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IN VITRO ANTI-BACTERIAL, ANTI-OXIDANT AND ANTI-INFLAMMATORY ACTIVITY OF GREEN SYNTHESIZED COPPER OXIDE (CUO) NANOPARTICLES USING LEAF EXTRACTS OF CYPERUS ROTUNDUS

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ABSTRACT:

Cyperus rotundus L. is a colonial, perennial herb considered to have originated in India 2000 years ago and widely used in Ayurveda to treat several ailments. In addition to its prehistoric uses, it is used in several systems of medicine for treating variety of diseases.

Copper nanoparticles are utilised in solar cells, photodetectors, field emissions, lithium-ion batteries, magnetic storage media, electrochemical sensors, supercapacitors, nanofluids, elimination of inorganic pollutants, and photocatalysis.The objective and aim of study is to biosynthesis and characterisation of copper oxide (Cuo) nano particles using Cyperus rotundus leaf extract: An invitro anti cancer study in lung cancer cell line.The present study demonstrated the successful green synthesis and characterization of copper oxide nanoparticles (CuO NPs) mediated using *Cyperus rotundus* extract, along with the evaluation of their biological activity. The synthesized nanoparticles were characterized using SEM and FTIR analysis, and their anti-inflammatory activity was compared with the standard drug diclofenac.In conclusion, the study on the antibacterial and antifungal activity of copper oxide nanoparticles derived from Cuperus rotundus leaves leaves holds significant potential and offers several promising avenues for future research. The findings from such a study can contribute to various fields, including biomedicine, agriculture, environmental remediation, material science, and surface coatings. The study demonstrates the potential of copper oxide nanoparticles synthesized from Cuperus rotundus leaves as effective antibacterial and antifungal agents.

Keywords: Human, Health, Disease, Illness, Medicine,

1. INTRODUCTION :

Nanotechnology is an emerging field that has gained major importance because of its wide range of applications in healthcare, agriculture, pharmaceuticals, and environmental management.(1) Among different metal oxide nanoparticles, copper oxide (CuO) nanoparticles are widely explored due to their unique physical and chemical characteristics, (2)including high reactivity, strong antimicrobial potential, catalytic activity, and compatibility with biological systems.(3) These properties make them suitable for several biomedical applications such as drug delivery, wound treatment, antioxidant therapy, and infection control.(4)

Conventional methods used for nanoparticle production generally involve hazardous chemicals, expensive equipment, and high energy consumption,(5) which may create environmental and health-related concerns.(6) In recent years, green synthesis has emerged as a safer and more sustainable alternative for nanoparticle preparation.(7) This method utilizes plant extracts as natural reducing and stabilizing agents, thereby avoiding the use of toxic substances.(8) In addition to being environmentally friendly and economical, plant-based synthesis can also enhance the biological efficiency of nanoparticles because of the active compounds present in medicinal plants.(9).Cyperus rotundus, commonly referred to as nut grass, is a traditional medicinal plant known for its therapeutic value.(10) The plant contains several important phytochemicals such as flavonoids, alkaloids, tannins, terpenoids, and phenolic constituents that possess antioxidant, antimicrobial, and anti-inflammatory properties. (9,11)These naturally occurring compounds play an important role during nanoparticle synthesis by facilitating the reduction of metal ions and maintaining nanoparticle stability.The present study focuses on the biosynthesis of copper oxide nanoparticles using leaf extract of Cyperus rotundus and the evaluation of their antibacterial, antioxidant, and anti-inflammatory activities under in vitro conditions.(12) The combination of plant-derived bioactive compounds with CuO nanoparticles may produce enhanced therapeutic effects through synergistic interactions. Investigating these biological properties could contribute to the development of effective and eco-friendly nanomaterials for future biomedical applications with reduced side effects and improved efficacy. This work therefore highlights the potential of green nanotechnology in producing biologically active nanoparticles using medicinal plants.

2. MATERIALS AND METHODS:

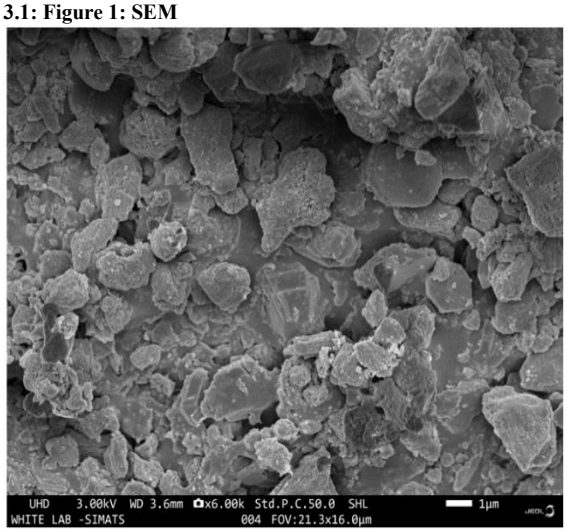
2.1 Collection and Preparation of aqueous plant extract : the green synthesis process and the subsequent antibacterial testing. It starts with the collection and preparation of aqueous plant extract, which is then filtered and distilled again. The extract obtained is used in green synthesis of nanoparticles of magnesium oxide (MgO) by Zaleya pentandra. The relevant bacterial strains, including Staphylococcus aureus, Pseudomonas aeruginosa, Streptococcus mutans and Escherichia coli, were obtained separately from the US type-culture collection and cultured on Muller-Hinton agar medium obtained from swab samples. Finally, these maintained pathogens are used to evaluate the antibacterial activity of synthesised MgO nanoparticles in vitro.

2.2 In vitro Anti Oxidant - DPPH scavenging activity: The antioxidant activity of green synthesised nanoparticles of magnesium oxide (MgO) synthesised from Zaleya pentandra was assessed in vitro. In particular, their antioxidant potential was quantified by measuring the scavenging activity of DPPH. This evaluation was performed using the standard 1,1-diphenyl-2-pyrazyl (DPH) method according to the established experimental protocol as described by Manzocco and colleagues (1998)

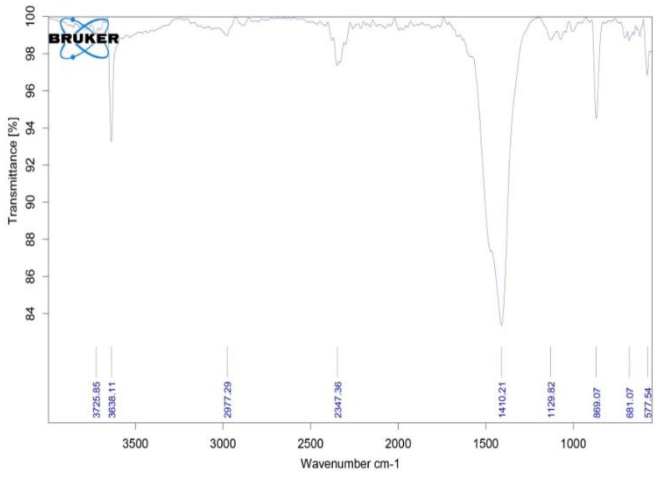
2.3 In vitro anti-inflammatory activity : The anti-inflammatory activity in vitro was assessed by inhibition of the egg albumin denaturation test. A total reaction solution of 5 ml was prepared by combining 1 ml of egg albumin (1 mM), 3 ml of phosphate buffered saline (PBBS) adjusted to pH 6.4, and 1 ml of a variable concentration (specifically 50 ml, 100 ml and 200 ml) of the test plant extract.

3. RESULT :

3.1: Figure 1: SEM



SEM image of Cuo of Cuperus rotundus Leaf



3.2: Figure 2: FTIR .FT-IR spectrum of green synthesised Cuo NPs

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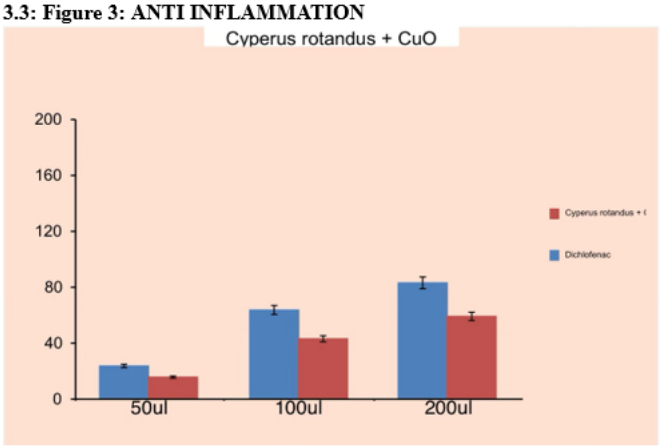
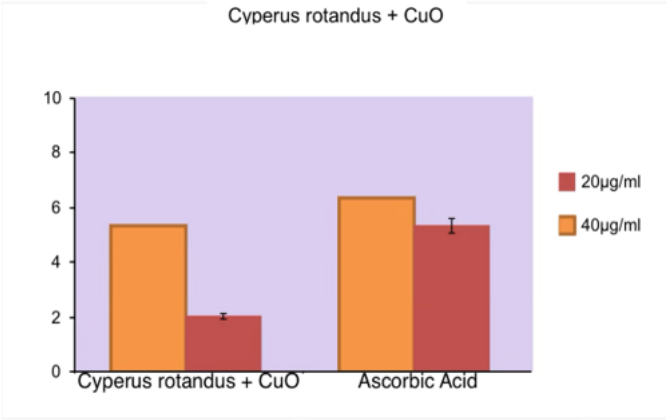
3.3: Figure 3: ANTI INFLAMMATION



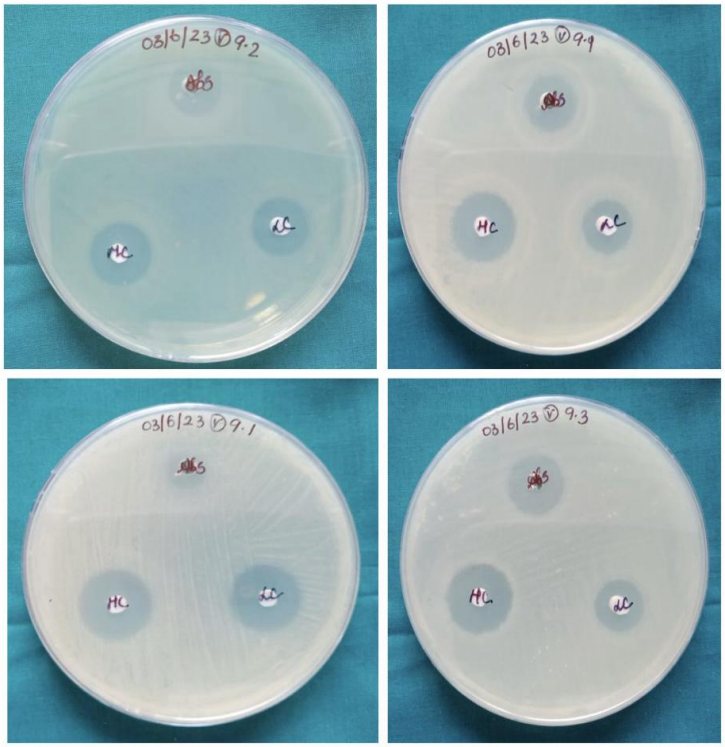
In vitro Anti- inflammation activity of green synthesized Cuo of Cuperus rotundus Leaf extract by DPPH Assay

3.4: Figure 4: ANTIOXIDANT



In vitro Anti-oxidant activity of green synthesized Cuo of Cuperus rotundus Leaf extract by DPPH Assay

3.5: Figure 5: ANTI MICROBIAL



Zone of inhibition of biosynthesized CuO NPs against (9.1) Staphylococcus aureus (9.2) Pseudomonas aeruginosa, (9.3) Streptococcus mutans (9.4) Escherichia coli

3.6: Figure 6: ZONE OF INHIBITION

Organisms	50µg/mL	100µg/mL	Standard
Staphylococcus aureus	16	19	11
Pseudomonas aeruginosa	14	16	13
Streptococcus mutans	15	19	14
Escherichia coli	13	20	14

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The sample shows clear dose-dependent antibacterial activity, with higher inhibition at 100 µg/mL than at 50 µg/mL. It exhibits strong effectiveness against all tested organisms, especially *E. coli* (20 mm), and performs better than the standard in most cases, indicating broad-spectrum antibacterial potential.

4. DISCUSSION:

The present study demonstrated the successful green synthesis and characterization of copper oxide nanoparticles (CuO NPs) mediated using *Cyperus rotundus* extract, along with the evaluation of their biological activity. The synthesized nanoparticles were characterized using SEM and FTIR analysis, and their anti-inflammatory activity was compared with the standard drug diclofenac.(13)

FTIR analysis confirmed the presence of various functional groups involved in the synthesis and stabilization of CuO nanoparticles. The peaks observed around 3725 cm^{-1} and 3638 cm^{-1} correspond to O–H stretching vibrations, indicating the presence of hydroxyl groups from phenols and alcohols.(14) The absorption band near 2977 cm^{-1} may be attributed to C–H stretching of alkanes, while the peak around 2347 cm^{-1} could represent atmospheric CO_2 absorption or carbonyl-associated vibrations. A strong peak at approximately 1410 cm^{-1} indicates C=C aromatic stretching or O–H bending vibrations. The bands around 1128 cm^{-1} and 869 cm^{-1} suggest C–O stretching and aromatic ring vibrations, respectively. Importantly, the peaks at lower wavenumbers near 681 cm^{-1} and 577 cm^{-1} confirm Cu–O bond formation, indicating successful synthesis of copper oxide nanoparticles. These findings suggest that phytoconstituents from *Cyperus rotundus*played an important role in reducing copper ions and stabilizing the nanoparticles.(13,15)

The anti-inflammatory assay demonstrated a concentration-dependent activity of *Cyperus rotundus*-mediated CuO nanoparticles. At all tested concentrations (50 µl, 100 µl, and 200 µl), the synthesized nanoparticles showed measurable inhibition activity, although the standard drug diclofenac exhibited comparatively higher inhibition values. At 200 µl concentration, the nanoparticles demonstrated the maximum activity, indicating enhanced biological interaction at higher concentrations(16). The observed anti-inflammatory effect may be due to the synergistic action of CuO nanoparticles and the phytochemicals adsorbed on their surface. Bioactive compounds such as flavonoids, phenolics, and terpenoids present in *Cyperus rotundus* are known to possess antioxidant and anti-inflammatory properties, which may contribute to membrane stabilization and inhibition of inflammatory mediators.(14,17,18)

Overall, the study confirms that *Cyperus rotundus* extract can be effectively utilized for the green synthesis of CuO nanoparticles with appreciable biological activity. The characterization results validated nanoparticle formation, while the biological assay highlighted their potential anti-inflammatory efficacy. Further studies involving particle size analysis, crystallinity assessment, cytotoxicity evaluation, and molecular mechanism studies would provide deeper insight into their biomedical applications.(14,17–19)

5. CONCLUSION:

In conclusion, the study on the antibacterial and antifungal activity of copper oxide nanoparticles derived from Cuperus rotundus leaves holds significant potential and offers several promising avenues for future research. The findings from such a study can contribute to various fields, including biomedicine, agriculture, environmental remediation, material science, and surface coatings. The study demonstrates the potential of copper oxide nanoparticles synthesized from Cuperus rotundus leaves as effective antibacterial and antifungal agents. The findings support their potential use as alternative antimicrobial agents and highlight the importance of plant-based materials in nanoparticle synthesis.

FUTURE SCOPE:

Agriculture and Crop Protection: Explore their potential as a natural alternative to chemical fungicides and bactericides for crop protection, with a focus on minimizing the environmental impact

Environmental Applications: Assess their potential for water purification, waste treatment, or air filtration systems to combat microbial contamination.

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