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Comparative Evaluation of Silver Nanoparticles Synthesized via Green and Chemical Routes: Size-Dependent Antibacterial Activity

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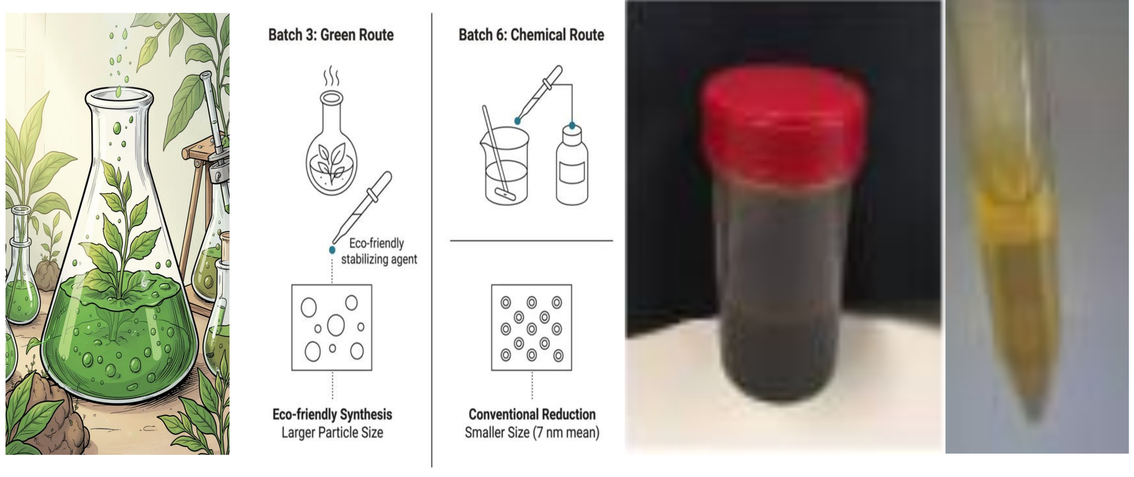
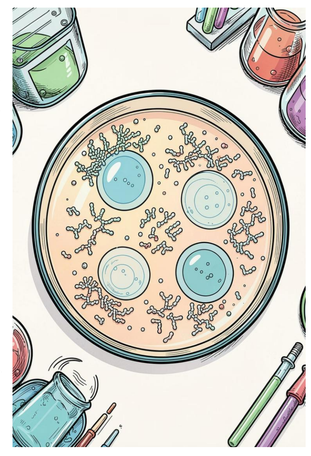
INTRODUCTION & AIM

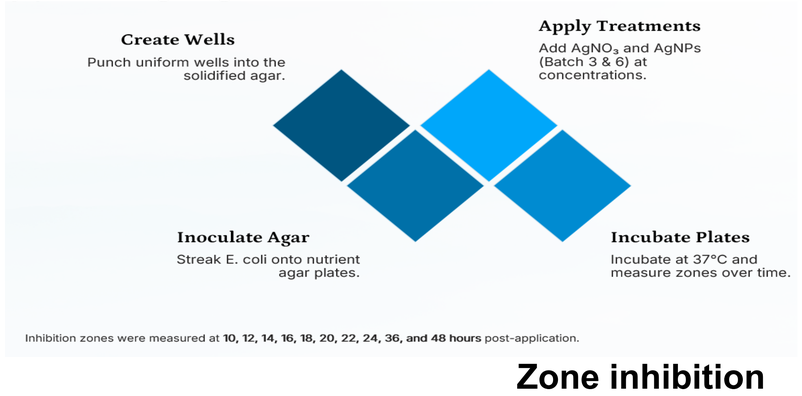
In this study, a systematic evaluation was conducted on two distinct batches of silver nanoparticles (AgNPs).
Batch 3, synthesized through an eco-friendly (green) route, and batch 6, prepared via a conventional chemical reduction process.



METHOD

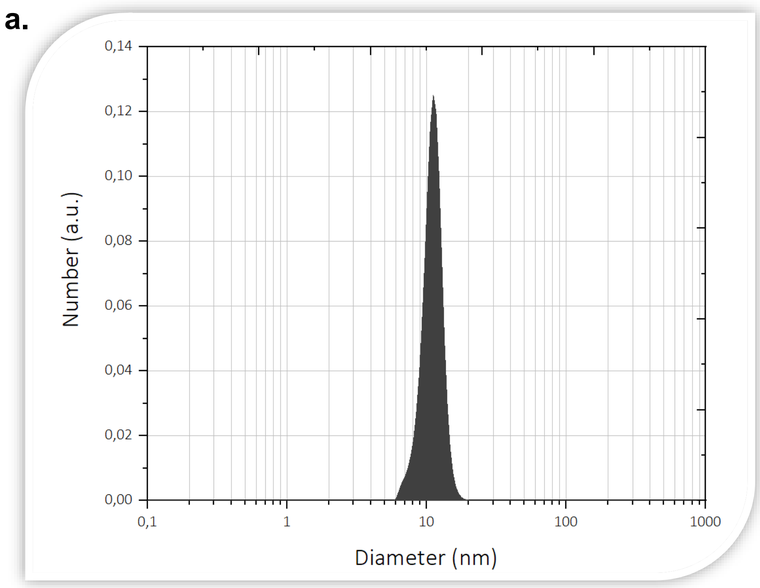
Both nanoparticle types, along with silver nitrate ($AgNO_3$) solutions as controls, were tested for their antibacterial efficacy against *Escherichia coli* using the agar well diffusion method. *E. coli* cultures were streaked onto nutrient agar plates, wells were created, and varying concentrations of $AgNO_3$ solutions, batch 3 AgNP suspensions (mean diameter 11 nm), and batch 6 AgNP suspensions (mean diameter 7 nm) were applied. Plates were incubated at 37 °C, with inhibition zones measured at 10, 12, 14, 16, 18, 20, 22, 24, 36, and 48 hours. Inhibition zones stabilized after 24 hours for both $AgNO_3$ ions and batch 6 AgNPs, with the latter consistently producing larger zones.

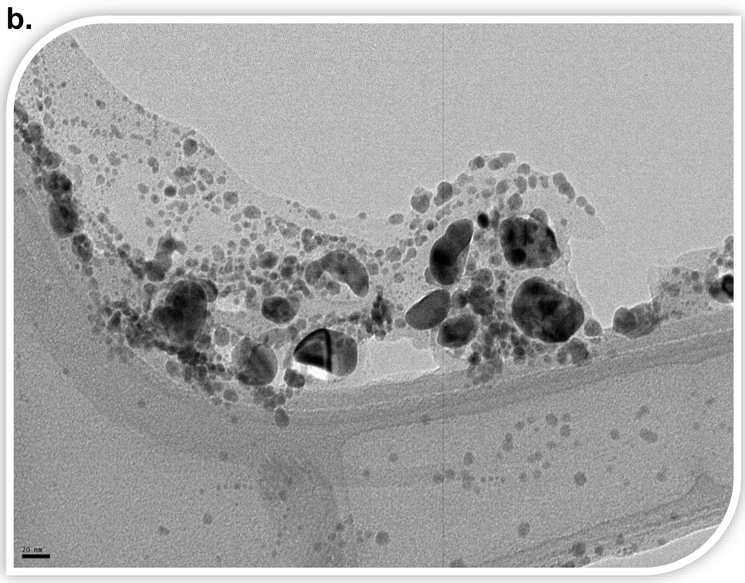


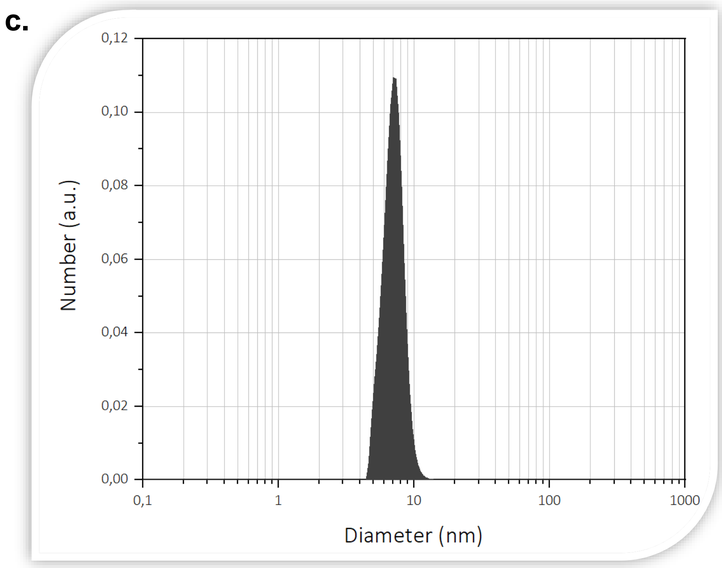


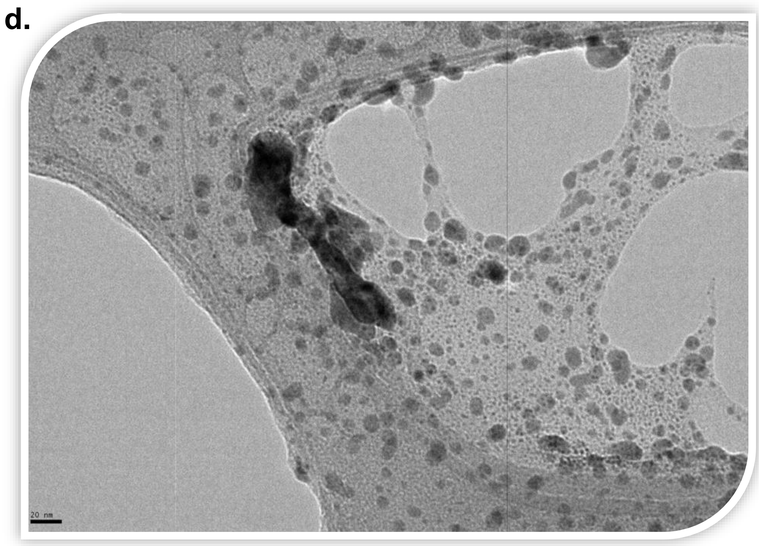
RESULTS & DISCUSSION

DLS & TEM analysis

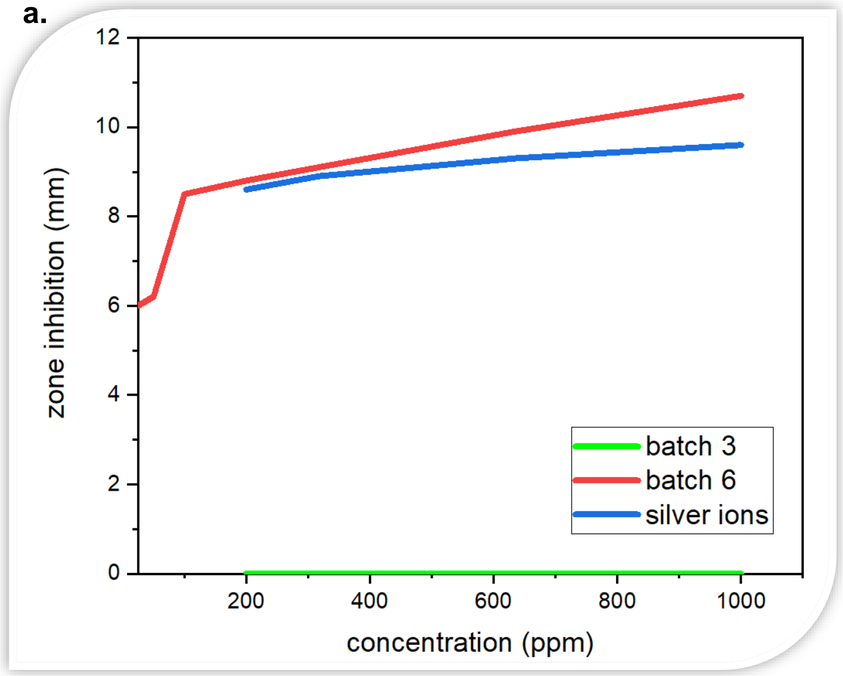








Zone inhibition



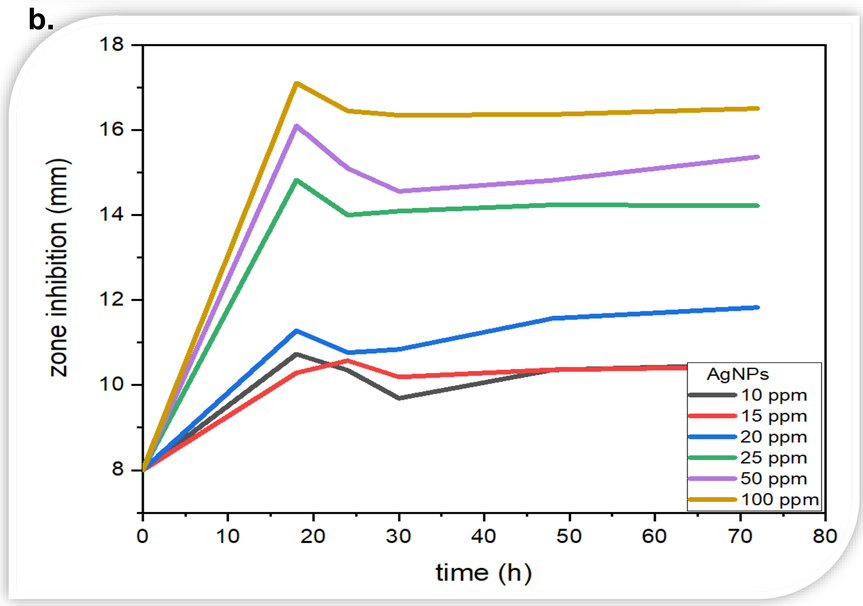


Figure 1. (**a, b**) DLS and TEM analysis of batch 3. (**c, d**) DLS and TEM analysis of batch 6.

Figure 2. **a.** Comparative inhibition zones of AgNP batches 3 and 6 and silver ions. **b.** Inhibition zone diameters as a function of AgNP concentration (batch 6).

CONCLUSIONS & FUTURE WORK

Batch 3 exhibited no inhibition at any concentration or time point.
This null result is attributed to its larger particle size (11 nm) and the use of a different stabilizing agent that likely limited silver ion release and nanoparticle–cell interactions [1,2].
Batch 6 consistently produced larger inhibition zones than $AgNO_3$ controls. Zones stabilized after 24 hours. Chemically synthesized Batch 6 AgNPs demonstrated pronounced antibacterial potential against resistant E. coli strains, possibly due to sustained ion release relative to $AgNO_3$ solutions, thereby enhancing overall efficacy.
Overall, the chemically synthesized batch 6 AgNPs demonstrated pronounced antibacterial potential against resistant *E. coli* strains, while the eco-friendly batch 3 nanoparticles failed to exert any measurable effect under comparable conditions. This clear divergence emphasizes the importance of optimizing both synthesis pathway and stabilizer composition to achieve effective and reproducible antimicrobial performance in nanosilver systems.

REFERENCES

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