance band for synthesized gold nanoparticles were positioned at 535 nm.(Fig.1)

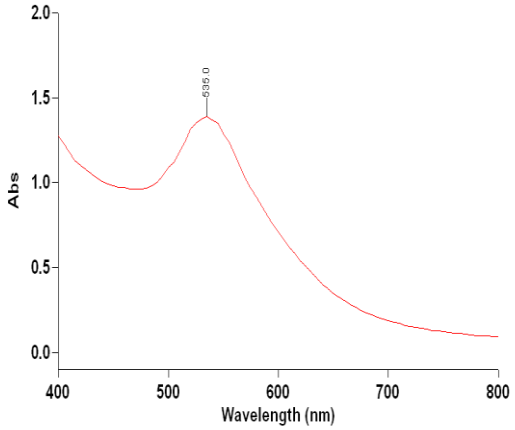

Figure 1: UV-Visible spectra of synthesised gold nano particles

Scanning electron microscopy (SEM) Analysis:

The SEM image of the synthesized gold nanoparticles showed a morphology structure is spherical in shape and its diameter is in the range of 40-50 nm in size.(Fig.2)

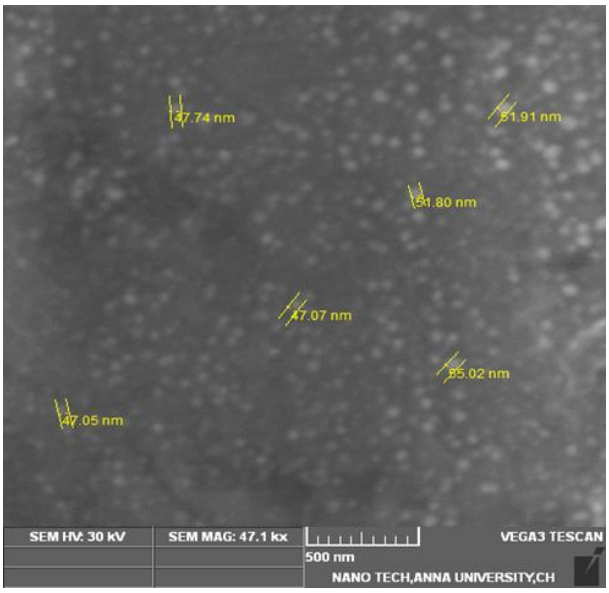

Figure 2 : SEM images of synthesised gold nanoparticles

Hydrogen peroxide scavenging activity:

Hydrogen peroxide (H_2O_2) is an oxidizing agent and can inactivate a few enzymes directly, usually by oxidation of essential thiol (-SH) groups. It can cross cell membrane rapidly and inside the cell. H_2O_2 probably reacts with Fe^{2+} and possibly Cu^{2+} ions to form hydroxyl radical which may be the origin of many of its toxic effects. It is therefore biologically advantageous for cells to control the amount of hydrogen peroxide that is allowed to accumulate. The scavenging activity of the "green synthesised gold nanoparticles " is shown in Fig.3 which increases in scavenging activity according to the concentration increases. Ascorbic acid was used as the positive control. It showed that the synthesised gold nanoparticles was acting as good free radical scavenger according to their concentration.

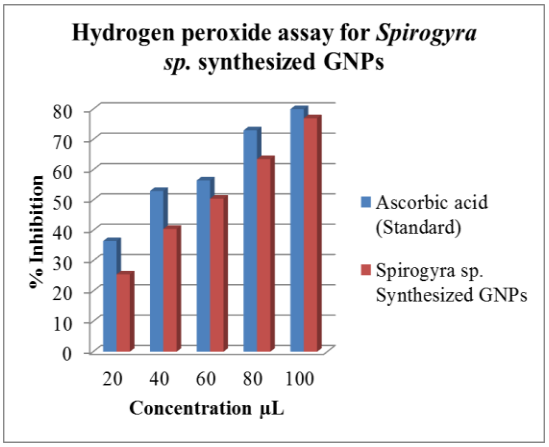

Figure 3. Antioxidant study of synthesised GNPs with Hydrogen peroxide using ascorbic acid as standard

IV. CONCLUSION

In this research work, a simple, non toxic method was adopted to synthesis gold nanoparticles using Spirogyra sp. were confirmed by peak obtained in UV visible spectrum at 535.0 nm and further confirmed by SEM analysis of size range from 40-50 nm. The free radical scavenging activity of the GNPs was determined by hydrogen peroxide showed a good free radical scavenger. Thus, the result reveals the fresh water algae which provides potential medicine to the mankind. This open the eye of the scientist to shine their research on to the fresh and marine water algae to utilize their bioactive compounds for the green synthesis approach based applications.

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