Study of Green Synthesis of Copper Oxide nanoparticles using *Pentalinon latium* Plant Extract

Mr. Sharad G. Shilkande

Department of Chemistry, Sudhagad Education Societys Seth J. N. Paliwala Commerce College and Arts and Science college, Pali –sudhagad Dist- Raigad 410205

Email: shilkandesharad19@gmail.com

Article DOI Link: https://zenodo.org/uploads/19883411

DOI: 10.5281/zenodo.19883411

Abstract

An important environmental issue is the increasing release of untreated textile effluents into aquatic environments. Stable synthetic colors are frequently not neutralized by conventional wastewater treatment. The green manufacturing of copper oxide nanoparticles (CuO NPs) as a sustainable option is examined in this chapter. CuO NPs were created and analyzed using SEM, FTIR, and XRD using *Pentalinon luteum* leaf extract as a reducing and capping agent. The resultant nanoparticles are strong candidates for the photocatalytic breakdown of hazardous industrial dyes because of their notable crystallinity and spherical shape.

1. Introduction

The textile, paper, and tannery industries are the main causes of water pollution in today's industrial environment. By preventing sunlight penetration and photosynthesis, the discharge of dye-laden effluents drastically affects aquatic flora by raising Biological Oxygen Demand. A revolutionary solution to this dilemma is provided by nanotechnology. CuO and other metal oxide nanoparticles have special optical, magnetic, and electrical characteristics. In contrast to conventional chemical synthesis, "Green Synthesis" uses phytochemicals originating from plants, such as tannins, phenols, and sugars, to decrease metal precursors. In keeping with the tenets of green chemistry, this approach is not only economical but also does away with the need for hazardous chemicals.

2. Materials and Experimental Methodology

2.1 Preparing Botanical Precursors and Extracts

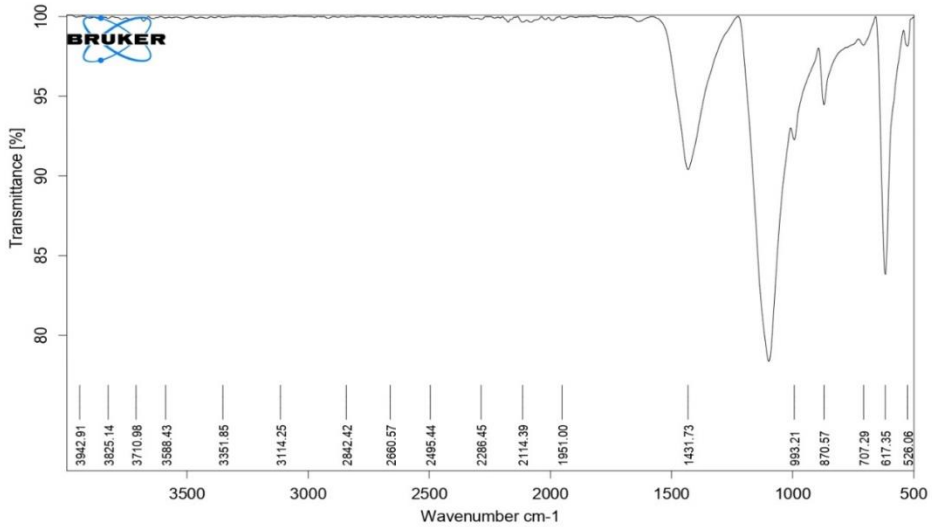
Pentalinon luteum leaves that were gathered from the Karjat district of Maharashtra, India, were used in the synthesis. The preparation entails: After being cleaned with deionized (DI) water, the leaves were left to air dry for six days. The dried biomass was ground into a fine powder. After dispersing 10g of powder in 300 mL of DI water, the mixture was heated to 70°C for 30 minutes. The bioactive substances needed for reduction are present in the resultant filtrate (Whatman No. 41).

2.2 Green Synthesis of CuO-NPs

A wet chemical method was used for the synthesis, which involved adding 2.496 g of copper sulphate to 100 mL of leaf extract. After a 24-hour stirring period, the solution was vigorously magnetically swirled for an hour at 70°C till precipitate formed. To get rid of contaminants, the product was centrifuged at 5000 rpm, dried at 100°C for 12 hours, and then cleaned with ethanol. To guarantee phase purity and crystallinity, the finished powder was calcined for two hours at 400°C.

3. Results and Characterization

3.1 Fourier Transform Infrared (FTIR) Analysis



FT-IR spectra of synthetic copper oxide nanoparticles are shown in Fig. 1

To determine the potential biomolecules in charge of the bio reduction of the produced copper oxide nanoparticles, FT-IR analysis was employed. The FT-IR spectra of copper oxide nanoparticles made from *Pentalinon luteum* leaves is

shown in Fig. 2. The stretching vibration of the Cu-O bond is represented by the absorption bands at 526.06 and 617.35 cm-1.

3.2 Morphological Analysis (SEM)

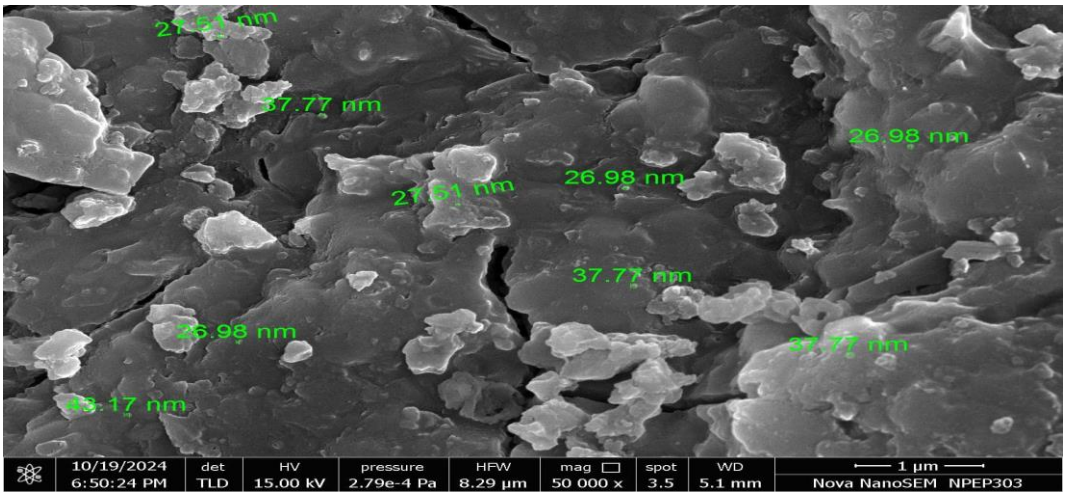


Figure 2: SEM pictures of nanoparticles of copper oxide

Images from Scanning Electron Microscopy (SEM) show that the produced CuO NPs are primarily spherical. The individual crystallite diameters stayed within the Nano scale range of 16.19 nm to 43.17 nm, despite some agglomeration, which is a typical feature of biogenic metal oxides.

3.3 TEM

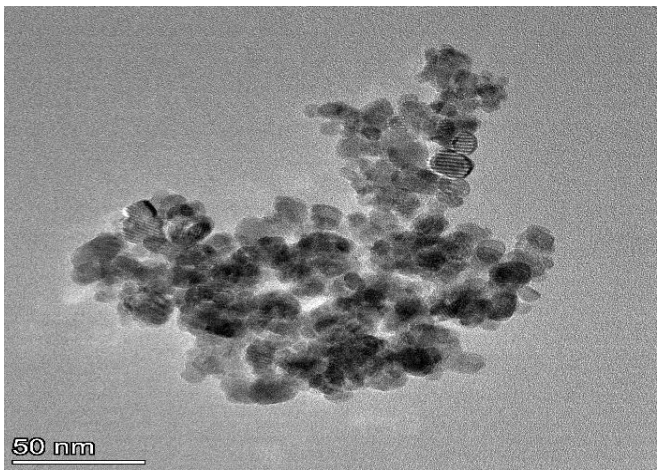


Figure 3: TEM Morphology Pictures

TEM examination was used to determine the size and shape of green produced tin oxide utilizing an aqueous extract from *Pentalinon luteum* leaves. Fig. 3.

Demonstrates how the green produced Copper oxide nanoparticles are spherical in shape and have a cluster-like appearance due to the aggregation of tiny particles. The green produced Copper oxide nanoparticles have a size range of 20–100 nm, according to TEM examination.

4. Discussion and Conclusion

4.1 Synergy of Phytochemicals

The Pentalinon Luteum extract's carbohydrates, flavonoids, and tannins help reduce the ions of Cu (II) to Cu (0), which is then oxidized and stabilized into CuO. High surface-area-to-volume ratios are produced by this environmentally friendly method, which increases the particles' effectiveness as electron carriers in catalytic reactions.

4.2 Conclusion

This work effectively illustrates a low-cost, environmentally acceptable method for producing CuO nanoparticles. The successful creation of crystalline, spherical CuO NPs is confirmed by the characterisation results. 18.17 nm is the average particle size. *Pentalinon luteum's* usefulness as a natural stabilizing agent. The produced nanoparticles have enormous potential for photocatalytic degradation, providing a workable technique to detoxify and decolorize wastewater from the textile sector while safeguarding aquatic biodiversity.

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