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COPPER BASED NANOPARTICLES PREPARED WITH THE HELP OF TULSI LEAVES (*OCIMUM TENUIFLORUM*) USING GREEN SYNTHESIS

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ABSTRACT

Currently green synthesis plays the major role for the preparation of the nanoparticles towards the researchers with easy method with low cost. Bulk solution is taken as copper sulphate 0.1M and Tulsi leaves extract. Take a beaker and add 150 ml of Tulsi extract and 50ml of copper sulphate and mixed in a beaker for testing. Green Synthesis and Characterization of Copper Oxide Nanoparticles using *Ocimum tenuiflorum* (Tulsi) Leaf Aqueous Extract can reduce copper ions into copper nano particles within 10 minutes of reaction time and settle down the brown coloured. Biosynthesized nanoparticles of copper oxide are characterized through FT-IR, UV-Vis spectra and XRD. In UV-Vis spectra a peak was obtained at 520 nm due to inter band transition of electrons In core and band gap energy of 2.85 eV was observed through tauc plot. Sharp peak at 515.06 and 607.62 cm-1 in FT-IR spectrum is due to Cu-O bond. CuO Nano particle is crystalline. The particle sizes of CuO NPs are found in different sizes range of 80 to 200 nm, 35 to 50 nm respectively.

Keywords: Copper Oxide Nanoparticles, *Ocimum tenuiflorum* (Tulsi), Nanotechnology

INTRODUCTION

Nanoscience is the branch of science that deals with the study of materials at the scale of nanometer (1-100 nm) at least in one dimension **[1-3]**. Nanotechnology on the other hand, concerns itself with tools and techniques of manipulating the nanoscale objects at molecular level **[4]**. Nanoscale objects or nanomaterials attain immense importance because of their superior chemical, physical, optical, magnetic, thermal, electrical, imaging and unique properties they are highly in various disciplines like agriculture, catalysis mechanical properties compared to their conventional counterparts **[5-7]**. Because of these, chemistry, electronics, environmental sectors, food industry, physics, solar cells and also in biomedical healthcare **[8]**. Acquiring the knowledge from nanoscience about the material behavior of nanoscale objects, nanotechnology focuses on engineering various nanomaterials for widespread applications **[9]** in the field of photonics, electronics and medicines **[8]**. Specially in the field of medicine, numerous nanoplatforms have been explored extensively for biosensing, bioimaging drug delivery, gene therapy, tissue engineering and nanomedicine **[10]**.

Copper nanoparticles have drawn much attention because of their natural abundance, good electrical conductivity, high melting point, minimal electrochemical migration, excellent soldering ability, catalytic activity and affordability **[11]**. Copper has substituted the place of other metals such as Ag, Au and Pt, in many applications like, heat transfer and inkjet printing **[12]**' because of its low cost, high conductivity, **[13]** small size, high surface/volume ratio, improvement of size, shape and oxidation resistance, etc. **[14]**. Moreover, high boiling point of copper helps to withstand high-temperature and- pressure chemical reactions and thus helps in various organic transformations. All these distinctive properties, have made copper one of the most precious metals in recent years.

In literature, the Cu nanoparticles are synthesized from vapor deposition, electrochemical reduction, radiolysis reduction, thermal decomposition, chemical reduction of copper metal salt, and room temperature synthesis using hydrazine hydrate and starch. In recent, green synthesis of Cu nanoparticles was achieved by using plant extract. tulsi leaves play a vital role in arresting disease pathogens and tulsi has an anti- inflammatory property, treat fungal infection, useful in detoxification and it also prevents gastrointestinal disease, treat wounds and strengthening immune system. Tulsi leaves play a vital role in arresting disease pathogens and Tulsi has anti- inflammatory properties, treat fungal infection, useful in detoxification and it also prevents gastrointestinal disease, treat wounds and strengthening immune system.

2. EXPERIMENTAL METHODS

2.1 Sample Collection

Ocimum tenuiflorum (Tusi) leaves were collected within the J.J college of Engineering campus and separate the greenish leaves that is very healthy leaves that leaves are used for the experimental work which is shown in **Figure 1**.

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Figure 1: *Ocimum tenuiflorum* (Tulsi) leaves

2.2 Extract preparation

The selected fresh green leaves were washed in running fresh water then washed thoroughly with distilled water. Then the leaves were dried using the absorbent paper. These leaves were dried up to 2 days and powdered it. Measure 25 g of dried Tulsi powder and which was taken in the beaker. Then add 250 ml of distilled water into it. This mixture was heated for 1 hour at 60 °C. By this time the aqueous part turns brown. This extract was filtered by using the Whatman No.1 filter paper. This filtrate was made up to 250 mL in a standard measuring flask. It was then stored in the refrigerator for further use.

2.3 Materials and instruments used.

From Nice Chemicals we purchase Copper sulphate ($CuSO_4.5H_2O$). Freshly prepared distilled water was used throughout the experiment. UV-Vis spectrometer (Jasco V-530) and FT-IR (Thermo Scientific Nicolet iS5) were used for characterization. Surface analysis done by Nanosurf Easy scan 2 AFM. The structure was analyzed by scanning electron microscopy (SEM, Hitachi S-2500C) and high-resolution transmission electron microscopy (HR-TEM; JEOL-2010). Copper concentrations were determined using inductively coupled plasma spectrometry (ICP,JY38Plus).

2.4 Synthesis of CuO Nanoparticles

For the synthesis of copper oxide nanoparticles 50 mL of copper sulphate and 150 mL of tulsi extract is taken and mixed in a beaker. When mixed it is observed that the color is dark green and brown coloured precipitate is settling down. This obtained precipitate is filtered using Whatman no- 1 filter paper, washed with distilled water, and left overnight to dry. The next day CuO nanoparticles were collected **(Figure 2)**.

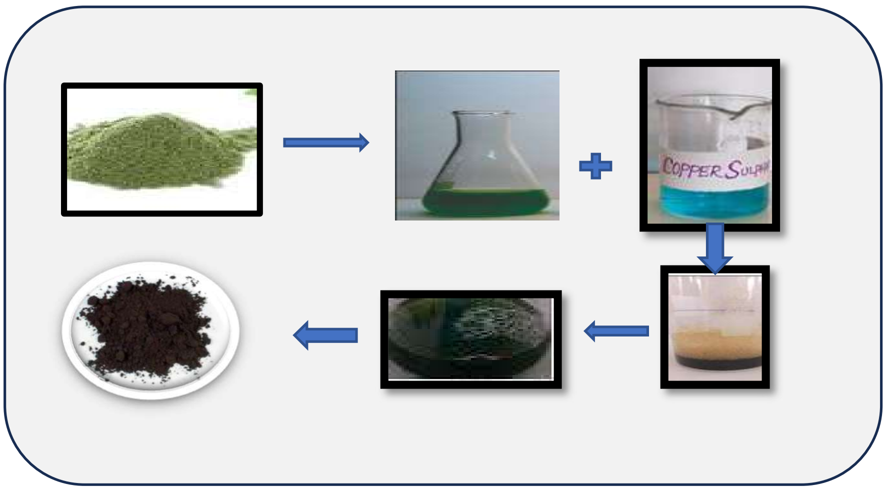

Figure 2: Dried Tulsi powder, b) Original extract, c) CuSO4, d) Original extract +CuSO4 e) Nanoparticles formation and d) Copper nanoparticles

3. RESULTS AND DISCUSSION

Reduction of the copper ion to copper nanoparticles during exposure to the plant leaf extract could be followed by color change and thus UV-vis spectroscopy. It is observed that the maximum absorbance occurs at 560 nm and steadily increases in intensity as a function of reaction time. We quantitatively monitored the concentrations of copper nanoparticles and conversion by measuring the absorbance at 560 nm. The linear relationship was obtained between the copper concentration determined by ICP and the absorbance at 560 nm. TEM images obtained with 15 - 20% Neem leaf broth and 1 mM $CuSO_4{\cdot}5H_2O$ solution showed that relatively spherical nanoparticles are formed with diameter of 45 - 110 nm. As the reaction temperature increased, both synthesis rate and conversion to copper nanoparticles increased. The conversion after 24 hr was about 70% at 25° C and 80 - 100% at 60 and 95 °C. The average particle size decreased from 110 nm at 25°C to 45 nm at 95°C. Regarding the reason for the decrease in particle size with temperature, we can hypothesize as follows.

As the reaction temperature increases, the reaction rate increases and thus most copper ions are consumed in the formation of nuclei, stopping the secondary reduction process on the surface of the preformed nuclei. Similar trends were observed with gold and silver nanoparticles synthesized using plant extracts. Effects of different neem leaf broth concentrations at 5 - 20% were investigated on copper nanoparticles formation at 1 mM $CuSO_4·5H_2O$. The reaction rate was highest at 20% leaf broth concentration. With increasing the leaf broth concentration, the average particle size decreased up to 15% leaf broth concentration and then increased at 20% leaf broth concentration. Effects of $CuSO_4·5H_2O$ concentration were also investigated on conversion to copper nanoparticles obtained with 15% neem broth concentration. The times required for more than 90% conversion were 1600, 1400, and 300 min at 95 ^oC, respectively, when $CuSO_4·5H_2O$ concentrations were 0.5, 1, and 2 mM, respectively. The average particle size decreased with increasing the $CuSO_4·5H_2O$ concentration. It is considered that particle size is dependent on various conditions such as reaction temperature, leaf broth concentration and $CuSO_4·5H_2O$ concentration. XRD spectrum showed characteristic copper peaks, suggesting that copper nanoparticles were successfully synthesized using tulsi leaves.

3.1 FT-IR discussions of copper nanoparticle

FT-IR spectroscopy is an important tool for the detection of functional groups of biomasses, which are responsible for capping and stabilizing agents of the prepared CuNPs. The FT-IR spectrum of tulsi leave extract show absorption bands at 3046, 2924, 2863, 1694, 1617, and 971 cm^{-1} **(Figure 3.1)**. The broad band at 3406 cm^{-1} may be attributed to the stretching vibration of copper nanoparticles.

3.2 Synthesis of CuNPs and UV-visible analysis

In the current work, Tulsi leaves extract was used for the synthesis of stable Cu nanoparticles in aqueous phase. The formations of CuNPs were confirmed using UV-visible spectra due to surface plasmon resonance. The UV-visible absorption spectra of synthesized CuNPs were recorded at fixed wavelengths from 200 to 800 nm. The UV spectrum of tulsi leaves extract shows absorption bands at 338 and 226 nm, which is characterized due to the absorbance of benzoyl-related systems of the biomolecules. The characteristic absorption peak of Cu colloids was observed at 600 nm, as shown in **Figure 3. 2**. Surface plasmon is the electron excitation in the conduction band of the nanoparticles surface. The metal nanoparticles providing the characteristic absorption spectra in the UV-visible region are called surface plasmon resonance of nanoparticles. It has been reported in the literature that the surface plasmon resonance band of Cu nanoparticles provides absorption from 520 to 700 nm. The CuNPs surface plasmon band stability at 600 nm confirms the formation of Cu nanoparticles and shows that particles in the solution are monodispersed with no sign of agglomeration.

3.3 FE-SEM analysis of CuNPs

For identification of size and surface morphology, FE-SEM was used. FE-SEM images of the green synthesized CuNPs were found to be spherical in shape without aggregation **(Figure 3. 3)**. From the images, it has been confirmed that the synthesized CuNPs are stabilized by biomolecules present in tulsi leaves extract. It has been reported in the literature that the optical and electronic properties of metal nanoparticles are shape dependant. For size and surface morphology determination, FE-SEM has previously been used by several investigators for the characterization of metal nanoparticles. The average size of the synthesized CuNPs was found to be monodispersity in **Figure 3.3a and b**. Higher magnification FE-SEM images show the well-defined surface modification and coating of biomolecules, which stabilize the fine surface of CuNPs.

3.4 XRD analysis of CuNPs

The XRD patterns of *tulsi* synthesized CuNPs is shown in **Figure 3.4**. The XRD pattern of the synthesized CuNPs is like previous reports. All the possible peaks observed indicate metallic copper, which also show the polycrystalline nature of CuNPs. In the XRD pattern, two distinct diffraction peaks for CuNPs are observed with a 2θ value of 45.72° and 50.18° representing Bragg's reflections of an planes of fcc crystal structures of CuNPs. The average crystallites size of copper was calculated from the Scherrer equation. The average crystallite size of the CuNPs was 75 nm, which is ably supported by high-resolution FE-SEM images as well. The small diffraction peak at 40.5°, which corresponds to the Bragg's reflections of [002] may be due to the formation of copper oxide. Here, the formation of copper oxide in small quantities cannot be ignored. Some unidentified peaks at 31.05°, 31.2°, 40.53°, and 45.72° were assigned These unassigned peaks might be due to the crystallization of biomolecules.

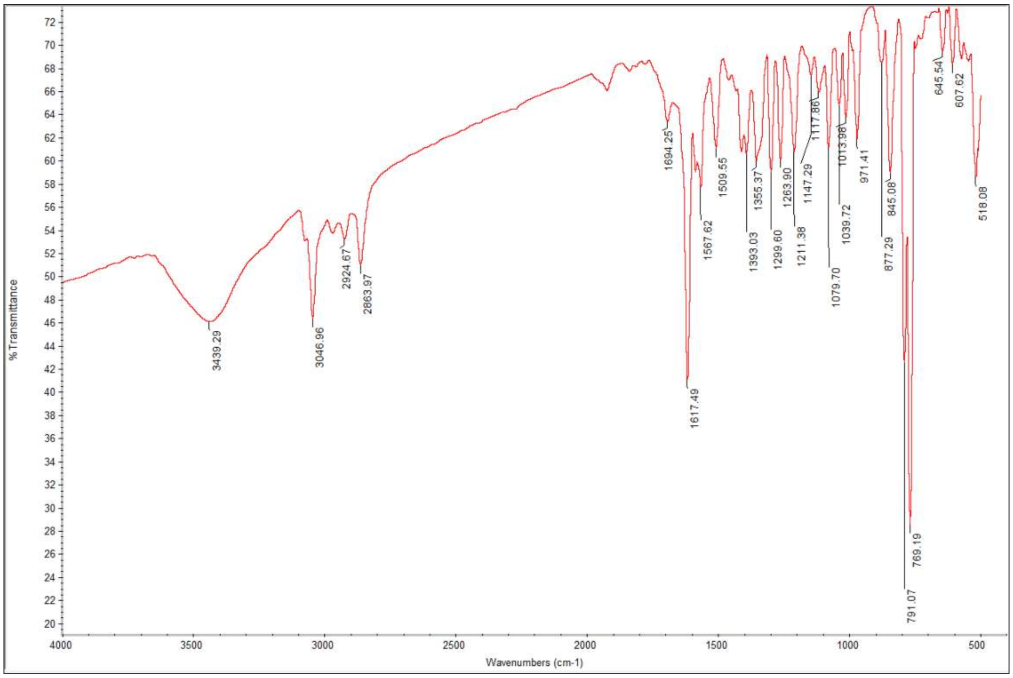

Figure 3.1: **FT-IR of synthesized CuNP**

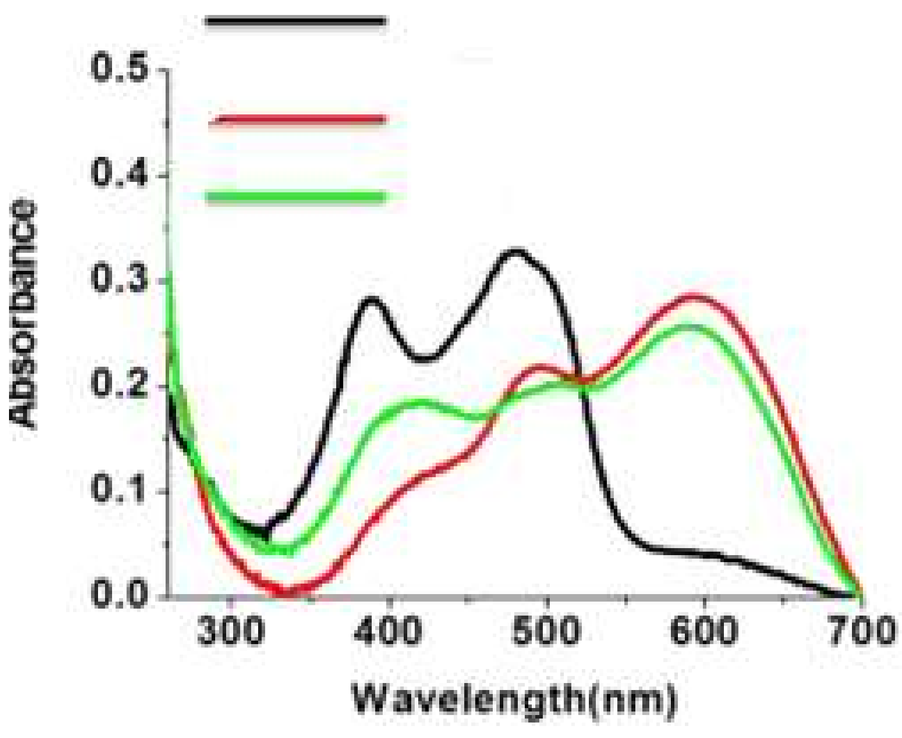

Figure 3.2 UV-visible spectra of tulsi leaves extract and synthesized CuNP

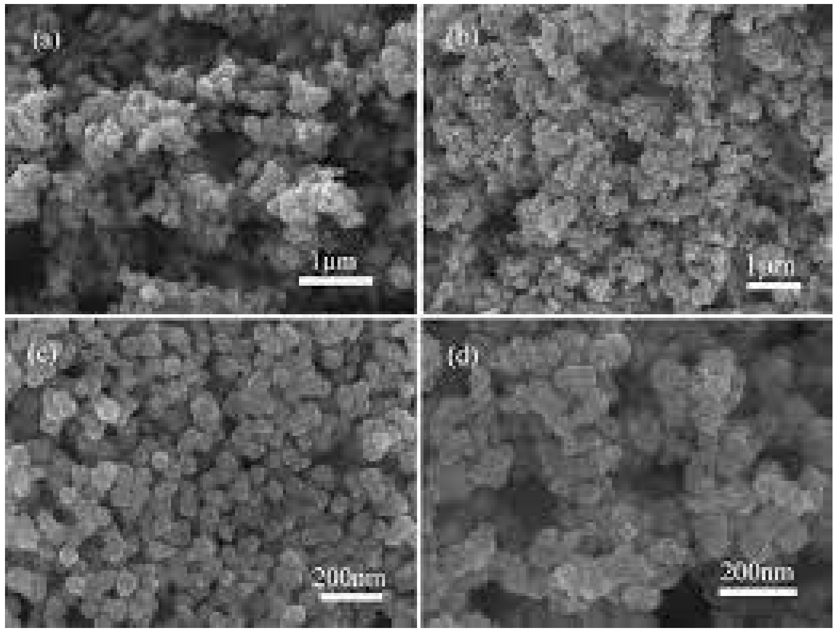

Figure 3.3 a-d: FE-SEM images of prepared CuNPs

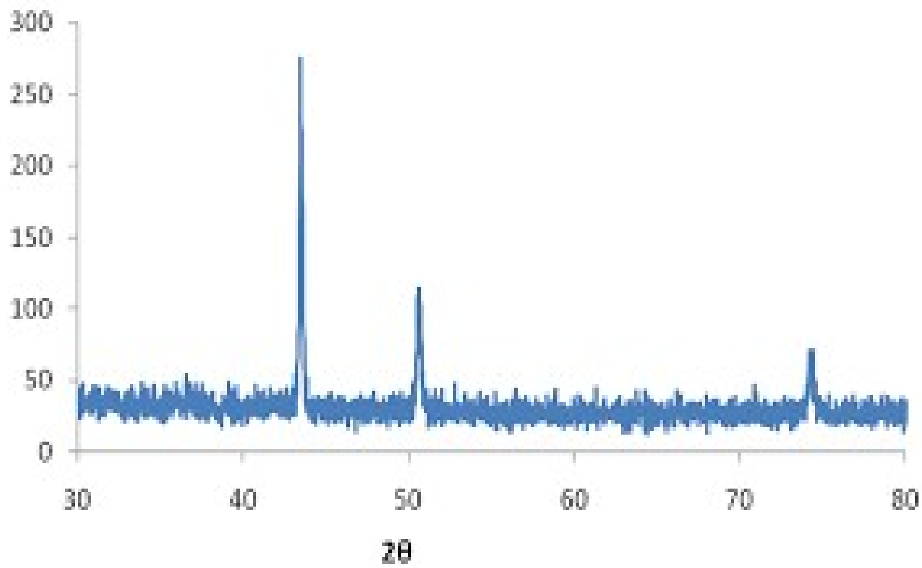

Figure 3.4: XRD patterns of *tulsi* synthesized CuNPs

4. CONCLUSION

Here, CuNPs were successfully prepared for the first time using *tulsi leaves* extract, in which the plant extract acts as a capping as well as a reducing agent. Initially, the formation of nanoparticles was confirmed through UV-visible spectrophotometer due their surface plasmon resonance. FT-IR spectra confirmed that biomolecules of tulsi leaves were responsible for the reduction capping of CuNPs. The prepared CuNPs were structurally and morphologically characterized by using FE-SEM, EDX, and XRD. Considering the excellent catalytic performance; the prepared CuNPs catalyst can be synthesized in large quantities due to their low cost, high stability and reusability, and environmentally friendly plant support and thus can be used for the purification of natural water from organic effluents.

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