# Antimicrobial Effect of Biologically Synthesized Copper Sulfide Nanoparticles

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## Introduction

- The growing number of drug-resistant bacteria is one of the major concerns in medical healthcare.
- Bacteria have developed multiple protection mechanisms of resistance to antibiotics such as enzyme inactivation, decreased cell permeability, altered antibiotic target site.[1]
- Copper sulfide (CuS) nanoparticles (NPs) have shown excellent antibacterial activity by creating Reactive Oxygen Species (ROS) and disturbing the bacterial membrane by oxidative stress.[2]
- Bacterial biomolecules may reduce and stabilize nanoparticle synthesis; aiding nanoparticle growth and dispersion.
- Biologically synthesized nanoparticles are fabricated by green synthesis and do not produce toxic byproducts; making it more attractive for biomedical applications.[3]
- This novel biological synthesis will also reduce high energy waste usually made by traditional chemical synthesis.[3]

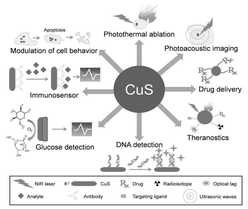



**Fig 1.** Different biomedical applications of chemically synthesized copper sulfide nanoparticles.[4]

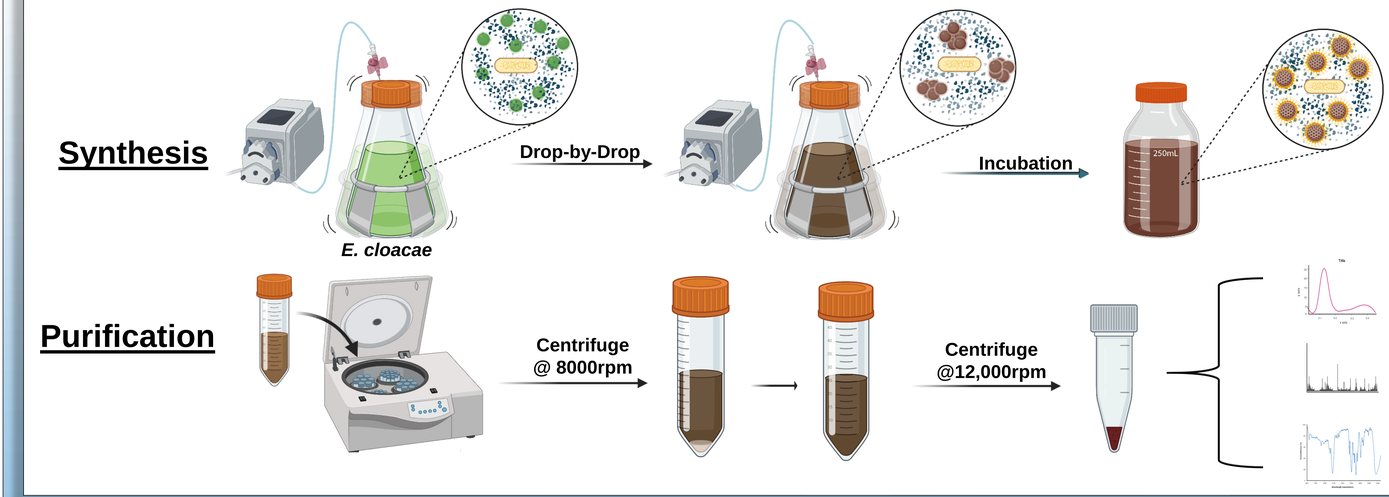
**Fig 2.** Demonstrates a disk diffusion test treated with antibiotics; a concrete example of the mechanisms developed by bacteria.[2]


**Fig 3.** Proposed enzyme-salts interaction during biogenic synthesis; where extracellular enzyme interactions could be the determinants in CuS biogenic synthesis.[5]

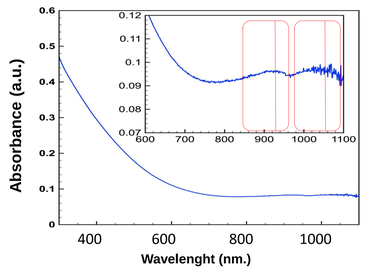
## Objectives

1. **Develop** a novel biogenic synthesis protocol.
2. **Evidence** nanoparticle production with microbial cultures
3. **Corroborate** the presence of a Protein Corona in NP's surface.
4. **Evaluate** CuS NP's antimicrobial potential and minimum NP toxic concentrations for multicellular organisms.

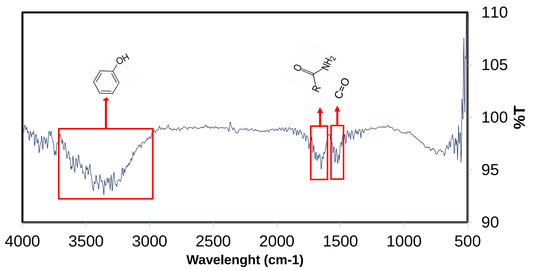
## Methodology



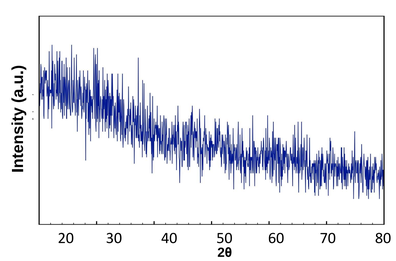

## Results




**Graph 1.** UV-Vis of CuS NPs biosynthesized with *E. cloacae*.




**Graph 2.** FTIR of CuS NPs biosynthesized with *E. cloacae*.




**Graph 3.** Evaluation of crystallinity with XRD suggests an amorphous structure.

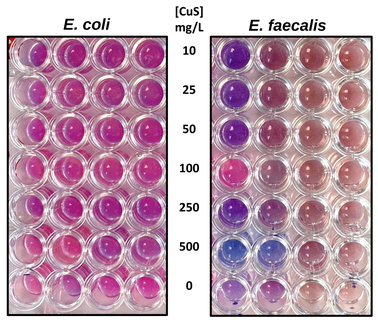



**Fig. 4.** Minimum Inhibitory Concentration was evaluated against Gram-negative *E. coli* (left) and Gram-positive *E. faecalis* (right).

**Table 1.** Zetasizer measurements of biosynthesized CuS NP

| | |
|---|---|
| **σ potential** | -30.9 mV |
| **Hydrodynamic size** | 779.9 nm |

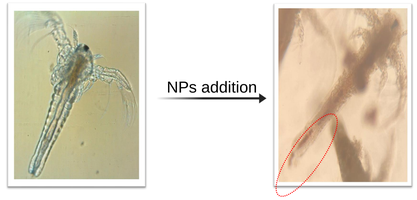
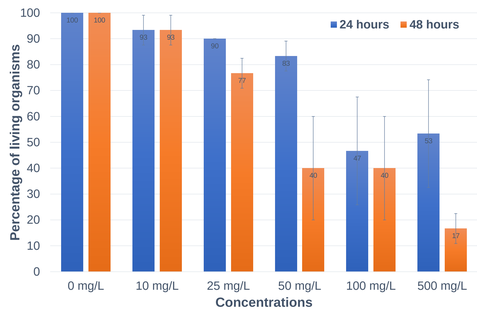



**Fig. 6.** Brine shrimp toxicological evaluation process.




**Graph 4.** Brine shrimp viability after 24 and 48 hours of exposure to biosynthesized CuS NPs at different concentrations (0-500 mg/L CuS NPs).

## Conclusions

- ✓ The pellet obtained after 8000rpm centrifugation implies an extracellular biogenic synthesis.
- ✓ **UV-Vis** showed two smooth peaks suggesting possible difference in NPs size due to absorption.
- ✓ **FTIR** indicates the presence of biologic material on nanoparticle's surface.
- ✓ **XRD** suggests the formation of amorphous nanoparticles.
- ✓ **Zetasizer** characterization measured a total Hydrodynamic size of ~780nm, including Protein Corona on NP surface.
- ✓ CuS nanoparticles showed a minimum inhibitory concentration for *E. facaelis* at 500 mg/L whereas *E. coli* was showed resistance at this concentrations.
- ✓ The brine shrimp lethality test showed a decrease in viability starting at 50 mg/L after 24h.

## Future Work

- Measure bacterial growth curves to verify the effects of the CuS salts when added to the bacteria culture medium.
- Characterize the possible Protein Corona in NP's surface through 2D Electrophoresis.
- Determine the NP's morphology by HRTEM and SEM characterizations.

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## References

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