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Controlled Aqueous Phase Synthesis of Gold Nanoparticles using Fruit extract of *Momordica charantia*

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ABSTRACT

Gold nanoparticles (Au NPs) were synthesized using aqueous fruit peel extract of *Momordica charantia* which is a very well known plant locally known as Bitter gourd. The extract contains compounds such as citric acid, flavonoids, phenols and volatile oil which not only act as a reducing agent for Au^{3+} but also as capping agent to prevent the aggregation of gold nanoparticles. The Au NPs of different sizes 20 nm, 50 nm and 75 nm are synthesized using aqueous phase green synthesis and characterized using UV-vis spectroscopic analysis and Dynamic Light Scattering (DLS). The size of these nanoparticles is dependent on the weight percentage of chloroauric acid. These are found to be highly monodispersed and can be potentially used as a nontoxic therapeutic and imaging agent for various diseases.

Keywords: Green synthesis, Gold nanoparticles, Momordica charantia, Dynamic Light Scattering (DLS)

INTRODUCTION

From the past few years nanoparticles have taken the centre stage of materials research due to their distinctive properties in the nanometre scale[1,2] and their potential uses in various fields like medical science, bioelectronics, photoelectrochemical cells, biochemical, biotechnology.[3-7] Gold nanoparticles have attracted much inerest for their novel optical properties which differ markedly from the bulk properties.Gold has different optical properties in suspension in water, particles above 100 nm show blue or purple color in water while below 100 nm gold colloid has wine red.[8] Properties and applications of colloidal gold strongly depend upon their size and shape[9] and therefore, it's quite important to finely control the morphology of the nanomaterials. Synthesis of gold nanoparticles is in increasing commercial demand due to the wide applicability in various areas such as electronics, catalysis, chemistry, energy, cosmetics and medicine.[10-12] Biochemical reduction of metal ion (Au^{+3} to Au^{0}) using microorganism, enzyme, and plant or plant extract has been suggested as possible eco-friendly technique.[13] Owing to its special advantages such as mild reaction condition, good dispersion of nanoparticles and absence of synthetic chemical additives as stabilizing or reducing agents, gold nanoparticles is the thrust area for scientists as environmentally acceptable green chemistry procedures. The synthesis of AuNPs using biosynthetic methodology requires long time for the complete reduction of Au^{3+} to Au NPs due to slow rate of reduction as using bacteria for metal nanoparticles' synthesis, 1-5 days of time is required for the completion of reaction. Thus, biosynthetic procedures have this disadvantage in comparison to the chemical synthesis of metal nanoparticles. In the recent study, gold nanoparticles have been synthesized using plant extract, this disadvantage is overcome significantly by plant extract (up to 90% reduction of gold ion observed in 9 h), due to non involvement of any processes such as intracellular synthesis, multiple purification steps and maintenance of microbial cell cultures. *Momordica charantia* is a well known medicinal plant for its antidiabetic, antiinflammatory, antitumor, antimicrobial properties and as an antitoxic agent for the treatment of many diseases such as piles, leprosy, jaundice, diabetes and snake bite. The fruit and leaves contain naturally occurring alkaloids, glycoside, saponin like constituent, rennin, aromatic volatile oil mucilage (terpenes, eugenols), polyphenols and carbohydrates. These compounds contain active functional groups, such as hydroxyl, aldehyde and carboxyl units which play vital role in the reduction of Au^{3+} to Au NPs. Gold nanoparticles obtained by using components of *Momordica charantia* extract, remain stable for certain time. Herein, we have used fruit peel extract of biodegradable, non-toxic and therapeutically important, *Momordica charantia* for synthesis of Au nanoparticles of different sizes in aqueous media and these nanoparticles are

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characterized by UV-vis spectrophotometer and dynamic light scattering (DLS). UV-vis spectra shows that the gold shows the characteristic plasma band tic of the reaction and then the cluster grows or aggregates to larger nanoparticles. SPR band as shown in the UV-vis indicates the spherical shape of the gold nanoparticles. DLS intense peak confirms the gold nanoparticles size distribution profile.

RESULTS AND DISCUSSION

The reduction of Au^{3+} to the Au NPs during the exposure of bitter gourd fruit extract is followed by colour change from yellow color to wine-red color solution. As the plant extract was added to it, the color change from yellow to wine-red indicates the formation of gold. It reflects that the extract contains the compounds that were responsible for the reduction of gold ions. The resultant size of gold nanoparticles is found to be 25 nm, 50 nm and 75 nm. The study of time dependent stability of synthesized Au NPs was carried out at room temperature. Up to study time of 30 days, size of 25 nm Au NPs (at 1 wt% precursor concentration) remains constant. Whereas, 50 and 75 nm size Au NPs shows 12 ± 3% increase in size with time. Stability of metal nanoparticles in solution depends on several factors such as solvent, chemical nature of capping agent, temperature, etc..

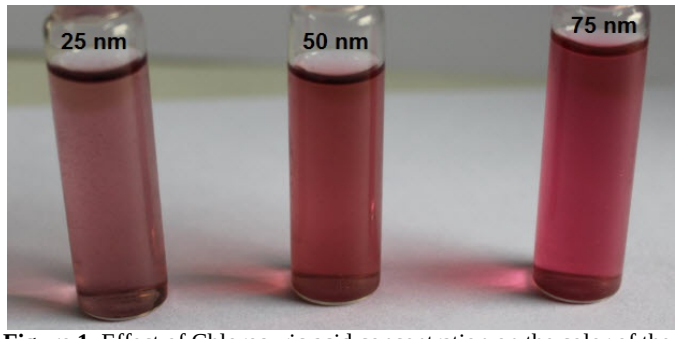

Figure 1. Effect of Chloroauric acid concentration on the color of the solutions.

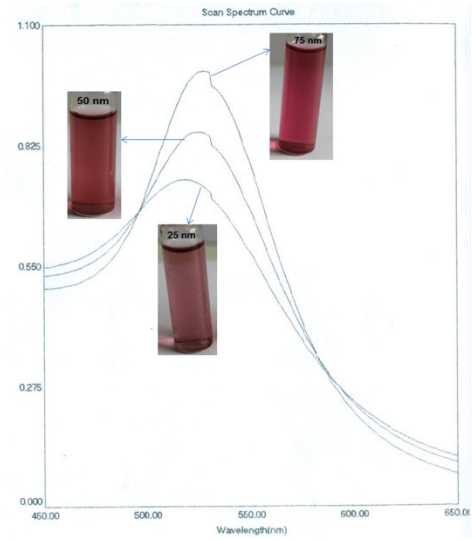

Figure 2. UV-Vis spectra showing effect of concentration of gold salt on particles size and plasma band of the gold nanoparticles synthesized by fruit peel extract of *Momordica charantia*.

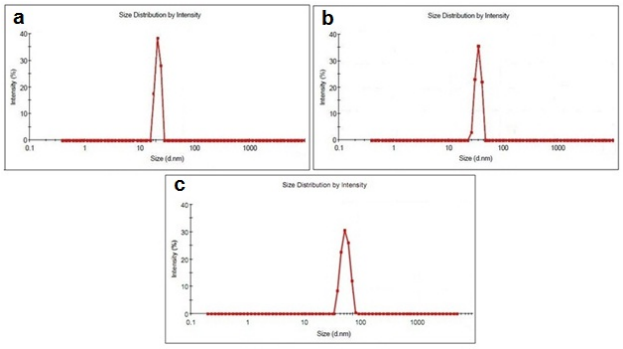

Figure 3. DLS data showing mean number average size of gold nanoparticles synthesized by using fruit peel extract of Momordica charantia at precursor gold salt concentration (a) 1% $HAuCl_4$ (b) 2% $HAuCl_4$ and (c) 3% $HAuCl_4$.

The fruit extract of *M. charantia* contains several chemicals such as saponin which on hydrolysis yields oleanolic acid and glucose. Free amino acids, galactose can act as capping agent for Au NPs. It is found that that amount of chemicals present in 275µl of *Momordica charantia* fruit extract has sufficient capacity/amount to reduce gold salt, auric ions and stabilize the 25 nm gold nanoparticles.

CONCLUSION

The size controlled non-toxic and cost effective gold nanoparticles are synthesized by green synthetic methodology using biodegradable and medicinally potent, *Momordica charantia* fruit extract. Gold nanoparticles have a wide range of applications in biomedical field since highly biocompatible nanoparticles are produced using biological entities. Thus, aqueous mediated Au NPs synthesis from biodegradable precursor may pave a path for a bright future as a good therapeutic and imaging agent for anti-diabetic, anti-cancer, anti-helminthic, anti-viral and cholesterol lowering drugs.

Tailoring gold nanomaterials to specific application requires both science and inventiveness. Applying them to technology is the state-of -the-art engineering. So, the further work on the applications of these NPs as potent drugs is yet to be explored.

EXPERIMENTAL SECTION

MATERIALS REQUIRED

Momordica charantia was purchased from local market. Chloroauric acid is purchased from Sigma and used without further purification and used distilled water (CIF, Jamia Hamdard, New Delhi, India).

1. PREPARATION OF EXTRACT

The fresh fruit of *Momordica charantia* was procured from local market and species was identified by taxonomist from department of Botany, Jamia Hamdard, New Delhi, India. The fruit was taken and washed thoroughly using sterile distilled water for 20 min.. Then 5g fruit was cut into very fine pieces without its seed part and grinded along with 2mL of sterile distilled water. The extract so obtained was filtered using Whatmann No.1 filter

paper three to four times to obtain 3.2 mL clear oil colored filtrate. The extract thus obtained naturally contained reducing agents to retain its activity and it should be stored in refrigerator.

2. SYNTHESIS OF GOLD NANOPARTICLES

50 mL of sterile distilled water was refluxed at a temperature of 100 ^{0}C with stirring and maitained the temperature stable for 15min.. The stock solution (1-3 weight %) of chloroauric acid ($HAuCl_4$) was prepared using triple distilled water. To the boiling water 100µl (1-3 weight %) of gold aurochlorate salt was added drop wise with constant stirring. The salt solution was refluxed for next 10 minutes. To that salt solution 275µl of extract was added dropwise with continuous stirring till the solution became wine-red in color which indicated the reduction of $Au^{3+}$to gold nanoparticles.

3. CHARACTERIZATION

3.1. UV-VIS SPECTROSCOPY: UV-vis absorption spectra (UV-1601 Shimadzu spectrophotometer, Kyoto, Japan) was used at CIF, Jamia Hamdard, New Delhi, India for measuring the characteristic plasma band tic of Au NPs.

Visible Observation

The clear colloidal solution of Au NPs exhibits a wide range of colors depending upon their size which is attributed to their unique optical properties. Au NPs visualized faint wine red to intense wine red color as the particle size increased up to 75nm from 25nm of Au NPs (Figure 1).

UV-Vis Spectroscopy

Effect of precursor concentration ($HAuCl_4$ on the UV-vis spectra of the NPs are shown (Figure 2). With increasing the concentration of $HAuCl_4$ from 1 to 3 wt%, The red shift (increase in wavelength from 519nm to 529nm, Figure 2) were observed. This indicates that with the increase in the concentration of gold salt, larger nanoparticles were formed which correlates with DLS data observation as well as with reported work [21].

3.2 DYNAMIC LIGHT SCATTERING (DLS): Dynamic light scattering (Zetasizer Ver. 6.01, Malvern) was used at Jamia Hamdard, New Delhi, India, equipped with vertically polarized He-Ne laser (632.8 nm) and auto-correlator) technique was used to determine the size distribution profile of Au NPs particles in suspension at 25^o C and constant angle 90^0.

Dynamic light scattering is a technique in which can be used to determine the size distribution profile of small particles in suspension. The number average mean hydrodynamic size of Au NPs at 1, 2, and 3 weight percent precursor (HAuCl4) concentration were 25 nm (Figure 3a), 50 nm (Figure 3b), and 75 nm (Figure 3c), respectively

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