IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

Green Route Synthesis Of Copper Nanostructures Using Mangifera Indica Leaf Extract

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Abstract: Nanoparticles find wide applications in various fields due to their change in properties from bulk to nanosize. Number of methods are available but green route synthesis finds to be attractive to all researchers. Green methods are preferred over traditional synthetic methods as they are eco friendly, using no carcinogenic solvents, cost effective, use of renewable reactants, use of catalyst. In this study copper nanoparticles are synthesized using green chemistry principles using an aqueous leaf extract of Mangifera leaves. Resultant copper nanoparticles are characterized by UV-Visible spectroscopy. Lambda max value for nanoparticles was obtained at 300 nm. While SEM analysis gives detailed morphology of final nanostructures. This method is effective and shows a futuristic approach as it supports green synthesis, reduces air and water pollution.

Keywords: Green chemistry principles, Copper nanoparticles, Mango leaf extract

I. Introduction

Nanoparticles are small molecules having size in the range of 1-100 nm[1]. Due to small size, high surface area nanoparticles show diverse effects in optoelectronic properties.[2-3] They show applications in photocatalysis, gas sensors. Their optical, magnetic, chemical, electrical properties changes with change in size.[4-11] Many traditional methods are available for synthesis of nanoparticles which involves costly and carcinogenic solvents, use of blocking groups, flammable and toxic reactants.

Many solvents containing halogens are carcinogenic, long exposure using such solvents can cause various types of cancer in human beings. Such toxic chemicals from industries if released directly into river water can affect aquatic as well as human lives. Many of these synthetic methods involve accidents and explosions.

Transition metals can be easily blend with any material showing superior properties. Copper nanoparticle synthesis is important as they contains interesting physico-chemical properties. These methods are simple, cost effective, easily available. In small size, high surface to volume ratio copper nanoparticles are highly efficient showing applications in solar cells, sensing, catalytic activities.[12-18] By oxidation and reduction reaction formation of copper nanoparticles takes place.

The green synthesis method is cheap, rapid, environmentally friendly, and sustainable since plant materials are available for large-scale nanoparticle production.[19-22] Copper NPs have been previously prepared using various plant extracts.

Various metal nanostructures such as silver, platinum, zinc and copper nanoparticles had been synthesized[23-28]. Amidst these nanoparticles copper nanoparticles (Cu-NPs) displayed unique properties such as been cost effective, less hazardous, exhibit high surface area to volume ratio and good heat transfer properties that are traceable to their physical characteristics such as morphology, crystallinity and composition. This method is also cost effective and easy. Cu-NPs produced via this method revealed good structural properties and biological activities[29].

2.0 EXPERIMENTALS:

2.1 Preparation of leaf extract of Mangifera indica

Fresh, dirt free mango leaves were collected from a mango plant. To remove contaminants, dirt particles the mango leaves were washed several times with distilled water, after they were air dried for removal of moisture. 20 gm of green leaves were weighed and broken into small pieces. 100 ml of double distilled water was added and then heated for half an hour below 100°C to the boil. Yellow coloured leaf extract solution is formed slowly by heating. The boiled solution was cooled and filtered with Whatman filter paper to obtain the extract for the synthesis.

2.2 Preparation of 0.1 M copper sulphate solution

0.1 M of copper sulphate is dissolved in 100 ml double distilled water. This blue coloured solution mentioned in figure 1c is further used for the formation of dark green coloured copper nanoparticles.

a) b) c)

Figure 1: synthesis methodology for the formation of nanoparticles a) Collection and weighing of mango leaves b) boiling process for formation of mango leaves extract c) comparison of solution colours of mango leaf extract and copper sulphate solution.

2.3 Preparation of nanoparticles:

0.1M copper sulphate was collected in a 100 ml beaker and mixed with double distilled water. Magnetic stirrer is used for stirring purpose. Dropwise addition of 20 ml mango leaf extract in copper sulphate solution with continuous stirring is done for one and half an hour. Slowly the blue colour of copper sulphate solution changes to green coloured solution with addition of leaf extract. This resultant solution is kept for 24 hours undisturbed so this green colour turns to dark green colour. Dark green colored solution indicates formation of copper nanoparticles. Centrifugation is done using 3000 rpm for 15 min. followed by washing with double distilled water and air dried.

Figure 2: Centrifugation and magnetic stirring for formation of nanoparticles.

The methodology used for formation of copper nanoparticles is mentioned in detail in figure 3.

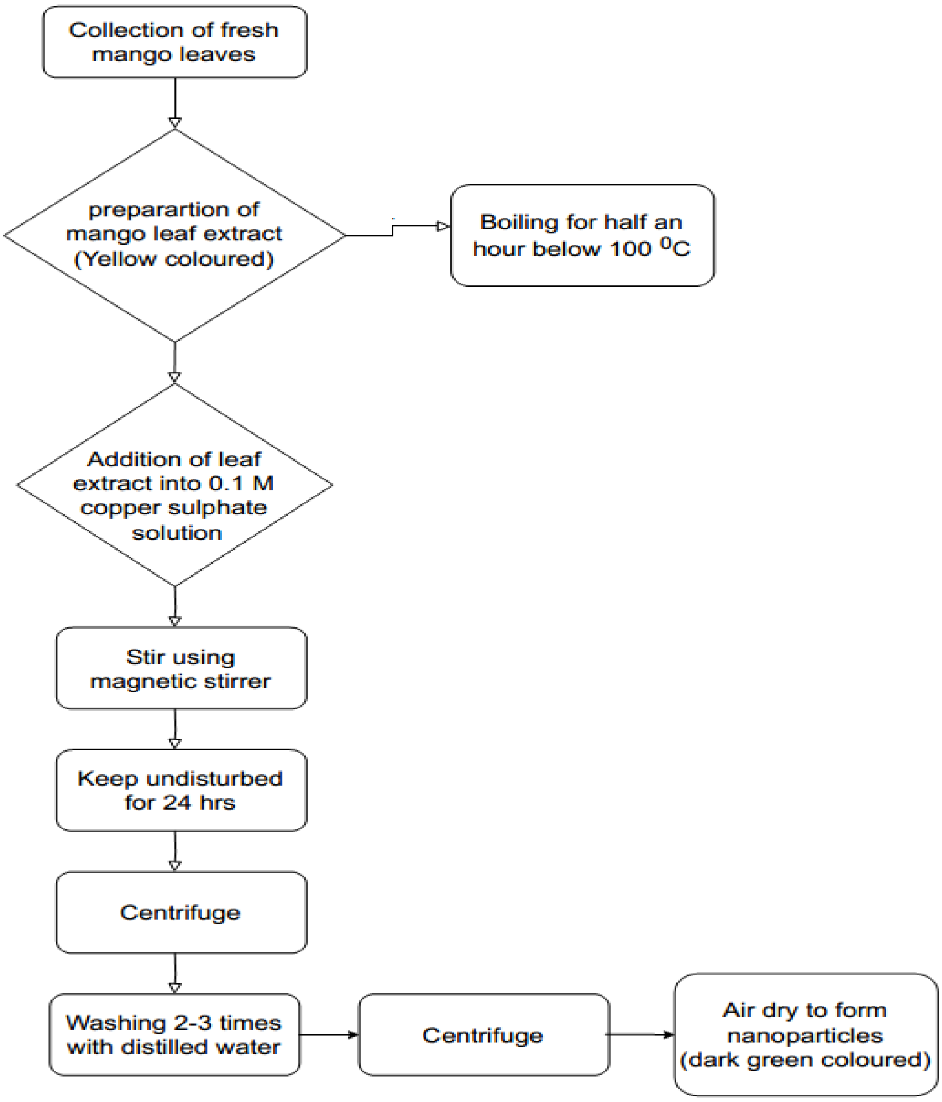

Figure 3: Methodology used for the research study.

2.4 Dissolution of copper nanoparticles:

By checking its dissolution copper nanoparticles further dissolved in mixture of acid and distilled water solution. After dissolving it was diluted to 250 ml distilled water. Absorbance and transmittance were checked for these solutions.

3. Characterization:

Resultant copper nanoparticles were analysed using spectroscopic methods. Using UV-Visible spectroscopy wavelength at which maximum absorption takes place is determined. SEM results gives detailed structural information.

3.1 UV-Visible spectroscopic Characterization:

Absorption for copper sulphate solution, leaf extract and copper nanoparticles were analysed using UV-Visible spectrophotometer containing wavelengths ranging from 400-700 nm. Concentration of solution was also determined using UV-Visible spectrophotometer. Copper nanoparticles shows lambda max value at 300 nm with absorbance 4 mentioned in figure 4.

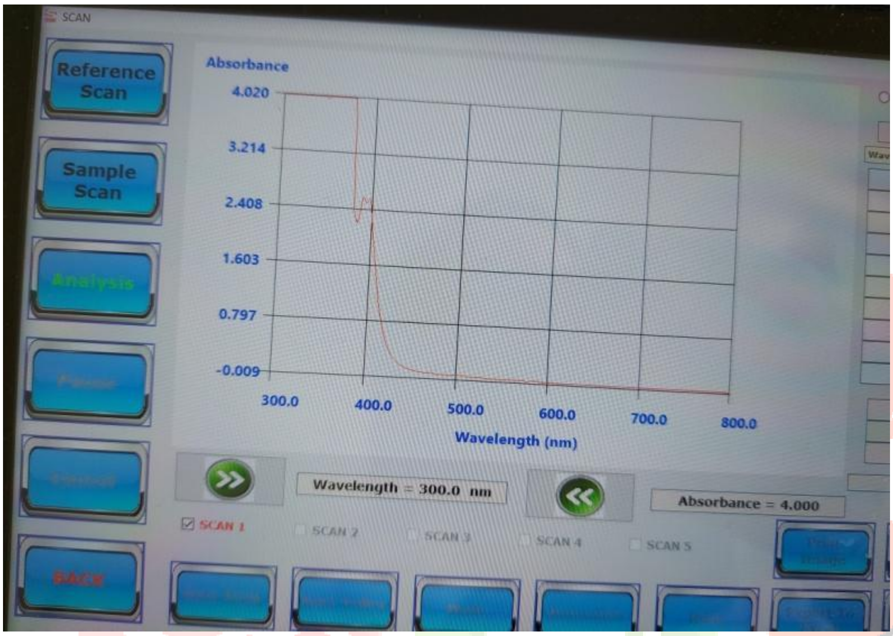

Figure 4: UV-Visible spectra for copper nanoparticles

The measurements were taken for copper nanoparticles, copper sulphate solution, and leaf extract.

3.2 SEM:

SEM analysis give morphology of copper nanoparticles formed. The SEM images are dipalyed in figure 5. SEM images observation shows that nanoparticles formed are spherical in shape with variation in diameter. The average diameter of copper nanoparticles is 9 nm.

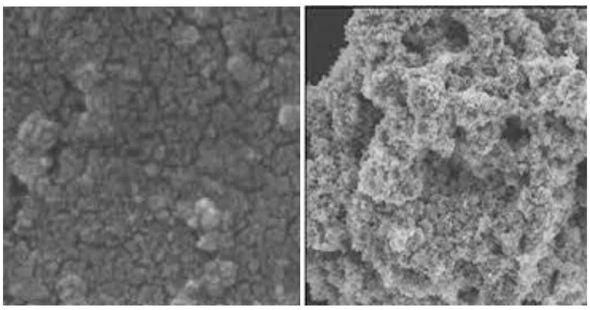

Figure 5: SEM analysis of copper nanoparticles

4.0 *RESULTS AND DISCUSSION*:

The color of the final nanoparticle solution changes from light green to dark green which is the indication of formation of copper nanoparticles. Continuous stirring is necessary as it requires proper mixing of leaf extract with copper sulphate solution. The change in the color of the solution with stepwise procedure and additions is shown in Figure 5. Leaf extract is kept for 24 hours and then addition into copper sulphate solution is done. During 24 hours light yellow colour of extract changes to dark yellow colour which indicates proper mixing of all ingredients of plant into extract.

e) f)

Figure 5: e) Resultant copper nanoparticles f) Formation of respective solutions stepwise during formation of copper nanoparticles.

***CONCLUSION*:**

This study involves green synthesis of copper nanoparticles by a simple, eco-friendly route using renewable reactants from plant extract. Absorption intensity was given by spectroscopic methods. UV-Visible spectrum gives a lambda max value of copper nanoparticles at 300 nm. SEM images confirms formation of spherical morphology of copper nanoparticles. This research supports green chemistry by following principles of green chemistry.

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