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Synthesis And Characterization of Silver Nanoparticles Using Different Parts of Azadirachta Indica and Murraya Koenigii

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Abstract: From last few decades nanoparticles have received great attention of all researchers for development of new generation nanodevices. In the present study Ag nanoparticles were synthesized from aqueous silver nitrate through a simple and eco-friendly route using broth solutions of Azadirachta and murraya plant parts. The constituents present in plant extract(broth) act as reducing agent and stabilizing agent simultaneously. FTIR spectroscopy was used to investigated the functional groups present in plant extract which are responsible for bio-reduction of silver ions. The formation of silver nanoparticles was confirmed through UV-Visible spectral analysis at different time interval of process. Besides green route of synthesis, silver nanoparticles may also be obtained from chemical route using sodium citrate like reducing agent. The synthesized silver nanoparticles could have major applications in the area of nanoscale optoelectronics devices and biomedical engineering. Our synthesis method has advantage over other conventional chemical routes because it is cost effective & environmental compatibility.

Keywords: Nanoparticles, Green synthesis, UV-Visible spectrophotometer, FTIR, silver nanoparticles, silver nitrate.

1. INTRODUCTION

The field of nanotechnology is one of the most active areas of research in recent material science. Nanoparticles are commonly used in the field of bio-medicine such as targeted drug delivery (Jayanth and Vinod , 2003), biosensing (Huang et all , 2007), optics (Murphy et all , 2005), electronics (Y.Cui , 2001), optoelectronic (K.Tanabe , 2007) and catalysis (Tsang et all ,2004). So due to the importance of nanoparticles in every field, it is necessary to find out the better, convenient and cheapest method of formation of nanoparticles. [1,2,3,4,5]

Various physical and chemical methods are being reported (Nelson D etal 2005, Hemanth NKS etal 2010, Elumalai EK etal 2010, Vijayaraghavan K etal 2012, Amarendra DD 2010, Guidelli EJ etal 2011) for nanoparticles synthesis but properties of nanoparticles varying on reaction conditions. From last few decades, bio-synthesis of nanoparticles with controlled size and shape offered a simple and eco-friendly route in this area. The green synthesis of metal nanoparticles is eco-friendly as well as cost effective also. Various plants have been explored for synthesis of different nanoparticles. [6,7,8,9,10,11]

In the present study green synthesis of Ag nanoparticles were carried out using Azadirachta and Murraya plant (family Maliaceae), a traditional medicinal plant of India commonly known as Neem and Meetha Neem. Plant extracts were obtained from different parts like flowers, leaves, stem, bark, root etc. The silver nanoparticles were characterized by using UV-Visible spectra and FTIR.

2. EXPERIMENTATION

Normally bio-reduction route involves addition of aqueous extract solution (broth) and an aqueous solution of the appropriate metal salt. (Shirisha, A etal 2023 , Chauhan, C etal 2022 , Vijapur, L. S., etal 2019 , Khan, M. Z. H., etal 2018) The metal ion reduces at room temperature and nanoparticles obtained are informed through colour change of solution. [12,13,14,15]

2.1 MATERIALS

Materials used for bio-synthesis of silver nanoparticles are silver nitrate (E.Merck), neem (Azadirachtha indica) and meetha neem (Murraya koenigii) broth solutions. Solutions are prepared using de-ionised water.

Figure 1 : Picture of Azadirachta indica flowers

Figure 2 : Picture of Murraya koenigii flowers.

2.2 PREPARATION OF PLANT EXTRACT

Both plant samples were taken from a rural empty area of jodhpur district to avoid artificial growing environment. Different plant parts like flowers, leaves, bark, stem, roots are isolated from the plant. Now rinse all the plant materials thoroughly with tap water followed by de-ionised water to remove the dirt and dust on the surface. Now the samples were air dried at room temperature for 48 hours. After that all samples are dried in an oven for 15 minutes at 50 °C. Samples are cut into small pieces and grinded to obtain fine powder. 10 gm of finely grind powdered material is transferred into 250 ml beaker containing 100 ml de-ionised water. Now the mixture is stirred at 80 ° C for 20 minutes and cooled to room temperature. The solution is filtered twice through whatsmann filter paper 125 mm. The extract was then refrigerated at 4 °C in flask for further experiment.

2.3 PREPARATION OF 1 mM AgNO3 SOLUTION

1mM or 0.001M AgNO3 (Merck India Ltd) was prepared by dissolving 0.169gm AgNO3 in 1 lt de-ionised water and kept in dark coloured bottle to avoid auto oxidation of silver.

Figure 3 : Samples of Azadirachta indica and Murraya koenigii.

Figure 4 : Plant extract(broth) solution obtained from Azadirachta indica.

Figure 5 : Plant extract(broth) solution obtained from Murraya koenigii.

Figure 6: Testing and Sampling at Lab

2.4 GREEN SYNTHESIS OF SILVER NANOPARTICLES

In the route of experiment 10% sample broth solution was added to 50ml of 1mM AgNO3 aqueous solution. Now the sample mixture was heated on magnetic stirr at 30 °C temperature for 5 minutes. The change in colour of solution indicates the formation of AgNPs. Time and colour change were periodically recorded by scanning with UV-Visible spectrophotometer. The complete solution kept aside for 24 hours for complete bio-reduction and saturation denoted by UV-Visible spectrophotometer.

2.5 CHARACTERIZATION

2.5.1 UV-VISIBLE SPECTRAL ANALYSIS

Bio-synthesized silver nanoparticles were confirmed by sampling through UV-Visible spectrophotometer (ELICO U.V.165) at room temperature running between 250-800 nm. For spectral recording, sample must be very diluted (10 times) to overcome the errors originated due to the high optical density of the solution. Spectrum were recorded after regular intervals but the formation of nanoparticles completed after 24 hours confirmed by UV-Visible spectra.

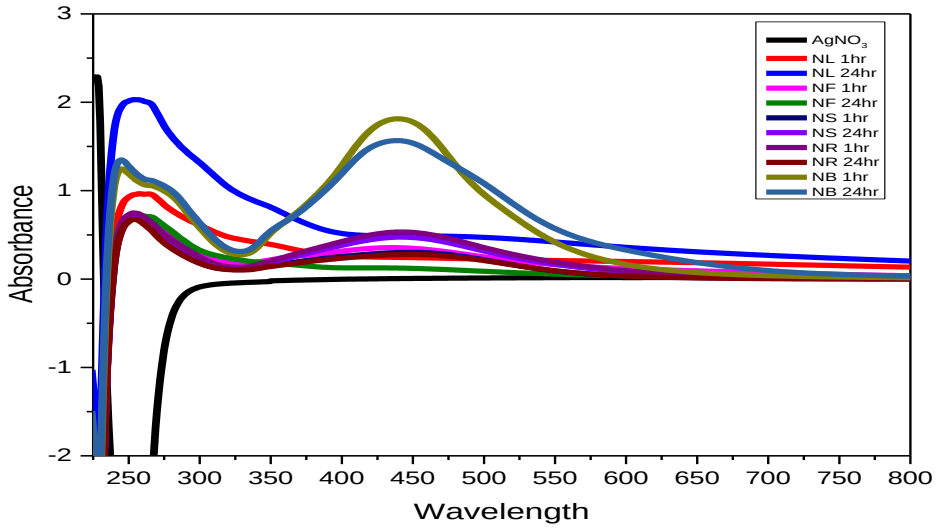

Figure 7 : UV-Vis spectra of AgNPs obtained from Azadirachta indica 10:1 ratio at different time intervals.

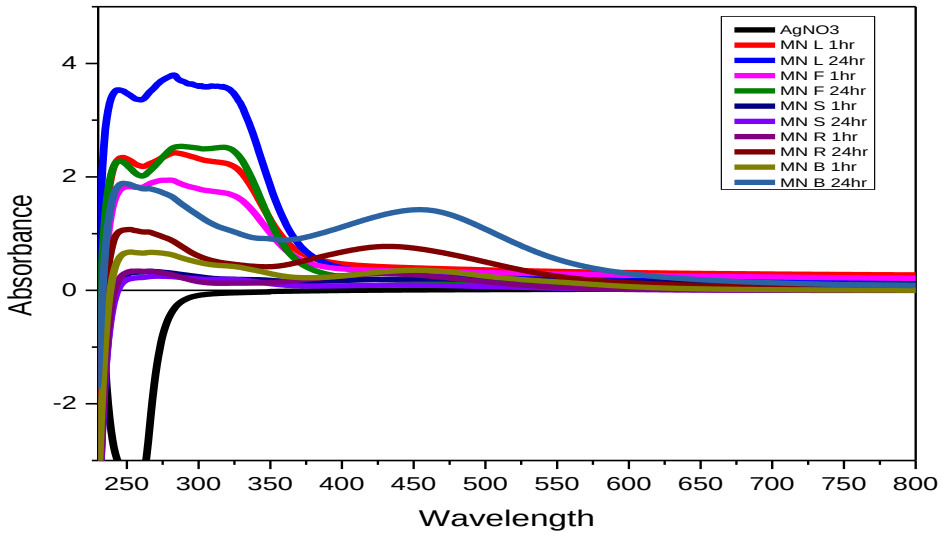

Figure 8 : UV-Vis spectra of *AgNps obtained from Murraya koenigii* 10:1 ratio at different time intervals.

***Note:** *N stands for NEEM and MN Stands for MEETHA NEEM & L- Leaves, F- Flower, S- Stem, R- Root, B- Bark*

2.5.2 FTIR SPECTRAL ANALYSIS

Brucker tensor 27 model was used for scanning of bio-reduced Ag nanoparticles. FTIR spectral peaks confirms the presence of bio-molecules present in broth solution which are responsible for reduction and capping process for nanoparticles. The FTIR spectra runs between the range 4000-400 cm^{-1}.

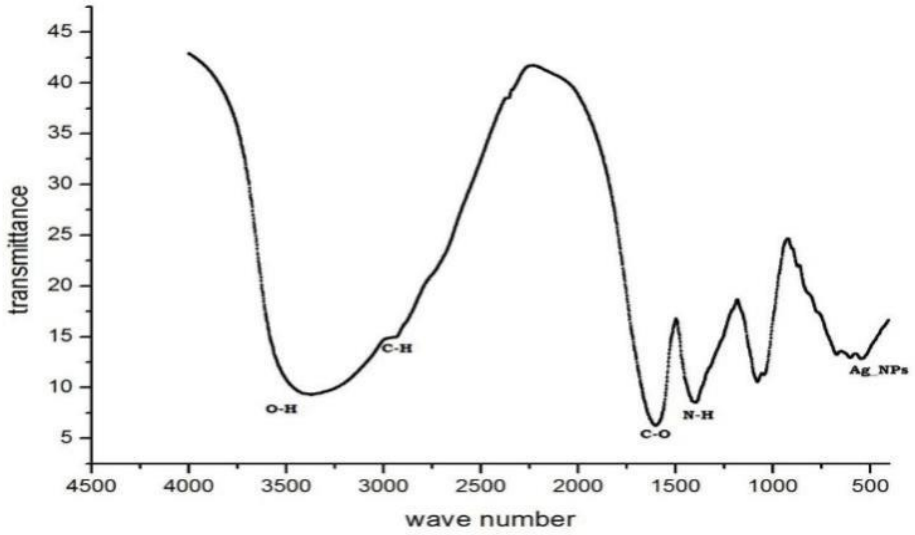

Figure 9: FTIR result for 10:1 ratio silver nanoparticle (Neem).

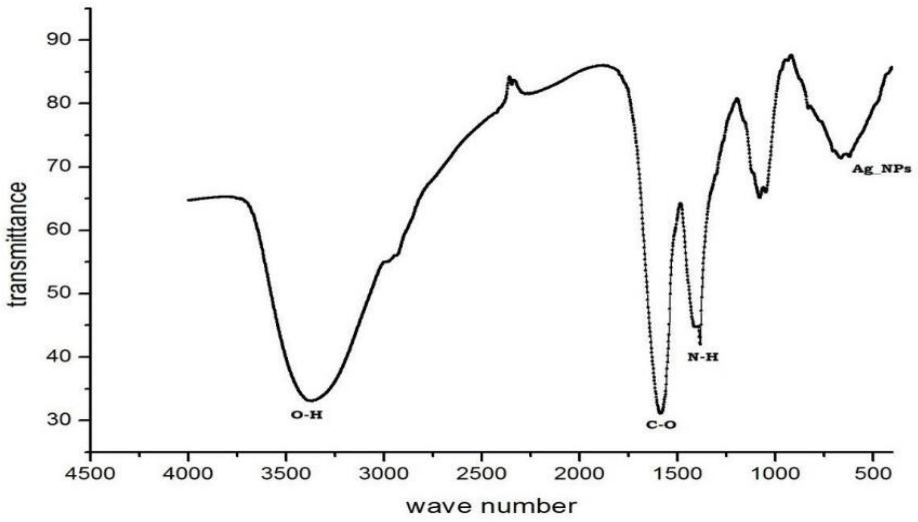

Figure 10: FTIR result for 10:1 ratio silver nanoparticle (Meetha neem)

3. RESULT AND DISCUSSION

The present study reveals the use of different plant parts for the bio-reduction of Ag+ ion. Different component present in plant extract like enzymes, proteins, vitamins, amino acids (Jagadeesh et al , 2004) carbohydrates , flavonoids , phenols (Collera et all) (Vedpriya et all , 2010) play a vital role in reducing and stabilizing the

nanomaterials. UV-Visible spectroscopy provides a convenient technique for identification of nanoparticles synthesized. This technique is based on surface plasmon resonance phenomenon. The FTIR spectra of bio-synthesized nanoparticles given in figure 9 and 10. The band position at 3463 cm^{-1} reveals the presence of hydrogen bonded OH stretching in alcoholic and phenolic compounds.

FTIR measurements were carried out to identify the biomolecules for capping and efficient stabilization of the metal nanoparticles synthesized. The FTIR spectrum of silver nanoparticles in case both of 10:1 ratio showed the band between 3490-3500 cm^{-1} corresponds to O-H stretching H-bonded alcohols and phenols. The peak found around 1500-1550 cm^{-1} showed a stretch for C-H bond, peak around 1450-1500 cm^{-1} showed the bond stretch for N-H. Whereas the stretch for AgNPs were found around 500-550 cm^{-1}. Therefore, the synthesized nanoparticles were surrounded by proteins and metabolites such as terpenoids having functional groups. From the analysis of FTIR studies we confirmed that the carbonyl groups from the amino acid residues and proteins have the stronger ability to bind metal indicating that the proteins could possibly from the metal nanoparticles (i.e.; capping of silver nanoparticles) to prevent agglomeration and thereby stabilize the medium. This suggests that the biological molecules could possibly perform dual functions of formation and stabilization of silver nanoparticles in the aqueous medium. Carbonyl groups proved that flavanones or terpenoids absorbed on the surface of metal nanoparticles. Flavanones or terpenoids could be adsorbed on the surface of metal nanoparticles, possibly by interaction through carbonyl groups or π-electrons in the absence of other strong ligating agents in sufficient concentration. The presence of reducing sugars in the solution could be responsible for the reduction of metal ions and formation of the corresponding metal nanoparticles. It is also possible that the terpenoids play a role in reduction of metal ions by oxidation of aldehydic groups in the molecules to carboxylic acids. These issues can be addressed once the various fractions of the neem leaf extract are separated, identified and individually assayed for reduction of the metal ions. This rather elaborate study is currently underway.

4. CONCLUSION

The rapid biological synthesis of silver nanoparticles using different parts of Azadirachta indica and Murraya koenigii extract provides environmentally friendly, simple and efficient route for synthesis of benign nanoparticles. The synthesized nanoparticles were of spherical and sheet shaped and the estimated sizes were 160-180 nm. The size was bigger as the nanoparticles were surrounded by a thin layer of proteins and metabolites such as terpenoids having functional groups of amines, alcohols, ketones, aldehydes, etc., which were found from the characterization using UV-vis spectrophotometer and FTIR techniques. From all these techniques it is proved that the concentration of plant extract to metal ion ratio plays an important role in the shape determination of the nanoparticles. The higher concentrated nanoparticles had sheet shaped appearance whereas the lower concentrations showed spherical shaped. The sizes of the nanoparticles in different concentration were also different which depend on the reduction of metal ion. The green route synthesis of Ag nanoparticles from neem and meetha neem provide a better and convenient way than physical and chemical synthesis. The nanoparticles obtained was easily characterised through UV-Visible and FTIR spectral analysis but the mechanistic part of the reaction process was still to explore yet. Fourier transform infrared (FTIR) analysis indicates prominent bands of absorbance, which are responsible for reducing of Ag^{+} ions and stabilization of obtained silver nanoparticles. Results confirmed this protocol as simple, rapid, cost effective, eco-friendly and alternative conventional physical/chemical methods

From the technological point of view these obtained silver nanoparticles have potential applications in the biomedical field and this simple procedure has several advantages such as cost-effectiveness, compatibility for medical and pharmaceutical applications as well as large scale commercial production.

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