Synthesis of Silver Nanoparticles by Biological and Chemical Route and Study of its Antibacterial Activity

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Abstract - Silver nanoparticles have been the subject of research due to their unique electronic, optical, mechanical, magnetic, chemical as well as antibacterial property. In the present study, silver nanoparticles were synthesized using chemical and biological approach. In the chemical approach citrate of sodium and hydrazine hydrate were used as a reducing agent and in the biological approach Murraya koeniggi and Azadirachta indicca leaf extract were used as a reducing agent. In comparison to the chemical and biological method, biological method is easy to use, economical, non-toxic and eco-friendly method. The particles were characterized by using UV-Vis spectroscopy. The peaks revealed the formation of silver nanoparticle and band gap was calculated using Tauc plot method. Antibacterial activity was measured using Kirby bauer disc diffusion techniques.

Keywords- Silver nanoparticle, UV-Vis absorption spectrum, Kirby Bauer method, Biological and chemical approach.

I. INTRODUCTION

Nanotechnology is newly emerging technology, where there exploitation of material on a molecule, supramolecular and atomic scale.[1][2] Nanotechnology explains about the material whose one dimension is from 1 to 100 nanometers and express quantum mechanical effects. It can be capable of making various new devices and materials with a huge range of applications which is similar to energy production, medicines, biomaterials and electronics. On the other hand nanotechnology grows many same issues as several new technologies, along with the environmental and toxicity bang of nanomaterial. [3]

Nanoparticles have an incredible property of large surface to volume ratio, hence exhibiting completely new and better properties than its bulk counterparts. [4][5][6]

Silver nanoparticles are tremendously tiny nanoparticles, simple to synthesize and have various applications in the fields of medicine, health and electronics etc. The main applications of silver nanoparticles are anticancer activities and antimicrobial activities. [7][8] This is due to the fact that they have biological application specially in bactericidal result. Silver nanoparticles have extraordinary thermal, optical, electronic, magnetic, property and are considered to be an important area of research. [9] Silver nanoparticles can be synthesized by a variety of biological, physical and chemical methods. Over past some years, many fast chemical methods have been replaced by green synthesis. Silver nanoparticles can be prepared by traditional chemical routes which may use hazardous materials and those reactants may be toxic and produce toxic biproducts. They may also create adverse effects in medical applications. Some require high pressure, temperature or inert atmosphere etc. chemical route are hence being overtaken by biological alternatives for improvement/protection of environment as well as they provide a source of natural capping agent.

Biological synthesis includes synthesis from fungi, bacterial, DNA's etc. or also from plants extract like neem leaves, ananas extract and lemon extract etc. The plant extract contains reducing agent akin to flavanoids and amino acids etc. The biological synthesis of silver involves the oxidation and reduction reaction. [10] The plant extract contains the enzymes that act as the reducing agent on the silver metal compound for the formation of respective nanoparticles.

The present paper deals with the synthesis of silver nanoparticles both by chemical and biological route. In the chemical synthesis technique, silver nanoparticles were prepared from the aqueous solution of silver nitrate as metal precursor [11], hydrazine hydrate and citrate of sodium were used as a reducing agent and sodium dodecyl sulphate was used as a stabilizer. On the other hand in the biosynthesis method, Murraya koeniggi and Azadirachta indicca leaf extract [12] were used as a reducing agent with silver nitrate as a metal precursor.

The particles were characterized by UV-Vis spectroscopy. They exhibited characteristics optical absorption spectrum

in the UV-Vis region. The band gap of the nanoparticle has been calculated using Tauc plot method.

Antimicrobial activity testing was done by Kirby Bauer disc diffusion method. The Kirby-Bauer method is usually used for antimicrobial susceptibility testing. In this method standard zone of inhibition have been determined for different silver nanoparticles samples. The antibacterial characteristics of silver nanoparticles were demonstrated by exposing silver nanoparticles on the bacteria's present in sewage water. Instead of using separate bacteria cultures, we have used sewage water, which contains mainly E-*Coli* and Pseudomonas aeuroginosa.

II. EXPERIMENTAL

A) Chemical Synthesis

Materials-Silver nitrate, Hydrazine hydrate, Citrate of sodium dodecyl Sulphate, distilled water.

Preparation- For the preparation of silver nanoparticles two reducing agents, Hydrazine Hydrate and Citrate of Sodium were used separately. In the synthesis process 8 mM silver nitrate were used in 400 ml of distilled water and Sodium dodecyl sulphate was used. 16 mM of hydrazine hydrate and 2mM citrate of sodium was used and it is refers to fig. 1, 2 & 3.

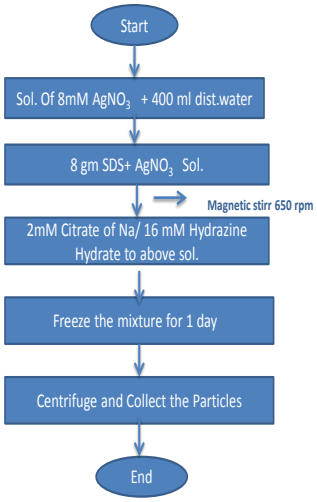

Fig.1 Flow Chart of Chemical Synthesis

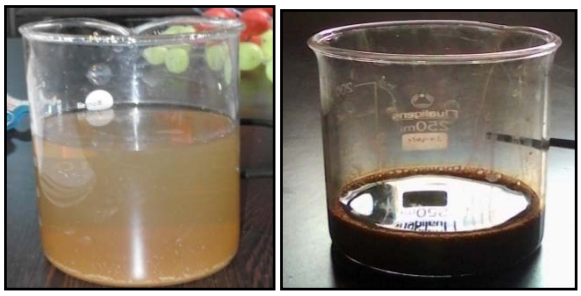

Fig. 2 Citrate of Sodium and Hydrazine Hydrate solution

Fig. 3 Nanoparticles formed by Hydrazine Hydrate and Citrate of Sodium

B) Biological synthesis

Materials- Leaf extracts were used Azadirachta indicca and Murraya koeniggi , silver nitrate, distilled water.

Preparation- For the Green Synthesis of the silver nanoparticle, leaf extracts as a reducing agent and silver nitrate as a metal precursor were used. 30 ml of both the leaf extract were mixed with 6 gm silver nitrate solution (ref. to fig. 4, 5 & 6).

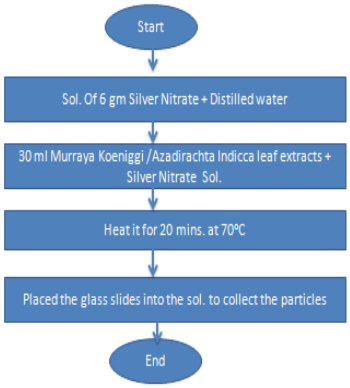

Fig.4 Flow chart of Biosynthesis

Fig.5 Murraya koeniggi and Azadirachta indicca extract.

fig 6.Nanoparticles formed by Murraya koeniggi and Azadirachta indicca

c) Antibacterial activity

Materials- Nutrient agar, Distilled water, Sewage water, Silver nanoparticles samples

Preparation- Nutrient agar plates were being prepared, for the growth of bacteria these acts as a colony and sewage water were used 5 ml (Escherichia coli., Pseudomonas aerugina) was slabbed on it and left a day and 6 mm discs were encapsulated with four separate silver nanoparticle samples. These discs were kept on the agar surface and incubated at 37 ℃ for 24 hours (ref. to fig. 7 & 8).

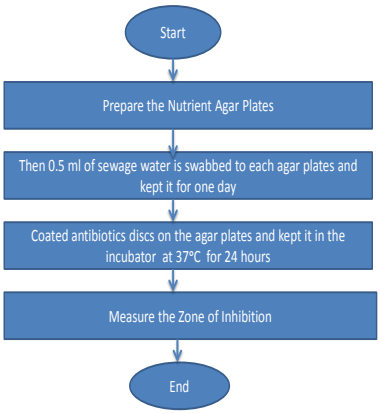

Fig.7 Flow chart of Antibacterial Activity

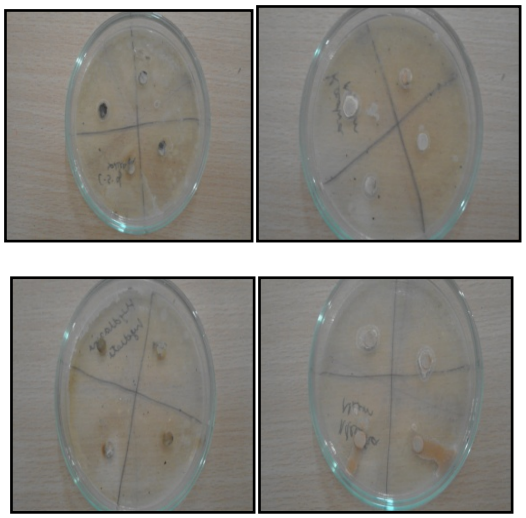

Fig. 8 Antibacterial activity using different silver nanoparticles samples

III. RESULTS and DISCUSSION

We have successfully synthesized the particles by using biological method and chemical route. The obtained nanoparticles were characterized by using UV-Visible spectrophotometer. The peaks of absorbance vs. wavelength confirmed the presence of silver nanoparticle refers to fig. (9 & 10). Silver nanoparticle band gap were found using the Tauc Plot as shown in fig (11 & 12) .The antibacterial activity was successfully measured by using Kirby-Bauer disc diffusion method, where the diameter of Zone of Inhibition was being measured.

Table 1 shows the variation in Band Gap using different reducing agents. Table 2 shows the various Zone of Inhibition found using different samples of silver nanoparticles.

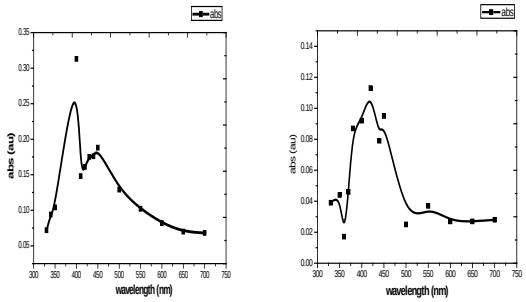

Fig. 9 Absorption spectra of Citrate of Sodium and Hydrazine Hydrate

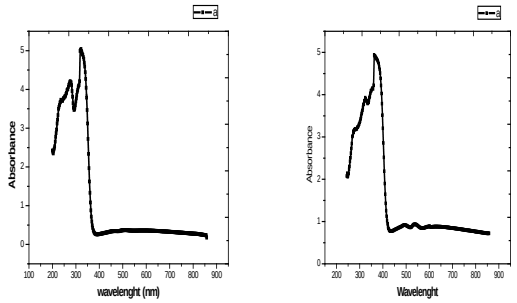

Fig. 10 Absorption spectra of Murraya koeniggi and Azadirachta indicca

The Band Gap of the Silver nanoparticle is calculated using Tauc Plot Method

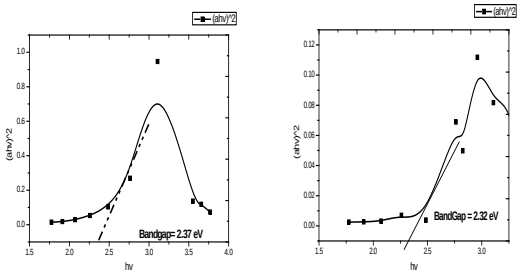

Fig. 11 Tauc Plot of Citrate of Sodium and Hydrazine Hydrate

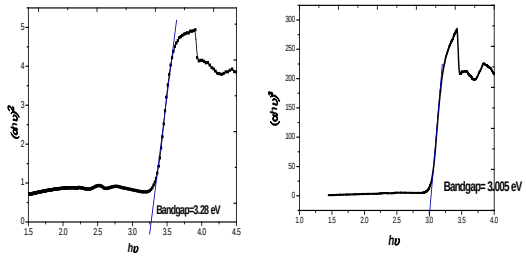

Fig. 12 Tauc plot of Murraya Koeniggi and Azadirachta Indicca

TABLE 1. Comparison in Band gaps using different Reducing Agents

S.No.	Reducing Agents	Band Gap
1.	Citrate of Sodium	2.37 eV
2.	Hydrazine Hydrate	2.32 eV
3.	Murraya Koeniggi	3.28 eV
4.	Azadirachta Indicca	3.005 eV

TABLE 2. Antibacterial activity of various samples of Silver Nanoparticles against bacteria

S.No.	Silver Sampless	ZOI (diameter)
1.	Murraya Koeniggi	12 mm
2.	Azadirachta Indicca	10 mm
3.	Citrate of sodium	8 mm
4.	Hydrazine hydrate	14 mm

IV. CONCLUSION

Sliver nanoparticles were synthesized by reducing the Silver salt with various chemical and biological reducing agents. Band gap measurements were being done on the particles using Tauc plots. The variation in the band gap indicated the variation in the size of the nanoparticles. The Antibacterial studies confirmed that Silver nanoparticles are capable of high antimicrobial efficiency and hence of great use in the field of medicine and water treatment.

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