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Full Length Research Article

Hibiscus rosa-sinensis Extract Assisted Green Synthesis and Antibacterial Activity of Copper Oxide Nanoparticles

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ABSTRACT

Copper oxide (CuO) nanoparticles (NPs) were synthesized using *Hibiscus rosa-sinensis* extract and copper nitrate as precursors. The *Hibiscus rosa-sinensis* extract and copper nitrate is dissolved in DI water and the solution was stirred for 30 minutes. The resulting homogeneous solution is transferred to silica crucible and irradiation is carried out in using the microwave oven. The final product was characterized using FTIR spectra and HR-SEM and antibacterial activities. Powder XRD results showed that CuO is well crystalline monoclinic structure. HR-SEM images have shown the development of uniform and regular-shape crystallites. Cu, O elements present in the EDX analysis that confirm the CuO NPs without any impurities. Antibacterial experiments have shown that the CuO NPs under room temperature destroy the human pathogens due to their unique properties and the support of using medicinal plants extracts.

***Key words*: Medicinal plants extract, Copper oxide, *Hibiscus rosa-sinensis*, Antibacterial experiments

The nanostructures of metallic oxides with numerous morphologies have advantageous in lots of fields including medicinal and bio-catalytic properties [1-3]. Among them copper oxide (CuO) is p-type semiconductor, due to its extraordinary houses, draws giant interest. In a couple of packages consisting of catalysis, sun strength conversion, fueloline sensor and subject emission [4-10], CuO nanostructures (NSc) has monoclinic shape with a band hole of 1.2 eV. Synthesis, but will decorate those novel houses which have proven extraordinary performance as in comparison to bulk opposite numbers in CuO nanostructures. Various morphologies such as nanowire, nanorod, nanoneedle, nano-flower and nanoparticles are synthesized in unusual nanostructures of CuO. CuO NSc physicochemical houses are strictly depending on their length and morphology [11, 12]. Thus, loads of tries are made to put together unique NSc. CuO of various dimensions and shapes is a critical fabric in CuO NSc, displaying advanced optical, and catalytic houses [13] and accordingly locating packages in fueloline sensing, magnetic storage, catalysis and conversion of sun strength [14-19]. So far, numerous CuO are synthesized.

In current decades, numerous techniques of manufacturing CuO NPs of numerous dimensions and shapes had been suggested, consisting of thermal oxidation, sonochemistry, combustion and speedy precipitation [20-22]. CuO NPs consequently show off interesting houses [23], in comparison with their bulk materials. CuO NPs synthesis of various dimensions and shapes, loads of bodily and chemical techniques are being produced. Different instruction techniques are used to synthesize CuO NPs which have their very own advantages and disadvantages [24]. Many techniques, consisting of sol gel, hydrothermal, flame spray pyrolysis, combustion and co-precipitation techniques, are used for the synthesis of CuO NPs [25].

The essential environmental risks are herbal dyes, due to their balance towards oxidising agents [26]. Plant extract assisted synthesis is an easy approach to prepare the metal oxide materials and can be used for antibacterial activity. CuO NPs are used ordinarily as antimicrobial agents. Due to their antimicrobial ability, over 99.9 % consistent with cent of Gram-positive and negative bacteria are used to smash in hospitals inside 2 hours of being uncovered if a dosage is adequate. Studies have additionally proven that using CuO decreases hospital-obtained contamination and health-care prices in healthcare facilities. Bed sheets with CuO NPs are taken into consideration as one of the maximum exciting hospital therapy technology as they dispose of microbial attachments and feasible microbial infections in hospitals. It has a huge kind of programs along with antibacterial and antimicrobial, thermoelectric, magnetic garage media, sensors, ceramic resistors, near-infrared tilters, sprucing and sensors. In the existing work, CuO NPs are organized the use of answer combustion approach and characterized the use of XRD, SEM, FTIR to investigate its microstructural properties. CuO NPs also are used as antibacterial agent against human pathogens.

MATERIALS AND METHODS

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Copper (II) nitrate (Sigma-Aldrich, 99%), and *Hibiscus rosa-sinensis* extract were utilized for the green synthesis of CuO NPs. Deionized water was utilized in all stages of the synthesis. The *Hibiscus rosa-sinensis* extract is mixed with the copper nitrate precursor with deionized water. The mixture was kept in a microwave oven. The final product were washed well with DI water and ethanol twice finally dried at 70°C and used for further characterizations.

Characterization techniques

The structural characterization of CuO NPs were performed using Rigaku Ultima X-ray diffractometer equipped with Cu-Kα radiation (λ =1.5418 Å). The surface functional groups were analyzed by Perkin Elmer FT-IR spectrometer. Morphological studies and energy dispersive X-ray analysis (EDX) of CuO NPs have been performed with a Jeol JSM6360 high resolution scanning electron microscopy (HR-SEM). UV-Visible diffuse reflectance spectrum (DRS) was recorded using Cary100 UV-Visible spectrophotometer to estimate their band gap energy (E_g). Magnetic measurements were carried out at room temperature using a PMC MicroMag 3900 model vibrating sample magnetometer equipped with 1 Tesla magnet.

Antimicrobial activity

Gram negative *Escherichia coli* and Gram-positive *Staphylococcus aureus*, bacterial pathogens were used for *in vitro* antimicrobial activity. These selected pathogenic strains were obtained from Microbiological Division (Jayagen Biologics Analytical Laboratory, Jayagen Biologics, Chennai).

RESULTS AND DISCUSSION

XRD analysis

(Fig 1) shows the powder XRD pattern of CuO NPs, indicating the polycrystalline nature. XRD pattern of the CuO NPs peaks reflections are corresponding to the (110), (002), (111), (202), (020), (113), (311) and (221) planes of monoclinic CuO phases (JCPDS 45-0937). Scherer's formula is used to calculate the average crystallite size of the CuO NPs:

$$D = \frac{K\lambda}{\beta\cos\theta}$$

where L is the crystallite size, λ, the X-ray wavelength, θ, the Bragg diffraction angle and β, the full width at half maximum (FWHM). The average crystallite size 'L' calculated from the diffraction peaks was found to be around 23 nm.

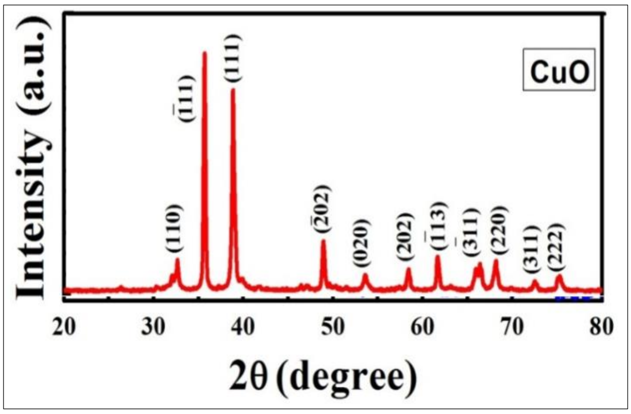

Fig 1 Powder XRD pattern of CuO NPs

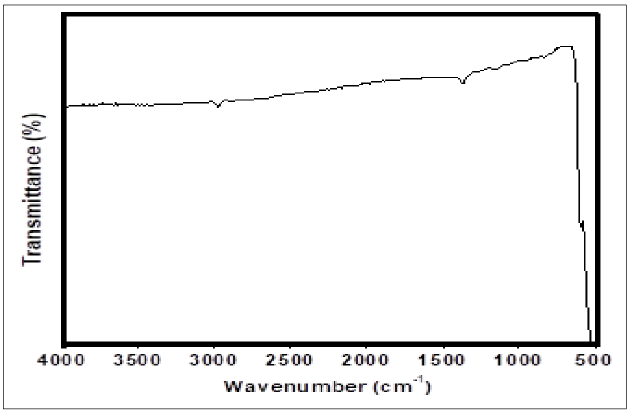

Fig 2 FTIR spectra of CuO NPs

FTIR analysis

FTIR spectrum of CuO nanoparticles was recorded in the wavenumber range from 400-4000 cm^{-1} and is shown in (Fig 2). FTIR spectrum exhibits vibrations about 585, 683, 857, 1565, 2948 and 2985 cm^{-1}, confirming the formation of highly pure phase product of CuO nanoparticles [24].

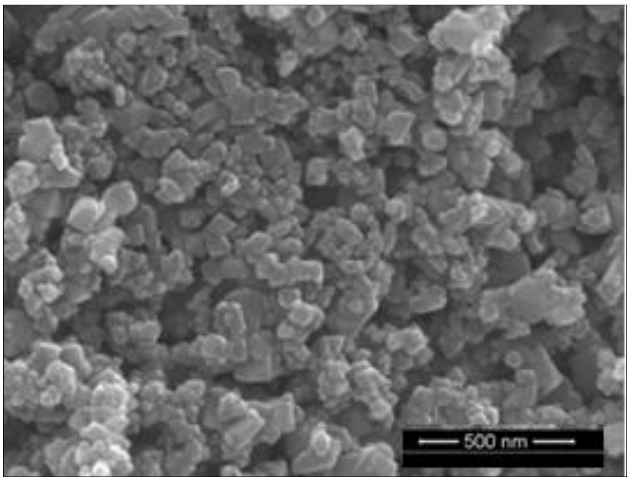

Fig 3 HR-SEM image of CuO NPs

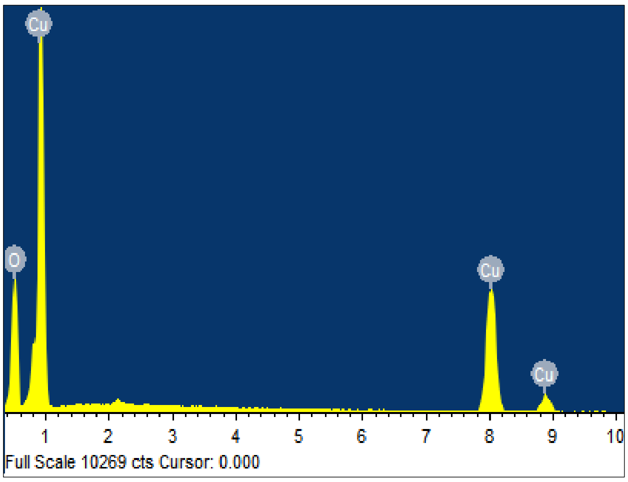

Fig 4 EDX spectra of CuO NPs

HR-SEM studies

(Fig 3) shows the HR-SEM images of CuO NPs. It shows the surface morphology of CuO NPs. The SEM images clearly show that the well-defined morphology and agglomeration with the formation of spherical crystallites with uniform shapes and size of the particles with nano level.

EDX analysis

The EDX results (Fig 4) confirms that there are only Cu, O elements only presence, which indicating the purity of CuO NPs without any other impurities [24-25].

Antibacterial activity

The antibacterial activity was determined by well diffusion methods. About 25 mL of molten Mueller Hinton Agar was poured into a sterile Petri plate (Himedia, Mumbai, India). The plates were allowed to solidify, after which 18 h grown (OD adjusted 0.6) 100 µl of above said pathogenic bacteria cultures were transferred onto plate and made culture lawn by using sterile L-rod spreader. After five min setting of the bacteria, the wells were made using sterile 5 mm cork borer and test samples were dissolved in sterile water at various concentrations (i.e., 25, 50, 75 and 100 µl/well). The sterile water served as control. The plates were incubated at 37°C in a 40 W fluorescent light source (~ 400 nm) for 24 h. The antibacterial activity was determined by measuring the diameter of the zone of inhibition around the well using antibiotic zone scale (Himedia, Mumbai, India). The antibacterial activity profile of test samples was capable to kill all the tested pathogens ranging from 6 mm to 29 mm of zone of inhibition. The test materials are highly active against all test pathogens.

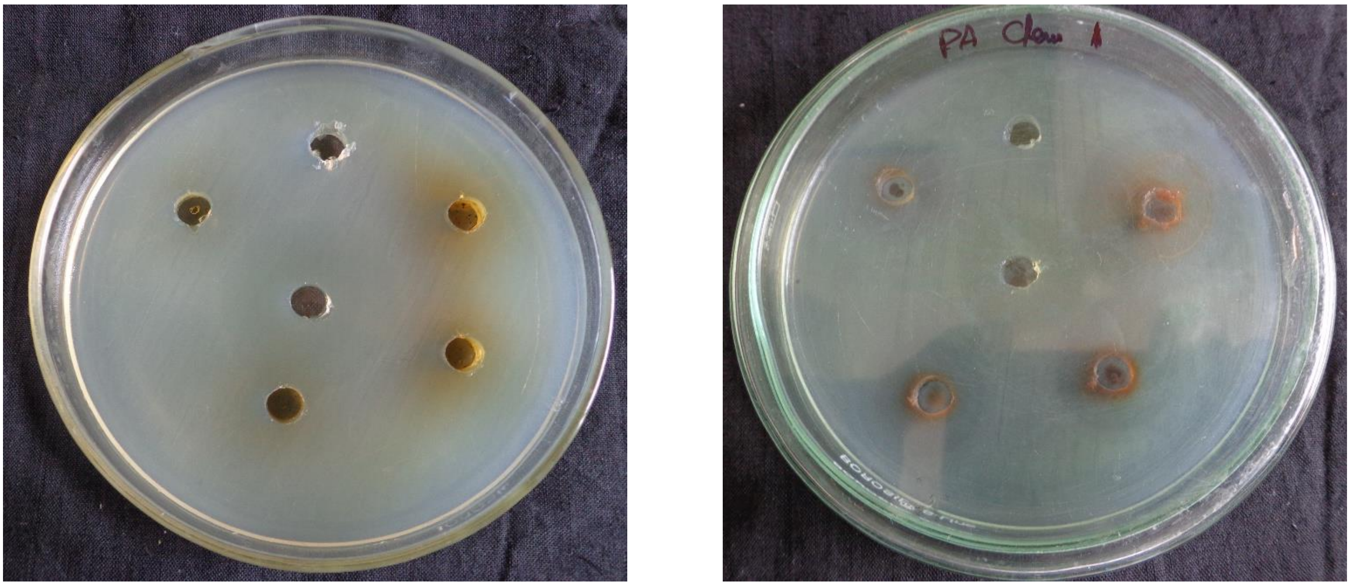

Fig 5 Antibacterial activity against human pathogens using CuO NPs

CONCLUSION

Semiconductor CuO NPs are successfully synthesized by *Hibiscus rosa-sinensis* extract assisted microwave irradiation method. Structural, functional, morphological and antibacterial activities of the prepared CuO NPs are analyzed. Polycrystalline CuO NPs was confirmed by the XRD studies. The formation of sphere shapes and sizes of the CuO NPs was confirmed by HR-SEM results. The antibacterial activity profile of test samples was capable to kill all the tested pathogens ranging from 6 mm to 29 mm of zone of inhibition. The test materials are highly active against all test pathogens.

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