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Short Communication

EICHHORNIA MEDIATED COPPER OXIDE NANOPARTICLES: *IN VITRO* ANALYSIS OF ANTIMICROBIAL ACTIVITY

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ABSTRACT

Objective: The present investigation determines the biological synthesis and characterization of Copper oxide nanoparticles from aqueous extract of *Eichhornia crassipes* and assessing its effects on antimicrobial activity against the pathogens.

Methods: In this method *Eichhornia* mediated copper oxide nanoparticles were synthesized and characterized by FT-IR, FESEM and EDX and also antimicrobial activity was determined using the well diffusion method.

Results: The antimicrobial activity of *Eichhornia* mediated copper oxide nanoparticles was tested against selective pathogens and maximum zone of inhibition was observed in *S. aureus* and *A. flavus* at 100 µg/ml concentration.

Conclusion: The green synthesized copper oxide nanoparticles have antimicrobial activity against selective microorganisms and it can be effectively used as a good antimicrobial agent.

Keywords: Copper oxide, *Eichhornia,* EDX (Energy-dispersive X-ray spectroscopy), FESEM (Field emission scanning electron microscope), Fourier transform infrared spectroscopy (FT-IR), Nanoparticles and Antimicrobial activity.

Copper oxide nanoparticles achieved more significant interest due to their unique physical and chemical properties. They are widely used as gas sensors [1-3], superconductors [4-7], catalysts [8], solar energy exchange tools [9], etc. Copper oxide nanoparticles play a vital function in medicinal field as antioxidants [10] and antibacterial [11] agents. Chemical methods have adverse effects in medicinal field due to the inclusion of toxic compounds and to overcome this, green chemistry method is used for the synthesis of nanoparticles. In green methods, extract of living organisms such as plants, microorganisms and enzymes etc., are used [12]. *Tabernaemontana* mediated synthesized copper oxide nanoparticles are monodispersed with an average size of 48±4 nm and its antimicrobial activity was seen against UTI pathogens [13]. *Acalypha indica* mediated copper oxide nanoparticles were biosynthesized with an average size between 26–30 nm and its effect was seen against antimicrobial and anticancer agent [14]. *Eichhornia crassipes* (Family: Pontederiaceae) is one of the aquatic noxious weeds of the world. It is resistant to all eradication methods (mechanical, chemical, biological or hybrid means). Therefore, nano biotechnology approaches have been utilized to minimize the difficulty of aquatic weed exclusion and management [15].

In this study, the green synthesized copper oxide nanoparticles were tested for antimicrobial activity using well diffusion method**.**

E. crassipes were collected from Ukkadam Lake, Coimbatore, Tamil Nadu, India (11 °31'N; 76 °39' E). All the chemicals used in this analysis were bought from Sigma-Aldrich chemicals, India and double distilled water has been used for synthesis of copper oxide nanoparticles. Bacterial and fungal strains such as *Escherichia coli*, *Pseudomonas aeruginosa*, *Pseudomonas fluorescens*, *Proteus vulgaris*, *Staphylococcus aureus*, *Candida albicans*, *Aspergillus flavus* , *Aspergillus niger* and *Fusarium oxysporium* were obtained from the Department of Microbiology, School of Life Sciences, Karpagam University, Coimbatore, India. The culture samples were maintained on nutrient broth and potato dextrose broth.

Eichhornia mediated copper oxide nano particles were synthesized according to Sivaraj *et al.* 2014. The functional groups, elemental analysis and shape of the green synthesized copper oxide nanoparticles were analysed by Fourier transform infrared spectroscopy (Perkin–Elmer 1725X), Field emission scanning electron microscopy (Model JSM6390LV, JOEL, USA) and Energy dispersive X-ray spectrometer (RONTEC's EDX system, Model Quan Tax 200, Germany.

Antimicrobial activity of *Eichhornia* mediated copper oxide nanoparticles were determined using well diffusion method [16]. The bacteria and fungi were cultured in nutrient and potato dextrose broth at room temperature and kept in orbital shaking incubator (Remi, India) at 200 rpm for 2-3 d. The muller hinton agar plates (bacterial culture) and potato dextrose agar plates (fungal culture) were prepared and microbial strains were swabbed. After 5 min the well (5 mm size) was made by using gel puncher and different concentrations (25 µg, 50 µg, 75 µg and 100 µg/ml) of the copper oxide nanoparticles was added in the well. The positive control (10 µg/ml) (tetracycline) and (amphotricin B) was prepared and poured into wells. The plates were incubated at 37 °C for 24h (bacteria) and room temperature for 48h (fungi). After incubation, the antimicrobial activity was assessed. Each screening test was performed with three replicates and the mean values are recorded.

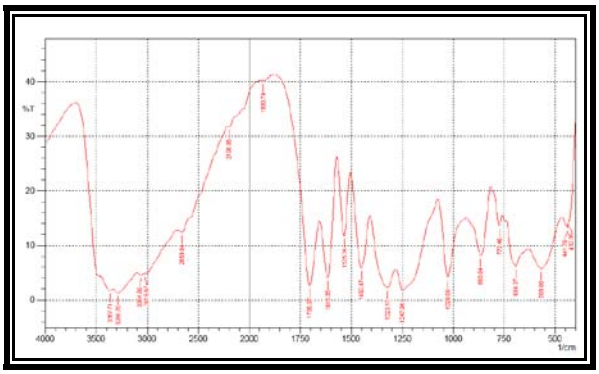

Fig. 1: FT-IR spectra showing the functional groups present on the surface of synthesized *Eichhornia* mediated copper oxide nanoparticles

FT-IR spectra analysis was performed to find the functional groups present in the surface of green synthesized copper oxide

nanoparticles (fig. 1). The spectrum showed bands at 428 and 497 cm^{-1} corresponding to metal–oxygen (M–O). The band at 819 and 912 cm^{-1}shows the presence of C–C stretching of alkanes [17, 18]. The bands at 1354 and 1624 cm^{-1} refer to N–H bending mode. The intense bands observed at 1217 cm^{-1} corresponding to C–O–C stretch was also obtained [17].

Field emission scanning electron microscope (FESEM) showed that the copper oxide nanoparticles (fig. 2) are spherical in shape. This is similar to the earlier literature [19].

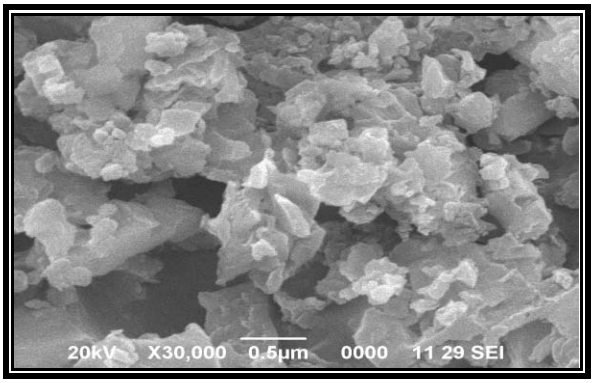

Fig. 2: FESEM showing the shape of the synthesized *Eichhornia* mediated

Copper oxide nanoparticles

It is shown that 79.18% of copper and 20.82% of oxygen were present in green synthesized *Eichhornia* mediated copper oxide nanoparticles by Energy-dispersive X-ray spectroscopy (EDX) (fig. 3) which was very similar to the reports, Rajeshwari *et al.* [14], Rajiv *et al.* [20] and Vanathi *et al.* [15].

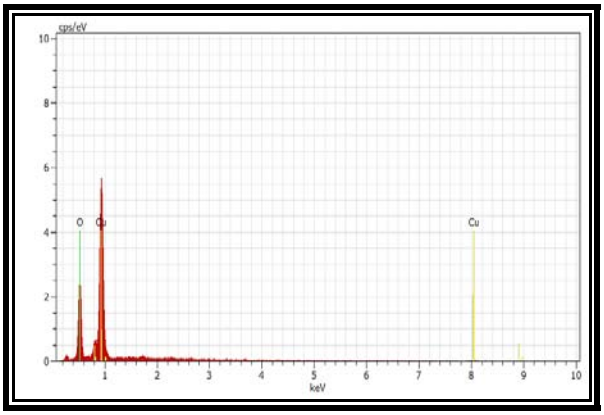

Fig. 3: EDX spectra showing the percentage of copper and oxygen in Eichhornia mediated copper oxide nanoparticles

Fig. 4 and fig. 5 shows the results of the antibacterial activity of the *Eichhornia* mediated copper oxide nanoparticles. The zone of inhibition was maximum at the concentration (100 µg/ml) of copper oxide nanoparticles. The highest zone of inhibition was observed in *S. aureus* (25.33±1 mm) and *A. flavus* (21.66±1 mm) at a concentration of 100 µg/ml. Similarly, the lowest zone of inhibition was observed in *Proteus sp.*, (15.33±1 mm) and *Fusarium culmorum* (9.21±1 mm) at a concentration of 25 µg/ml which are similar to the previous studies [21]. Rajiv *et al.* reported the antifungal activity of *Parthenium* mediated zinc oxide nanoparticles [20]. Rajeshwari *et al.* reported the antibacterial activity of copper oxide nanoparticles against UTI pathogens [13]. Azam *et al.* found the antibacterial activity of copper oxide nanoparticles against both gram-positive and negative bacterial strains [11]. The results confirm that green synthesized copper oxide nanoparticles shows excellent antimicrobial activity.

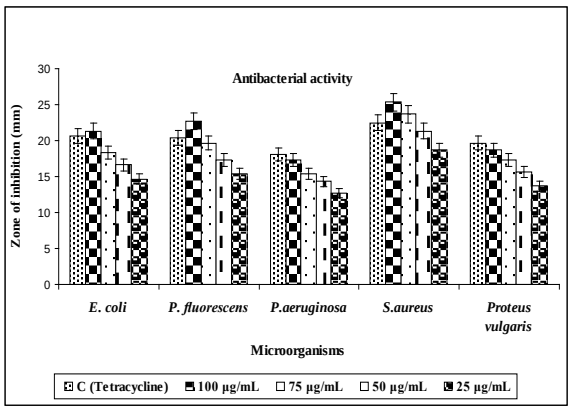

Fig. 4: Antibacterial activity of *Eichhornia* mediated copper oxide nanoparticles

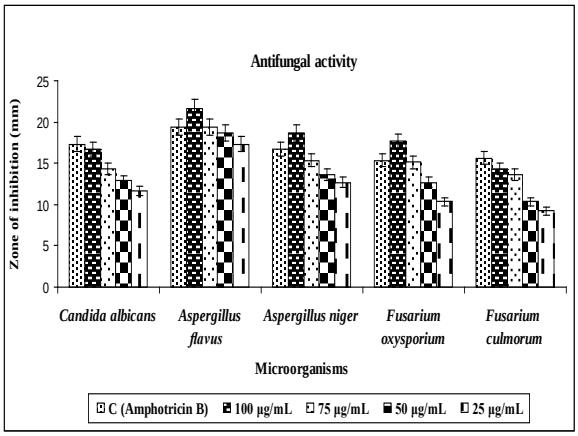

Fig. 5: Antifungal activity of *Eichhornia* mediated copper oxide nanoparticles

The study demonstrates the green synthesis of copper oxide nanoparticles from *E. crassipes* extract by simple, inexpensive and eco friendly method. It has been confirmed from the results that the *Eichhornia* mediated copper oxide nanoparticles have effective antimicrobial activity against *A. hydrophila, S. pyogenes, S. aureus, E. coli, A. flavus, F. culmorum* and *P. aeruginosa*.

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CONFLICT OF INTERESTS

Declared None

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