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BIOSYNTHESIS OF COPPER OXIDE NANOPARTICLES USING *Uraria picta* (JACQ.) PLANT EXTRACT AND ITS CHARACTERIZATION

SARTAJ SHEIKH[1], ARVIND J. MUNGOLE[2]*, HARSHA P. KANFADE[3], A. P. PAWAR[4], MRUNAL I. WARHADE[1], SNEHAL BHANDAKKAR[6] AND A. N. YERPUDE[7]
[1]Department of Botany, Gramgeeta Mahavidyalaya, Chimur, Maharashtra - 442 903, INDIA
[2]Department of Botany, [4]Department of Chemistry,[7]Department of Physics
Nevjabai Hitkarini College, Bramhapuri, Maharashtra - 441 206, INDIA.
[3]Department of Botany, SBMM, Bramhapuri, Maharashtra - 441 206, INDIA.
[6]Department of Botany, ACS College Maregaon, Maharashtra - 445 303, INDIA.
e-mail: aru.mungole@gmail.com
ORCID ID:htpp://orcid.org/0000-0003-2241-7790

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***Corresponding author**

ABSTRACT

The complete plant extract from Uraria picta was used in the current study as a natural reagent to synthesize CuO nanoparticles. A large part of the synthesis in response to the plant extract served as a reducing and stabilizing agent, resulting in copper oxide nanoparticles (NPs) of different sizes and forms. The synthesized nanoparticles were characterized using XRD, FTIR, UV-Vis spectroscopy, SEM and TEM. Strong absorbance peaks at 294 nm in the UV-visible spectrum are caused by the formation of CuO. The synthesized CuO XRD diffraction peaks closely matched those of the previously published CuO XRD. According to FTIR studies, the Cu-O bond stretching can be seen in the absorption bands at 515.50 cm-1 and 623.64 cm-1. The SEM micrographs show that the CuO particles are spherically formed, densely packed together, and irregularly dispersed. The TEM picture showed an average particle size of 50 nm. In this study, copper oxide nanoparticles of Uraria picta (JACQ.) plant extract prepared using the biosynthesis and characterized.

INTRODUCTION

Biosynthesis of metal oxide nanoparticles, mediated by plant extracts has become a promising area of research due to their intensive applications in the environmental, pharmaceutical, nanofluids food and cosmetics industries (Chang *et al.*, 2011). Biological synthesis has received widespread attention as a reliable, sustainable, and environmentally friendly method for the synthesis of metal or metal oxide nanoparticles (Singh *et al.*, 2018). Nanoparticle biosynthesis is considered to be an important tool in reducing the destructive effects associated with traditional nanoparticle synthesis methods used in laboratories and industries (Jeevanandam, *et al.*, 2016 and Chauke *et al.*, 2020).

Nanoparticles with their unique size-dependent property have the ratio of the surface area to volume. The smaller the sized particles carry a greater aspect ratio *i.e.*, greater surface area compared to their volume. This increasing field of smaller nanoparticles enhances the nanoparticle's reaction with the surrounding molecules. Metal oxides at the nanoscale can restrict the movement of electrons due to their small size. They can tune their band gaps and can therefore control their light absorption and emission wavelengths (Mungole *et al.*, 2021). Potential applications of copper oxide nanoparticles (CuONPs) in field launch transmitters, agriculture, gas sensing, waste treatment, catalysis, batteries, food preservation, high-temperature superconductors, solar energy conversion, photovoltaic devices, dye removal, *etc.* have been established (Akintelu *et al.*, 2020). Due to CuO nanoparticle's high thermal conductivity, optical, magnetic, and electrical properties (Chandrasekar *et al.*, 2021) researchers are truly attracted to it. Besides these applications, CuONPs also have biomedical activities such as anticancer (Rehana *et al.*, 2017), antimicrobial (Ahamed *et al.*, 2014), and antioxidant as well as catalytic efficacy (Dobrucka *et al.*, 2018). The extensive application in wound healing by copper nanoparticles synthesized by *Falcaria vulgaris* leaf extract were examined by . Zangeneh, *et al.*, 2019). Weiss *et al.*, reviewed applications of nanoparticles in food nanotechnology also (Weiss *et al.*, 2006).Presently nanoparticles of various metals using different plants are synthesized with different goals (Pawar *et al.,* 2023; Dandapat *et al.*,2023., Padhiary *et al.*,2023).

For the synthesis of CuONPs, physical and chemicals methods used traditionally might be a tedious process (Akintelu *et al.*, 2021) and can give rise to hazardous chemical by-products (Ananda Murthy *et al.*, 2018). On the contrary, the biosynthesis of CuO nanoparticles has been carried out by various biological materials like bacteria, fungi, alga, and plant extract. Among all these methods of biosynthesis of copper oxide nanoparticles, the plant extract mediated approach is a comparatively simple and easy process to produce nanoparticles at a larger scale to bacteria and fungi-mediated synthesis. The presence of effective phytochemicals in plants such as ketones, aldehydes, flavones, terpenoids, carboxylic acid, phenols, ascorbic acid, *etc.* is active to reduce metal salts into metallic nanoparticles as well as stabilizes the prepared nanoparticles (Sheikh *et al.*, 2022).

Uraria picta (Jacq.) DC belongs to the family Leguminosae-Papilionaceae, a perennial herb known for its medicinal property. In Uraria picta the presence of alkaloids, flavonoids, steroids, terpenoids, phenols, and saponins in all plant parts was reported (Saxena *et al.*, 2014). Due to the phytochemicals included in the extract, the aqueous extract of U. picta displayed radical scavenging potential, which may contribute to the extract's ability to treat or manage Alzheimer's disease (Veronica *et al.*, 2013). The large-scale production of CuONPs by using Uraria picta whole plant extract might be beneficial in biomedical applications as it is safer than chemically synthesized copper oxide nanoparticles. Nanoparticles has been synthesized and evaluated for their several properties and applications by many workers to prove its signifacances (Bhokare *et al.*, 2019, Choudhary *et al.*, 2017, Sathya and Mahimairaja, 2018). In this study, copper oxide nanoparticles of Uraria picta (JACQ.) plant extract prepared using the biosynthesis and characterization was done..

MATERIALS AND METHODS

Preparation of plant extract

Plant material of Uraria picta was collected from Ghodazari, which is located near the Nagbhid city of Chandrapur district, Maharashtra, India. The collected plant was washed thoroughly with running tap water to remove dirt particles and then again washed with distilled water. The washed plants dried in the shade, then the powder was prepared from it. For the preparation of plant extract, 25g powder was taken and boiled with 250 ml distilled water at 80° for 2 Hrs. The prepared extract was filtered through Whatman no. 1 filter paper. The filtrate was stored at 0° for further use.

CuO NPs biosynthesis

CuO NPs were synthesized by adding 5g of copper sulphate pentahydrate in 50ml Uraria picta plant extract with continuous stirring on the heating plate at about 80!. The stirring and heating were continued until paste formation. The obtained paste was then calcinated at 400-500° for 2 Hrs. the dark green to blackish powder was produced considered to be CuO nanoparticles. Figure 2 shows the biosynthetic pathway of CuO NPs.

Biosynthetic pathway of CuO NPs

Characterization of CuO NPs

Characterizations of biosynthesized copper oxide nanoparticles were done by various methods *viz.* UV-visible spectrophotometry determination (SAIF, Cochin) of optical absorption of CuO NPs, bio-reduction of Cu was identified by performing functional group identification on Fourier transform infrared spectroscopy (FT-IR) (SAIF, Cochin), X-ray diffraction (SAIF, Cochin) was studied to determine crystalline and lattice structure of the CuO NPs and is carried in the diffraction angles (2θ) from 20 to 80°.

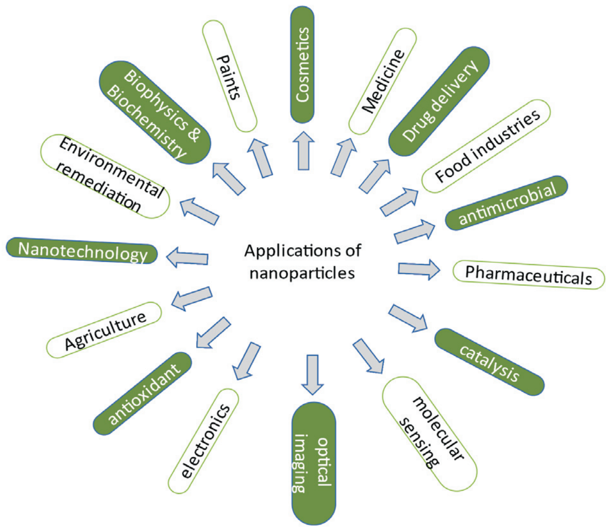

Figure 1: Applications of nanoparticles

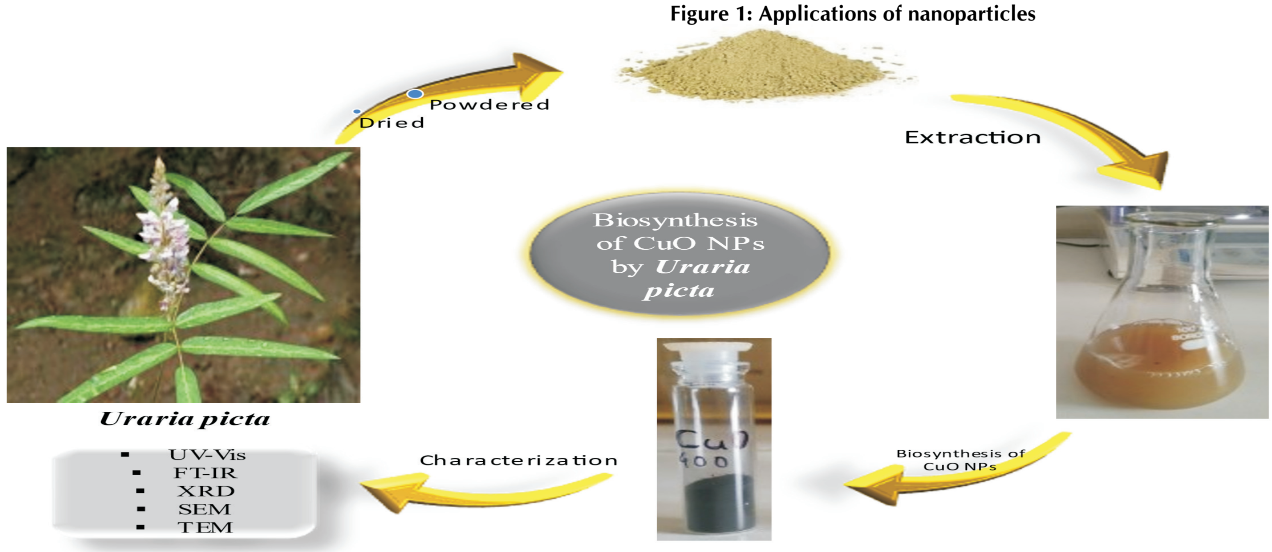

Figure 2: Biosynthetic pathway of CuO NPs

RESULTS AND DISCUSSION

UV-Visible Analysis

spectrum of CuO NPs synthesized by Uraria picta plant extract

As shown in Fig. 3, the UV-Vis spectra revealed a maximal wavelength of 294 nm, confirming the production of CuO NPs. In the UV vis spectrum two absorbance peaks centered at 274 nm and 294 nm which are due to the formation of CuO (Abboud *et al*. (2014). This result was consistent with the findings of Yulizar Y. *et al*. (Yulizar *et al*. (2018). The Surface Plasmon Resonance (SPR) phenomenon of metal oxide nanoparticles created this peak.

XRD Analysis

XRD analysis depicts crystalline structure and it is confirmed from Figure 4 which shows an X-Ray Diffraction plot of CuO NPs. It was compared with standard (JCPDS CuO Number 045-0937) (Mari *et al*., 2020, Peddi *et al*., 2021, Devipriya, 2017). The XRD shows the position of the peaks of 2 ϕ values

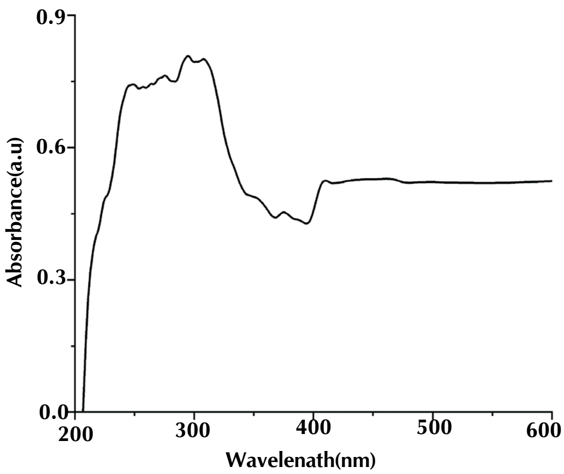

Figure 3: UV-Vis spectrum of CuO NPs synthesized by Uraria picta plant extract

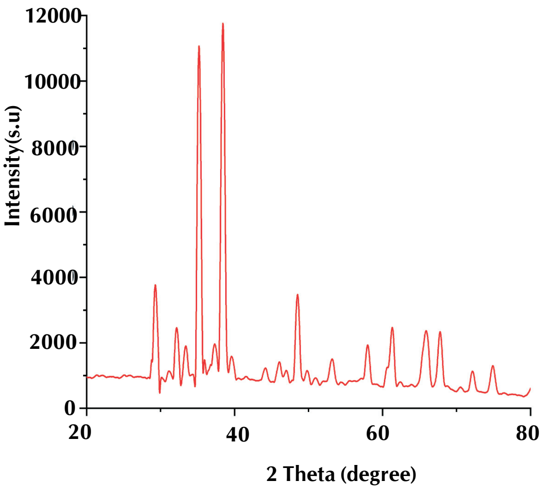

Figure 4: XRD of CuO NPs synthesized by Urariapictaplant extract

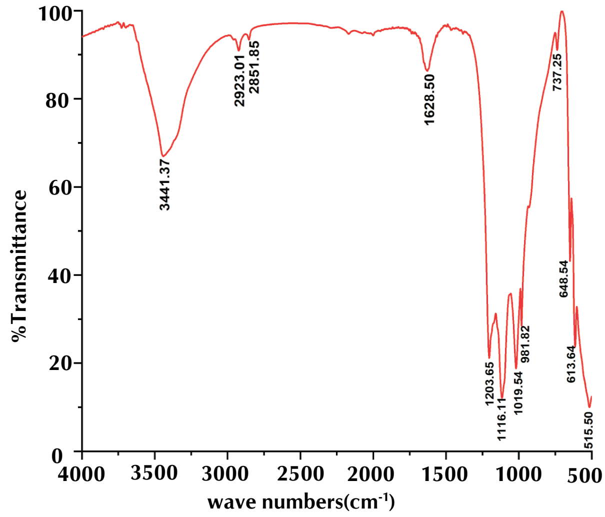

Figure 5: FT-IR of CuO NPs synthesized by Uraria picta plant extract

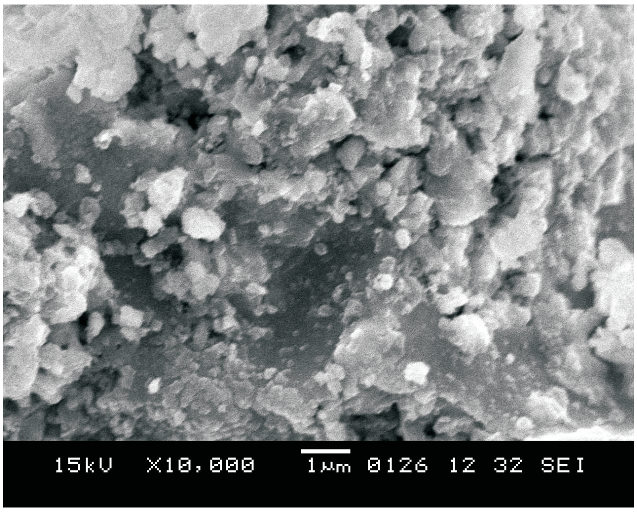

Figure 6: SEM image of CuO NPs synthesized by Uraria picta plant

at 35.217°, 38.40°, 48.500, 53.16°, 58.001°, 61.28°, 66°, and 67.80° correspond to (002), (111), (202), (020), (202), (113), (311), and (220) the miller indices (Ahamed *et al*., 2014). The above diffraction peaks match with the formation of CuO. We may conclude that the prepared CuO NPs is pure and does not contain any other phases by noting that all of the obtained peaks belong to the monoclinic phase of the CuO. The prominent peaks are clearly the characteristic peaks for the pure monoclinic phase of CuO NPs.

FT-IR analysis

FT-IR of CuO NPs synthesized by Uraria picta plant extract is shown in fig.5. A FTIR spectrometer was used to record the FT-IR of CuO NPs in the spectral range of 500 to 4000 cm^{-1}. The Cu-O bond stretching vibration in monoclinic CuO appears in the absorption bands at 515.50 cm^{-1} and 623.64 cm^{-1} (Xia *et al*., 2009). In FT-IR characterization strong vibrations found at 515.50 cm-1 clearly indicate Cu-O functional group present in the sample as FT-IR analysis does for the detection of functional groups in the synthesized samples. For the rest

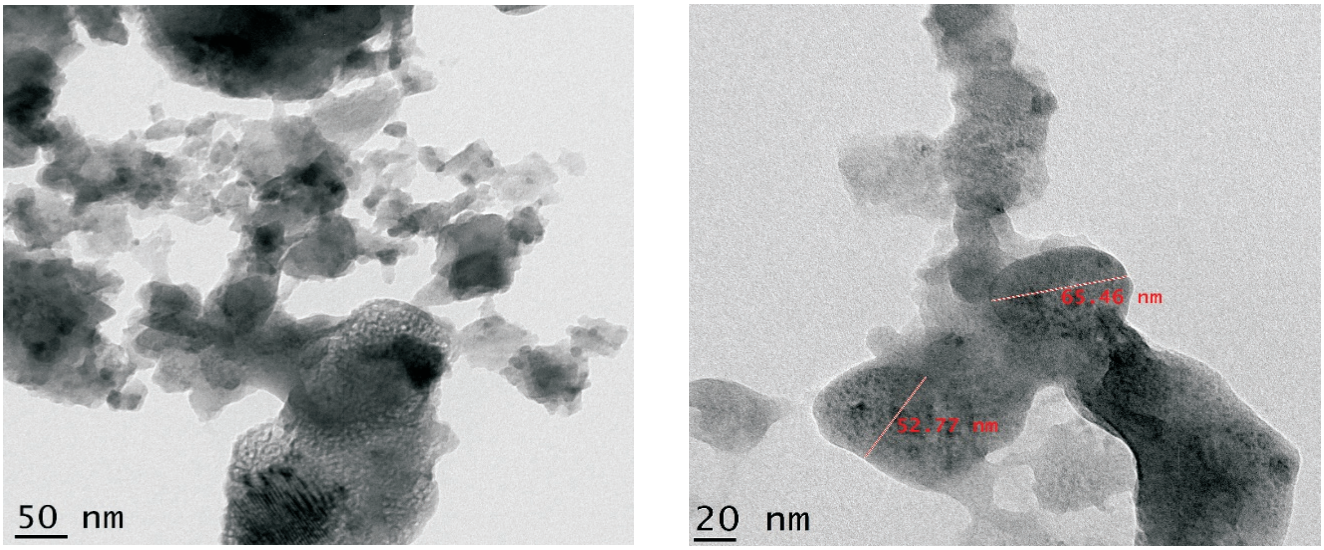

Figure7 : TEM image of CuO NPs synthesized by *Uraria picta* plant extract

of this, there are absorptions that indicate the presence of secondary metabolites in Uraria picta plant extract, as the peaks that appeared at 1019 indicating ester bond between copper species (Rabiee *et al*., 2020), 1116 cm^{-1} correspond to C-OH of phenols and alcohol (Peddi *et al*., 2021), 1628 cm^{-1}as C=O in ketone or aldehyde compounds, 1203.50 cm^{-1} represent C-O-C bond, 3441.37 cm^{-1} contribute in O-H stretch of polyphenols (Selvam *et al*., 2020). In the CuO NPs formation, the secondary metabolites play an important role. Cu_2O impurities' vibrations in the spectral region between 615 and 621 cm^{-1} were undetectable (Dagher *et al*., 2014). Due to the presence of water molecules, wide absorption bands have been found at 3441.37. The FTIR study showed that the CuO NPs produced by the plant extract of Uraria picta were in the pure phase of CuO.

SEM Analysis

Using SEM examination, the morphology of the CuO NPs has been determined as shown in figure 6. According to the SEM micrographs of the synthesized CuO nanoparticles, the particles have a spherically shaped and are closely bound to one another and unevenly distributed. SEM micrograph indicates the presence of CuO NPs with a somewhat uniform shape but a range of sizes.

TEM Analysis

To determine the detailed structure and the size of biosynthesized nanoparticles transmission electron microscopy were done. The result of TEM analysis is shown in figure 7. As per the image obtained the spherical shaped CuO nanoparticles with an average particle size is 50 nm has been confirmed. The TEM image shows that there is a difference in particle size.

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