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# Biosynthesis of copper oxide nanoparticles using Momordica charantia leaf extract and their characterization

**S. Alwin David[*1], S. Immanuel Rajadurai[2],S. Vignesh Kumar[3]**

[1,2,3]*Department of Chemistry, V.O. Chidambaram College, Thoothukudi Tamil Nadu, (India)*

## ABSTRACT

*Biological methods of nanoparticles synthesis using plant extracts is suggested as possible ecofriendly choice to physical and chemical methods. In this work, we have synthesized copper oxide nanoparticles (CuO NPs) by using Momordica charantia leaf extract. Characterizations of the CuO NPs were made by UV-Visible Spectroscopy, Infrared spectroscopy (IR), X-ray diffraction (XRD), Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM). A SPR band at 246 - 252 nm in the UV–vis spectrum exposed the formation of CuO NPs. XRD and SAED patterns established the existence of FCC structure and highly crystalline CuO NPs. This CuO NPs were irregular in shape and 20 to 50 nm in size, as apparent by TEM and SEM. Phenolic compounds available in the Momordica charantia were principally responsible for the synthesis of CuO NPs.*

***Keywords: Green synthesis, copper oxide nanoparticles, Momordica charantia leaf extract, Phenolic compounds.***

## I.INTRODUCTION

Green synthesis refers to the synthesis of nanoparticles using naturally obtainable reducing agents like plant extracts, polysaccharides, micro-organism like fungus and bacteria, etc. This method is eco friendly and consumes less energy and is economically cheap.

Copper oxide nanoparticles (CuO NPs) have attracted huge attention due to its catalytic, electrical, sensing, conducting, antimicrobial and optical properties. Copper oxide nanoparticles are successfully used as antimicrobial agent, gas sensor, metal adsorbent, catalyst, high-temperature superconductors, solar energy converter and magneto resistance materials [1, 2].

*Momordica charantia* has shown anti-obesity, antifungal, antibacterial, antileukemic, antitumorous, antiviral, antiparasitic, hypoglycemic, anticancerous, anti-ulcer, antiprotozoal and immune stimulant activities [3]. The major components of *Momordica charantia* which are accountable for the therapeutic properties are steroids, triterpnes, alkaloids, proteins and phenolic compounds [4, 5].

Here, we used environment-friendly and handy technique for the synthesis of CuO NPs by reducing $Cu^{2+}$ ions in the copper sulphate solution by using *Momordica charantia* leaf extract.

## II.MATERIALS AND METHODS

### 2.1. Chemicals used

Copper sulphate pentahydrate used for the synthesis of CuO NPs was bought from E. Merck, Germany. Leaves of *Momordica charantia* used in the synthesis were taken from local region (Thoothukudi, India).

### 2.2. Preparation of leaf extract *of Momordica charantia*

About 10g of fresh leaves of *Momordica charantia* were collected and washed thoroughly using water to eliminate dust particles. These clean leaves were slice into tiny pieces and heated in 100 mL distilled water about in a round-bottom flask for 1hour. The leaf extract of *Momordica charantia* was filtered using filter paper (Whatman No. 41).

### 2.3. Biosynthesis of copper oxide nanoparticles

About 75 mL of 0.1M $CuSO_4.5H_2O$ solution was added to 25mL of *Momordica charantia* leaf extract. This combination was heated for 3 hours at 60°C. The synthesized CuO NPs were collected using centrifugation and then dried.

### 2.4. Characterization of copper oxide nanoparticles

The UV-Vis spectra of the CuO NPs and *Momordica charantia* leaf extract were taken on JASCO UV-Visible spectrometer. FTIR were taken on a iS5 Thermo Scientific Nicolet instrument at 4 $cm^{-1}$resolution in KBr pellets. The size of CuO NPs was calculated by XPERT-PRO X-ray diffractometer working at 40 kV voltage and 30 mA current with Cu Kα radiation. Philips-CM200 TEM was used for the study of particle size and shape lattice image of the CuO NPs. SEM analysis was performed on a JEOL 6390 (Japan) model with maximum magnification of 300,000X and resolution of 3.5 nm at Karunya University, Coimbatore. EDAX analysis was performed on a PNCA PENTA FETX3 (England) at Karunya University, Coimbatore.

## III.RESULTS AND DISCUSSION

### 3.1. UV-Vis Spectroscopic analysis

As exposed in UV-Vis spectra (figure 1), the absorbance band at around 246nm proves the formation of CuO NPs. The band at 246nm is owing to the Surface Plasmon Resonance (SPR) of CuO NPs [6]. The UV-Vis spectrum of the leaf extract (figure 1) shows bands at 270nm and 316nm arising as a result of $\pi \rightarrow \pi^*$ transitions and these absorption bands reveal the presence of phenolic compounds in the leaf extract.

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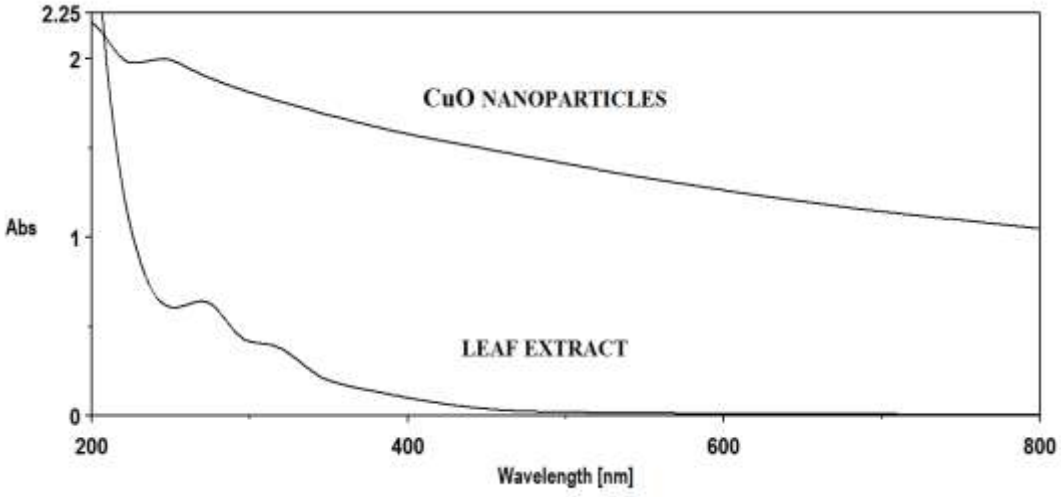


Figure 1 - UV-Vis spectra of CuO NPs and leaf extract of *Momordica charantia*

### 3.2. X-ray diffraction analysis

The peaks at 2θ values of 32.89°, 36.51°, 39.86°, 52.37°, 57.79°, 63.83° and 72.28° can be ascribed to the (110), (111), (200), (202), (020), (202) and (220) crystalline planes of FCC structure of CuO NPs, respectively. XRD pattern clearly shows that CuO NPs synthesized are crystalline in character [6 7]. The size of the CuO NPs as determined by Scherrer equation is 28.47 nm.

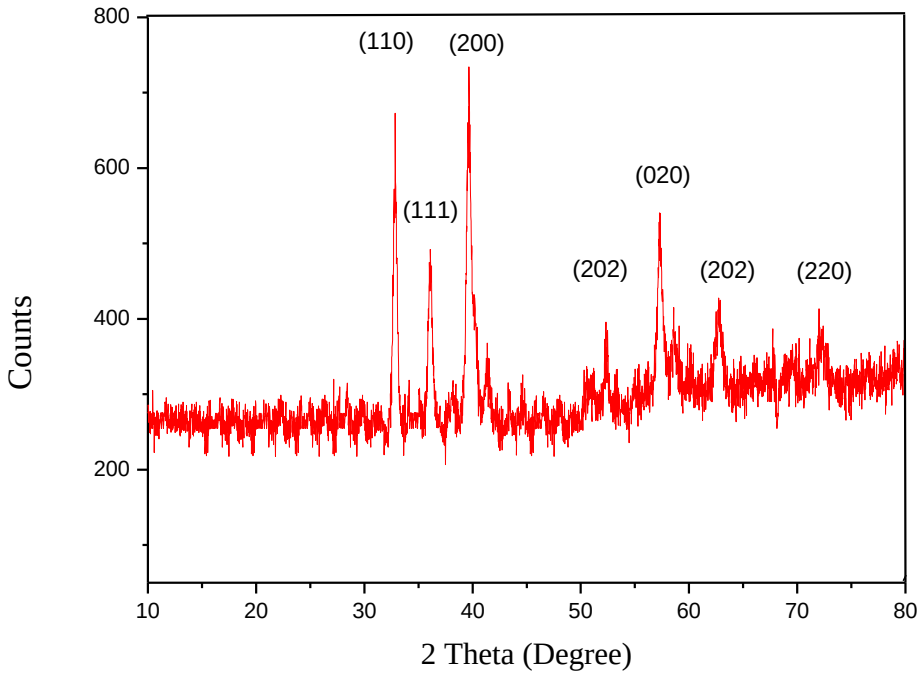


Figure 2 - XRD pattern of CuO NPs

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### 3.3. Transmission electron microscopic analysis

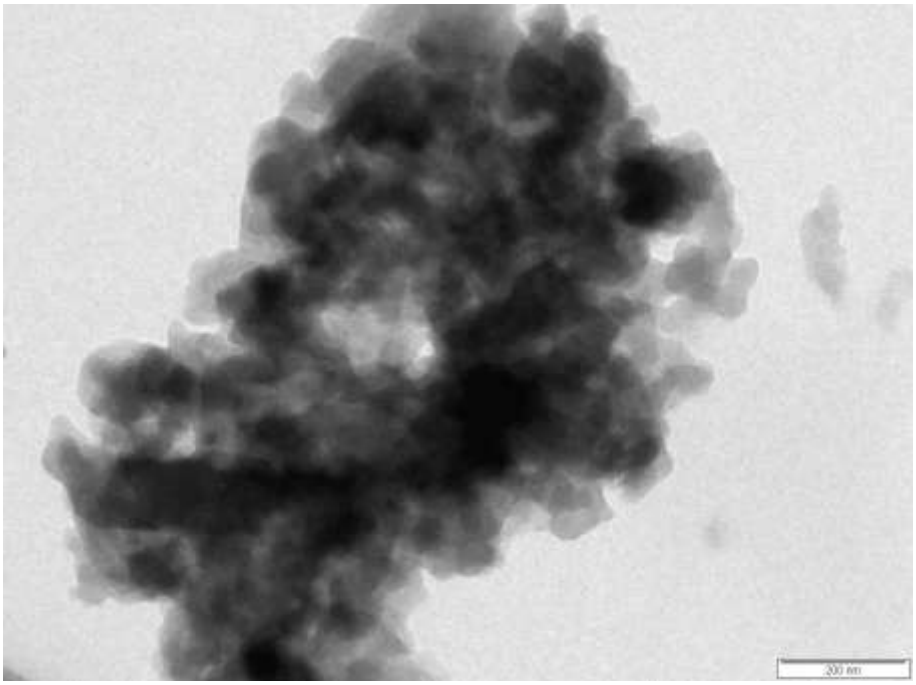

Figure 3 - TEM image of CuO NPs in 200 nm scale

TEM image (Figure 3) exposes that CuO NPs formed are irregular in shape with 20-50nm in size.

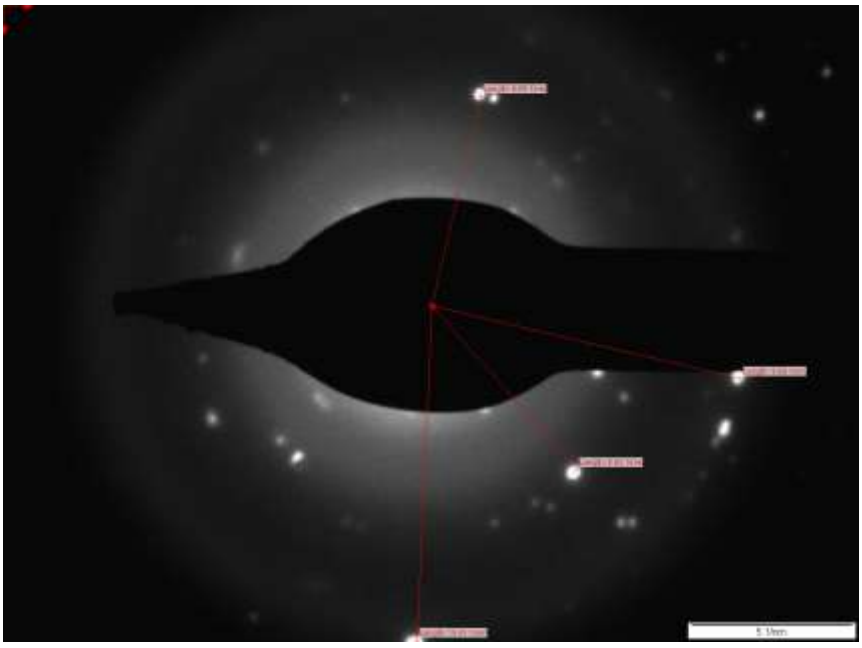

Figure 4 - SAED pattern of CuO NPs

The ring-like diffraction pattern with roughly circular SAED spots reflects that CuO NPs have crystalline nature.

### 3.4. Energy dispersive X - ray analysis (EDAX)

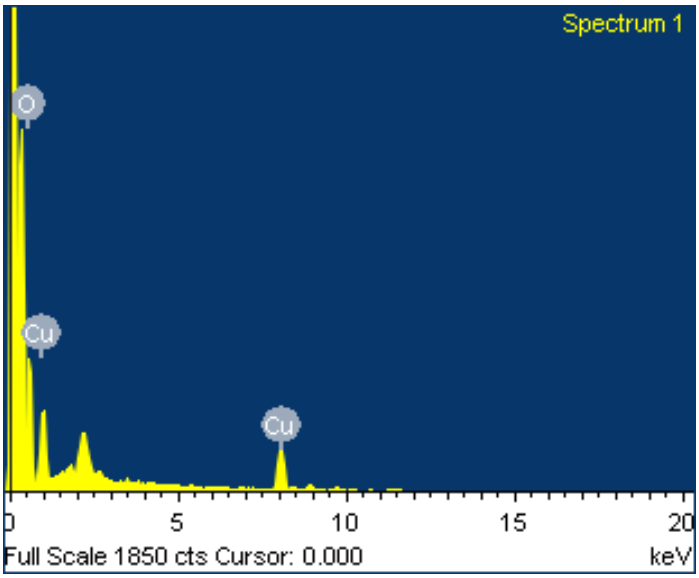


Figure 5 - EDAX spectrum of CuO NPs

EDAX analysis was performed to confirm the elemental composition of the synthesized CuO NPs. The presence of copper and oxygen signals peaks in the EDAX spectrum confirms that the synthesized NPs are CuO NPs (Figure 5).

### 3.5. Scanning electron microscopic analysis (SEM)

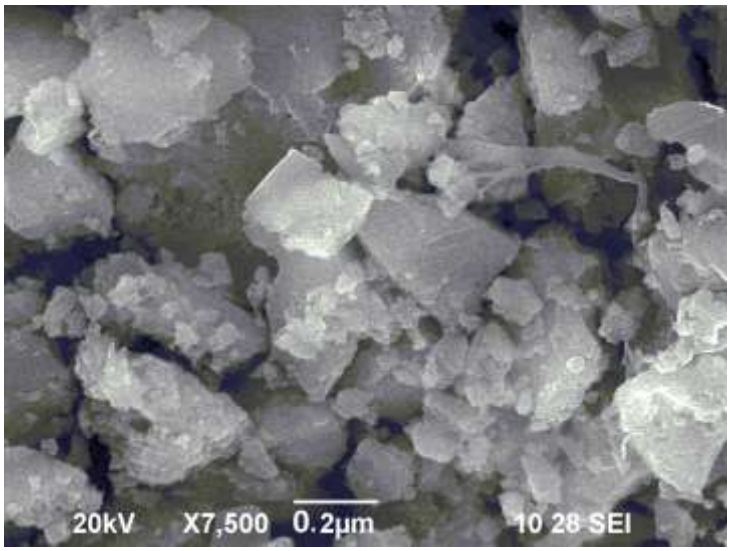


Figure 6 - SEM image of CuO NPs in 0.2 µm scale

The SEM images (Figure 6) show that the product mostly consists of nano clusters with panoramic view. However, careful observation reveals that these nanoclusters are assembled by smaller nanoparticles, which exhibit irregular shape. The average size of these CuO NPs is about 20 – 50nm.

### 3.6. FTIR analysis

The FTIR spectrum of leaf extract of *Momordica charantia* shows peaks at 638, 1050, 1385, 1597 and 3445 $cm^{-1}$ due to C-H out of plane bending, C–N stretching, C-H group, C=O stretching mode and O–H stretching mode respectively. These FTIR bands are characteristic of proteins, triterpenes, alkaloids, steroids and phenolic compounds available in the leaf extract [3].

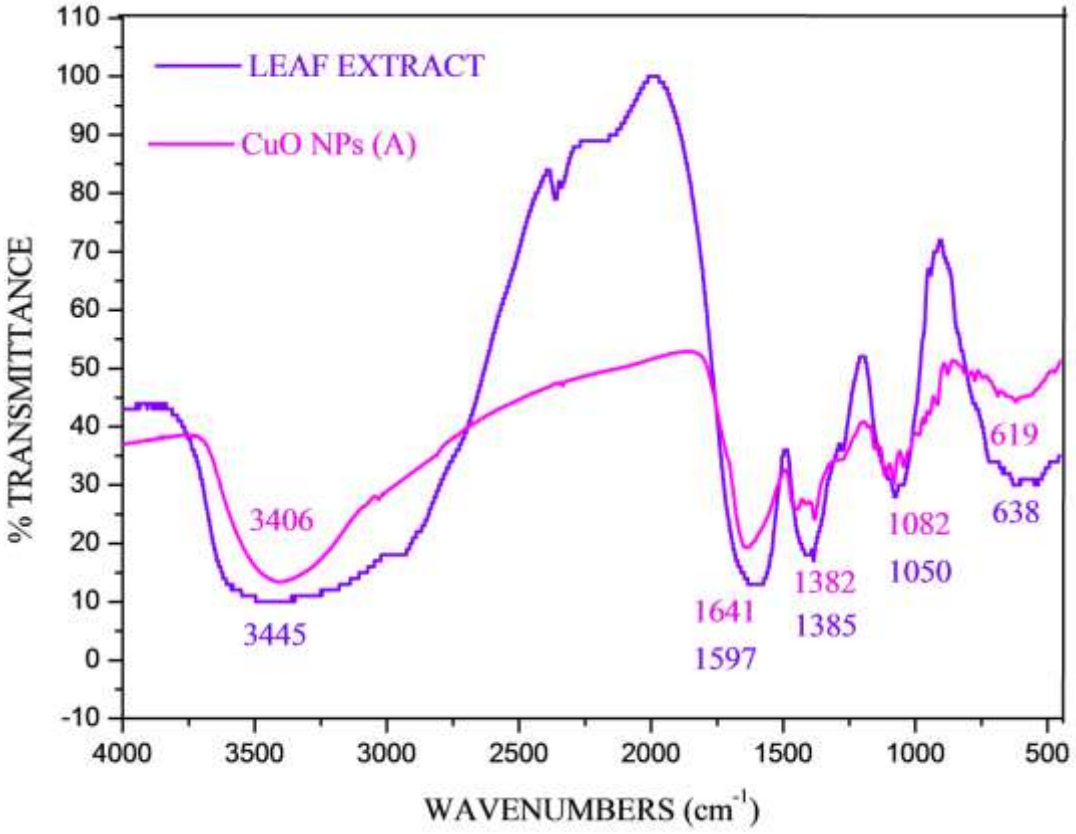


Figure 7 - FTIR spectra of CuO NPs and *Momordica charantia* leaf extract

The FTIR spectrum of CuO NPs (Figure 7) shows peaks at 1082, 1382, 1641 and 3406 $cm^{-1}$ due to C–N stretching, C-H group, C=O stretching mode and O–H stretching mode respectively. In particular, the intense and broad absorption peak at 3445 $cm^{-1}$ due to the OH stretching mode of phenolic compound. The shift from 3445 to 3406 $cm^{-1}$ may point out the participation of OH group in the reduction of $Cu^{2+}$ ions, [8].

The FTIR absorption spectra show that the peak of carbonyl group (stretching vibration) shifted from 1597 to 1641 $cm^{-1}$. The shift from 1597 to 1641 $cm^{-1}$ may indicate that phenolic compounds are simply oxidized

from phenolic form to quinine form [9]. The spectrum of CuO NPs shows a characteristic absorption peak at 619 $cm^{-1}$, which confirms the formation of metal–oxygen stretching of Cu-O nanostructure [10].

### 3.7. Mechanism

The main components of *Momordica charantia* are proteins, triterpenes, alkaloids, steroids and phenolic compounds [3].

In this work, the mechanism of CuO NPs synthesis can be explained by using the phenolic content in the leaf extract of *Momordica charantia*. These phenolic compounds have high reducing ability. They facilitate the reduction of $Cu^{2+}$ ions to nano sized CuO NPs [11].

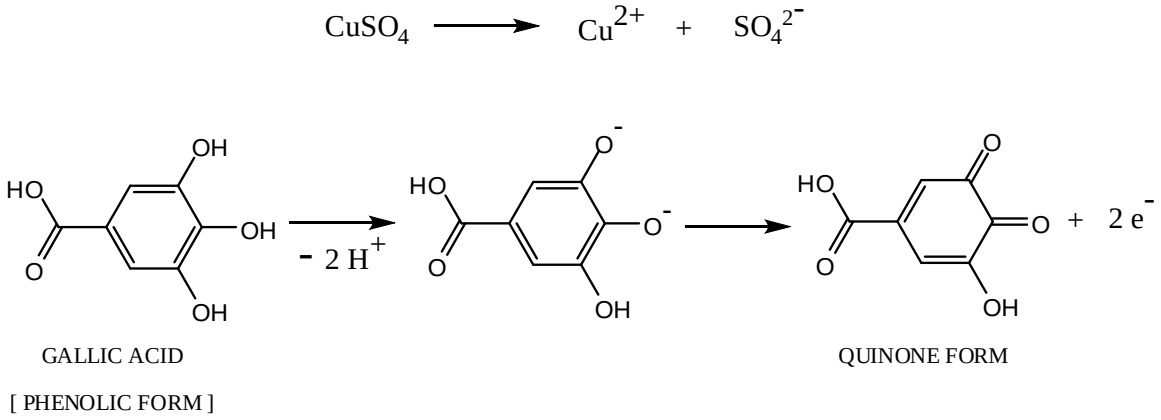


Figure 8 - Mechanism of CuO NPs synthesis

The probable mechanism for CuO NPs synthesis is presented in Figure 8. In this mechanism, Gallic acid undergo oxidation from phenolic form to quinone form with resulting reduction of $Cu^{2+}$ to CuO NPs [12]

## IV.CONCLUSION

This paper has demonstrated that CuO NPs could be synthesized by using the *Momordica charantia* leaf extract. The phytoconstituents like gallic acid act as reducing agents for CuO NPs synthesis and phytoconstituents give stability to CuO NPs. The synthesized CuO NPs were found to have a crystalline structure with FCC geometry as studied by XRD. The SEM and TEM images showed that the synthesized CuO NPs are having the size ranging from 20 -50nm.

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