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Synthesis of CuO Nanoparticles from *Mirabilis jalapa* Seed Extract and its Antibacterial Activity

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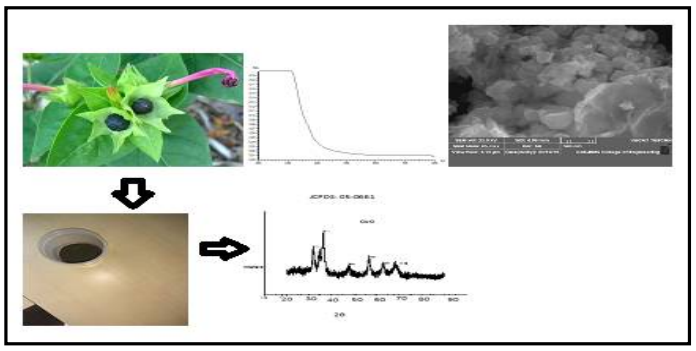
ABSTRACT

The nanoparticles produced using plant extracts are more stable. Copper oxide nanoparticles using Mirabilis jalapa Seed extract has been successfully synthesized by solution combustion method. The characterization of CuO nano particles were carried out to confirm the nano size and shape. The morphology of the CuO nanoparticles was confirmed by powder X-ray diffraction (PXRD). The CuO nanoparticles show the UV-absorption peak at 340 to 380nm. The free agglomerated large surface area with spherical shape is indicated by SEM images. The Scherrer's method used to find the average crystalline size in the range of 10-20 nm.

Graphical Abstract



Keywords: Plant extract, CuO nanoparticles, SEM images.

INTRODUCTION

The CuO nanoparticles production without using harsh, toxic and expensive chemicals have a significant potential to boost nanoparticle production [1-3].CuO nanoparticle play an important role in the field of medicine in which they act as antioxidant [4], antimicrobial agents [5] and pesticide formulations [6]. Apart from, it has numerous applications like gas sensors [7] and catalyst [8].

Nanoparticles synthesized through green route is an eco-friendly and inexpensive method. The following plants have been reported for the synthesis of metal oxide nanoparticles, Neem [9], Aloe Barbadensis Miller [10], Euphorbia tirucalli [11], Cassia fistula [12].

Mirabilis jalapa is popularly known as four o' clock plant. It belongs to Nyctaginaceae family. Chemical analysis of different parts of *Mirabilis jalapa* shows the presence of alkaloids, flavonoids, phenols and steroids. Leaves of *Mirabilis jalapa* are applied on external wounds [13]. Roots are used to arous aphrodisiac activity [14]. Leaf juice applied in to eyes as an eye drops. Present work, CuO nanoparticles were prepared using *Mirabilis jalapa* seed extract as fuel by solution combustion method [15]. The CuO nanoparticles were confirmed by the following characterization analysis such as UV-Visible, PXRD and SEM report.

MATERIALS AND METHODS

Materials: The seeds of *Mirabilis jalapa* plant were taken from the agriculture land in Varthur, Bangalore, Karnataka, India. The required chemicals cupric nitrate tri hydrate was purchased from vasa scientific company.

Preparation of Extract: *Mirabilis jalapa* plant seeds were dried in a shade, later seeds were powdered mechanically using mixer grinder and then sieved. The powder was mixed with double distilled water in a Soxhlet apparatus and the extraction process was carried out at 40 to 50°C for 68 h. The crude plant sample was collected at the end and it was stored in air-tight container in the refrigerator.

Synthesis of CuO Nanoparticles: The CuO nanoparticles were prepared using solution combustion method [16] by taking 0.1 g of plant crude extract and stoichiometric amount of copper nitrate trihydrate and dissolved in 10 mL of distilled water in a silica crucible with constant stirring for 10 to 15 min to get homogenous mixture. The muffle furnace was preheated upto (400±10°C) and the reaction mixture was kept for 10 min to get CuO nanoparticles. The black-colored particles were obtained was stored in air tight container until further use.

RESULTS AND DISCUSSION

The UV-peak bending curve absorbed at 340 to 380 nm indicates the presence of CuO nanoparticles shown in figure 1.

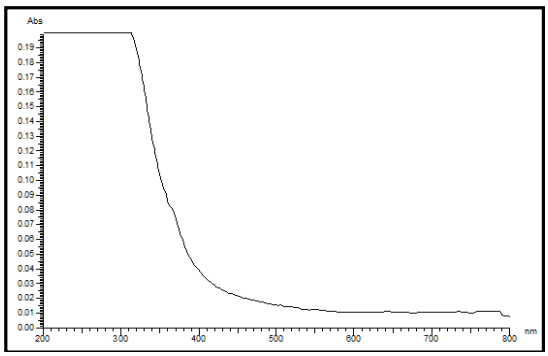


Figure 1. UV-Visible spectrum of the synthesized CuO Nps.

The PXRD- Pattern of CuO nanoparticles indexed to be monoclinic crystalline structure (JCPDS: 05-0661). The average crystalline size of CuO nanoparticles were calculated using Debye-Scherrer's formula [17] (Fig 2). $D=k\lambda/\beta\cos\theta$ k is a constant equal to 0.94, λ is the wave length of X-ray radiation

(1.5406 A^0), 2θ is the Bragg angle (degree).The average size of nanoparticles were found to be in the range of 10-20 nm.

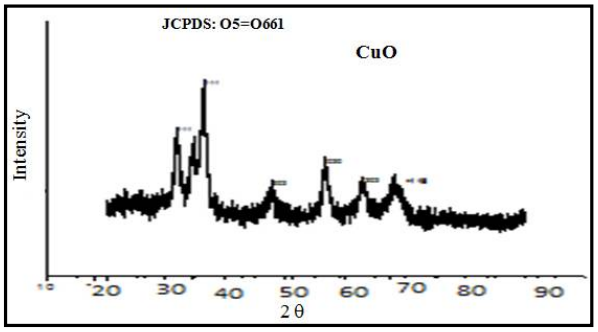


Figure 2. PXRD Pattern of the CuO nanoparticles.

The SEM images of CuO nanoparticles in figure 3, shows that the particles are almost spherical in nature with free agglomeration.

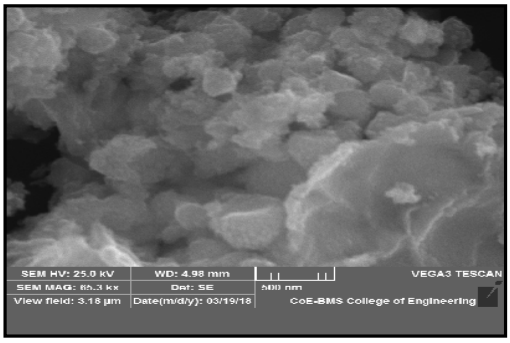


Figure 3. SEM images of CuO nanoparticles.

APPLICATION

Antibacterial activity of CuO nanoparticles: The antibacterial activity of CuO nanoparticles synthesized from *Mirabilis jalapa* seed extract has been carried out against *Staphylococcus aureus* (Gram +ve) and *Escherichia coli* (Gram –ve) by Agar well diffusion method (Fig.4). The wells were prepared in the plates with Cork borer. Each well was loaded with30, 45, 60, 75, 90µL of corresponding concentration of sample and 10 mg of Tetracycline dissolved in 1 mL of 10% DMSO was used as a positive control. The plates were incubated for 24 h at 37°C. The development of inhibition zone around the well was measured and recorded in table 1[**18, 19**].

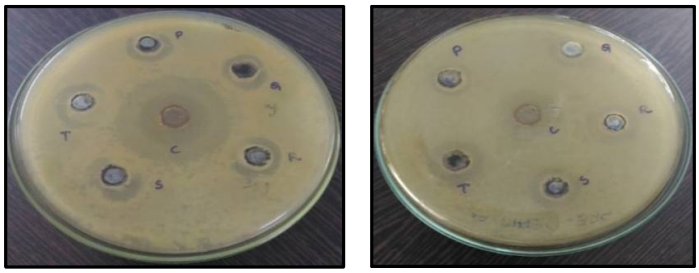


Figure 4. Antibacterial activity of CuO nanoparticles on *Stapylococcus aureus* and *Escherichia coli.*

Table 1. Antibacterial activity of *Stapylococcus aureus* and *Escherichia coli*

Sample	Concentration (µg)	Zone of inhibition(mm)	
		Sample	Control (300 µg)
Staphylococcus aureus	300	11	
	450	12	
	600	16	30
	750	16	
	900	19	
Escherichia coli	300	12	
	450	14	
	600	15	35
	750	15	
	900	16	

CONCLUSIONS

Green synthesis of CuO nanoparticles were successfully carried out using *Mirabilis jalapa* seed extract as fuel by solution combustion method. The bending curve at 340 to380 nm confirms the presence of CuO nanoparticles. The PXRD pattern revealed that monoclinic crystalline structures of CuO nanoparticles with the average size of 10-20 nm. SEM images indicate the spherical shape of the nanoparticles with the average size of 20-50 nm with free agglomeration. The antibacterial activity reports proved that the applicability of CuO nanoparticles as stabilizing and reducing agent.

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