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Green Synthesis and Characterization of Copper Nanoparticles Derived From Murraya Koenigii Leaves Extract

S. D. Ashtaputrey, P. D. Ashtaputrey * and Neha Yelane
Department of Chemistry, Institute of Science, Nagpur, MS, India, 440001
***Corresponding author: E-Mail: ashtaputrey@gmail.com, 9403111474**

ABSTRACT

In the recent years the green and eco-friendly method of synthesis for metal nanoparticles is an an emerging field in nanotechnology and nanoscience. The importance of nanoparticles in society and industries is due to the remarkable change in the physical and chemical properties of the materials in nanodimensions. The Copper nanoparticles (CuNPs) are mostly found their applications in the field of medical, electronic devices, biosensors, reagents in various reactions, lubricants, anti-biotic, anti-fungal, anti-microbial agents and many more. The present study involves the green and eco-friendly synthesis of CuNPs using the leaves extracts of the plant Murraya Koenigii (Curry leaves) and 1 mM Copper Sulphate ($CuSO_4.5H_2O$) solution. For this synthesis the different bio-components present in the leaves extract works as a reducing agents. The synthesized CuNPs were characterized by UV-visible spectroscopy, Scanning Electron Microscopy (SEM) and FTIR. The CuNPs formed were confirmed by the characteristics surface plasmon resonance (SPR) peak found at 340nm in UV-visible spectra. The morphological study from SEM images, it is confirmed that unsymmetrical spherical size Copper nanoparticles settled on leaves extract residue. FTIR spectrum clearly illustrates the green synthesis of copper nanoparticles mediated by the leaves extract. The method is fast and easy. As it does not involve the use of harmful and costly chemicals, it is more economical.

KEY WORDS: Copper nanoparticles (CuNPs), Plant extract, Characterization, UV-Vis. Spectra, SEM, FTIR.

1. INTRODUCTION

Nanoscience and Nanotechnology are modern and very useful fast growing branches of science and technology which deals with fabrication, characterization and applications of various nano (which is the billionth part of meter i.e.10^{-9} m.) metallic and non-metallic nanostructured materials of different compositions, sizes, and shapes (Lengke, 2007) that are playing an ever increasing role in day to day life, as more and more products based on nanostructured materials are introduced in the market. The properties of nanomaterials are found to be very distinct and more superior to the macroscale properties of the same substance. This leads to the increasing importance of research interest in these materials. The Copper nanoparticles (CuNPs) are mostly found their applications in the field of medical, electronic devices, biosensors, reagents in various reactions, lubricants and biotechnology (Sadowski, 2010). Among various types of nanoparticles available, copper nanoparticles (CuNPs) are the most commonly employed as they are simple to produce by reducing copper ions in the aqueous solution of copper sulphate. Further, copper has also been use as an anti-biotic, anti-fungal, anti-microbial agents in the treatment of wounds (Chatterjee, 2014). The various attempts have been made for the synthesis of of CuNPs by the methods of laser ablation, gamma irradiation, electron irradiation, thermal decomposition of metal compounds, chemical reduction, photochemical methods, microwave processing, and biological methods (Din, 2016). The major drawback of these methods is the use of toxic and expensive chemicals. (Murugan, 2014). Nowadays, therefore it is the need of hour to investigate a new route of synthesis which should be green and eco-friendly. Therefore bio-synthesis of CuNPs by employing different medicinal plant leaves extracts is found to be simple, easy, low cost and eco-friendly green technique for the production of CuNPs in bulk (Saranyaadevi, 2014). The main mechanism considered in such synthesis of nanoparticles is the role of phytochemicals present in the extract which acts as the reducing agents to reduce the aqueous metal ions. The phytochemicals that mainly cause the reduction of metal ions are flavonoids, terpenoids, carboxylic acids, quinones, aldehydes, ketones and amides (Prabhu, 2012). Different plants are being currently investigated for their role in the synthesis of nanoparticles The literature review showed that the many researchers have synthesized metal nanoparticles from the leaves extracts of the plants like Butea monosperma (Flame of Forest, Palas) (Chaturvedi, 2015), Piper longum (Jacob, 2012), Nerium oleander (Red kanher) (Gopinath, 2014) Ocimum sanctum (Kulkarni, 2013), Tea leaf (Vaseeharan, 2010), Glycine Max (Soybean) (Vivekanandhan, 2009), Aloevera plant (Chandran, 2006) etc. In the present study the synthesis of CuNPs from the leaves extracts of plant Murraya Koenigii (Curry leaves) was selected due to its potential medicinal value.

2. MATERIALS AND METHODS

Chemicals: Copper Sulphate ($CuSO_4.5H_2O$), Double Distilled water.

Glassware's: All glass wares (Conical flasks, Measuring cylinders, Beakers, Petri plates and Test tubes etc.) of borosil were used.

Plant used: The present work involves the synthesis of Copper nanoparticles (CuNPs) by green method using the leaves extract of plant Murraya Koenigii (Curry leaves).

Preparation of Copper Sulphate Solution: 500 ml of 1mM Copper Sulphate solution was prepared by dissolving 0.1245g in distilled water.

Preparation of the plant extract:

The Plant leaf extract was prepared by using 25g of fresh leaves, collected from the local area. Fresh leaves were washed extensively with water followed by final wash twice/thrice with distilled water to remove all the dust and unwanted visible particles. The leaves were cut into small pieces and then shade-dried for 2-3 days (figure 1). The shade-dried small leaves pieces were then put in 100 mL of distilled water and boiled on a water bath for 15 minutes. After boiling, the solution was cooled and filtered using whatman filter paper no. 1 to remove particulate matter and to get clear solution which was then stored at 4°C until further use within one week (Gardea-Torresdey, 2003). During every process, clean and hygiene were maintained for the good results.

Figure.1. The shade-dried Curry leaves

Synthesis of Copper nanoparticles: During synthesis of Copper nanoparticles, 1 mM Copper sulphate solution and leaf extract were taken. To reduce the Cu^{++} ions, 2 ml of leaf extract was added drop wise to 10 ml of 1 mM Copper sulphate solution with continuous stirring using magnetic stirrer. A slow but marked change in color of copper sulphate solution was observed from very light blue to greenish brown after 24 hrs at room temperature suggesting formation of Copper nanoparticles (CuNPs). Figure.2, shows the colour and translucency of (a) 1 mM $CuSO_4.5H_2O$ solution (b) Curry leaves extract (c) CuNPs after 2hrs. (d) CuNPs after 24 hrs. The noparticles formed were separated out from the mixture by pouring the sample mixture into a Petri dish and evaporate until it getting dried off, after that the dried sample is scrubbed and the powdered form of sample is stored in a sterile air tight glass bottle. It is then used for the FT-IR, SEM analysis.

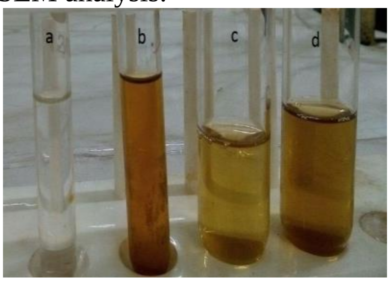

Figure.2. Synthesis of CuNPs using Curry leaf extract (a) Test tube containing 1 mM $CuSO_4.5H_2O$. (b) Curry leaves extract (c) Color of CuNPs after 2hrs. (d) Color of CuNPs after 24 hrs.

Characterization of Copper nanoparticles: Characterization of Synthesized Cu-nanoparticles can be carried out by UV- Vis spectroscopy. Metal nanoparticles have free electrons, which are responsible for a characteristics surface plasmon resonance (SPR) absorption band in UV- Vis spectra. This peak in UV-Vis spectrum is because of the strong interaction between the free electrons present on the surface of metal nanoparticles and light of specific wavelengths. The color of Metal nanoparticles depends upon their shape and size. The reduction of Cu^{++} was confirmed from the UV–Vis spectrum of the solution from region 300-600nm using an Equiptronics microprocessor based Single-beam spectrophotometer (EQ-825A). The FT-IR Characterization is used to find the entities with their functional group associate with the synthesized Nanoparticles. High-resolution Scanning electron microscope (SEM) analysis is employed to study the shape, size & surface morphologies of nanoparticle.

3. RESULTS AND DISCUSSIONS

UV-Vis Spectra: Synthesized Copper nanoparticles (CuNPs) were characterized by UV-Vis spectroscopy. The UV-Visible spectrum of the CuNPs solution recorded after 24 hours is shown in Figure.3. The sharp and high peak is appearing in the spectrum at 340 nm, suggesting the stability and size of the Copper nanoparticles (Gopinath, 2014; Ajitha, 2014). High absorbance indicates a high conversion of Cu^{++} to Cu as nanoparticle leading to higher concentration of CuNPs (Mathur, 2014).

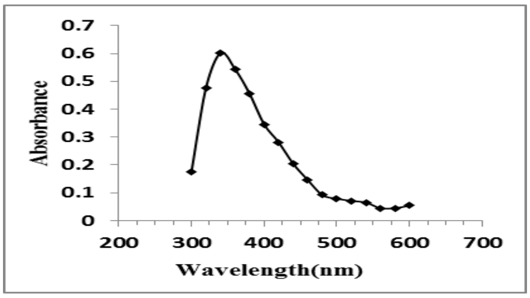

Figure.3. UV-Vis Absorption spectra of CuNPs using Curry leaves extract recorded after 24 hours

FT-IR spectra: FTIR gives the information about entities with their functional group associate with the synthesized Nanoparticles. FTIR spectrum as shown in Figure 4 clearly illustrates the eco-friendly green synthesis of Copper nanoparticles mediated by the leaves extract. In the spectra the broad peak at 3273.40 cm^{-1} corresponds to N-H or O-H stretching in amino acids, alcohols and phenols. The peak at 2926.81cm^{-1} corresponds to C-H stretching in alkanes and aldehydes, The weak peak at 2104.74 cm^{-1} corresponds to C≡C stretching in alkynes, The peak at 1587.34 cm^{-1} corresponds to C=C stretching, The peak at 1393.29 cm^{-1} corresponds to CH_2 & CH_3 deformation, The peak at 1043.06 cm^{-1} corresponds to C-O stretching, The weak peaks in between 850-550 cm^{-1} are associated to C-Cl stretching in halo compounds. Thus the nanoparticles formed were seems to be associated with metabolites and proteins like terpenoids having functional groups as ketons, aldehydes, alcohols, phenols and carboxylic acids. As the phenolic group has the more tendency to bind metal indicates that the phenols might be acts as the capping agent for the metal nanoparticles and thus prevent agglomeration, there by stabilizing the medium. This suggests that the bio-entities could probably play dual role of fabrication and stabilization of Cu nanoparticles in the aqueous solution (Kulkarni, 2014).

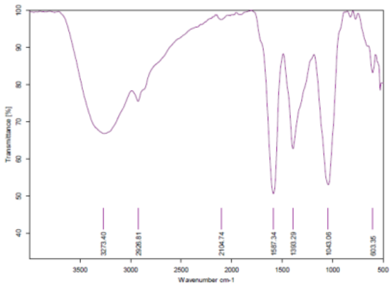

Figure.4. FTIR spectra of CuNPs using Curry leaves extract

SEM: After the evaporation of the water solvent, the surface morphology of the nanoparticles was obtained by Scanning Electron Microscopy (SEM) analysis. The Figure.5, shows the SEM image of Copper nanoparticles. From the image one can notice the existence of unsymmetrical spherical tiny copper nanoparticles settled on extract residue as the sample was prepared by the method of evaporation. However, it was not possible to us to investigate the exact surface texture of the observed nanoparticles.

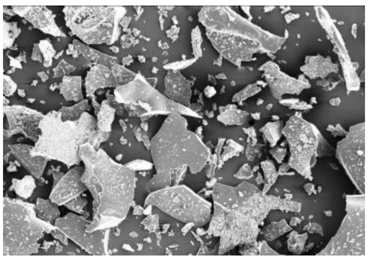

Figure.5. SEM Image of CuNPs using Curry leaves extract

4. CONCLUSIONS

It is strongly desired in the field of Nanoscience and Nanotechnology to develop the reliable, easy, low cost, safe, non-toxic and eco-friendly process for synthesis of metal nanoparticles .Eco friendly green synthesis of Copper nanoparticles by using plants leaves extract has all these aspects thus acts as a eco-friendly path of synthesis which can be adopted for the bulk production of CuNPs. The UV peak at 340nm clearly indicates the synthesis of CuNPs. The SEM studies were helpful in studying the surface texture of CuNPs. FTIR studies confirmed the green synthesis of the CuNPs by the action of various phytochemicals with its different functional groups in the extract solution. It can be concluded that CuNPs synthesized in present work are found very stable because of capping and stabilizing materials present in the leaves extract.

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