

SILVER NANOPARTICLES REDUCED BY TANNIC ACID AND SODIUM CITRATE: A SYNERGIC APPROACH WITH ANTIMICROBIAL PROPERTIES

Adriana S. Rodrigues^{1,2*}, Jorge G. S. Batista¹, Luciene A. R. Minarini², Patrícia S. Lopes², Ademar B. Lugão¹

¹ CEQMA/Instituto de Pesquisas Energéticas e Nucleares – IPEN-CNEN/Universidade de São Paulo, Brasil

² ICAQF/Instituto de Ciências Ambientais, Químicas e Farmacêuticas/Universidade Federal de São Paulo, Brasil

* Corresponding author: asouzar@usp.br

Keywords: silver nanoparticles; antimicrobial; green nanotechnology.

Introduction and objective: Green nanotechnology aims to reduce hazardous chemical waste in the environment through sustainable development. Phytochemicals are proposed to minimize environmental impacts and produce safe biological applications. Silver nanoparticles (AgNPs) have effective antimicrobial properties against Gram-positive and Gram-negative bacteria, fungi and viruses, being promising to reduce the microbial load. Antimicrobial systems based on AgNPs shows promise in combating bacteria.

Methodology: Confirmation of the formation of silver nanoparticles was evaluated by UV-Vis spectrophotometry. The hydrodynamic size and polydispersion index were evaluated by dynamic light scattering. The zeta potential was used to assess stability through surface charge. The obtained morphology and average size were evaluated by transmission electronic microscopy. The cytotoxicity assay was performed to assess cellular viability of silver nanoparticles in HUVEC cells. The antimicrobial activity was analyzed by minimum inhibitory concentration through microdilution in broth and later the inoculum was performed in plates.

Results and discussion: Characterization by spectrophotometry of AT_AgNPs and CT_AgNPs showed absorption bands at 430 nm. Hydrodynamic size analyzes revealed diameters of 57.87-97.45 nm, with polydispersion indices (Pdl) ranging between 0.289 and 0.392. The zeta potential was determined between -4.41 and -10.3 mV. Transmission electron microscopy (TEM) images revealed spherical morphology with sizes between 20-50 nm. AgNPs have been tested as a treatment against hospital microorganisms with risk classification level 2, including Gram-negative (*Acinetobacter baumannii*, *Escherichia coli*, *Klebsiella pneumoniae* and *Pseudomonas aeruginosa*) and Gram-positive (*Staphylococcus aureus*) bacteria. The Minimum Inhibitory Concentration (MIC) was determined to evaluate the lowest concentration that inhibits the growth of microorganisms. The MIC values obtained with the AT_AgNPs were: 4.18 ug/mL (AB14 and EC23), 8.36 ug/mL (EC26 and KP43), 16.72 ug/mL (PA17), 66.9 ug/mL (PA3) and 133.8 ug/mL (SA). For CT_AgNPs, they were: 51.8 ug/mL (AB14, EC26 and PA17), without inhibition in EC23, KP43, PA3 and SA strains. Synergism was evaluated by mixing suspensions of the two nanoparticles (ATCT_AgNPs), resulting in MIC values of 1.48 ug/mL (PA3 and SA), 2.96 ug/mL (EC23, KP43 and PA17) and 5.93 ug/mL (AB14 and EC26).

Conclusions: The results suggest that AT_AgNPs and the synergistic combination with CT_AgNPs have potential as effective antimicrobial agents against nosocomial bacteria. These AgNPs may represent a promising alternative for the development of new therapeutic strategies to combat bacterial infections. However, further studies are needed to investigate its activity in other contexts and its safety in clinical use.

References

[1] Makabenta, J.M.V., Nabawy, A., Li, CH. et al. Nanomaterial-based therapeutics for antibiotic-resistant bacterial infections. *Nat Rev Microbiol* 19, 23–36, 2021.

Acknowledgments

The authors thank to the home institutions, to the Laboratory of Supramolecular Chemistry and Nanotechnology (LQSN – IQ-USP), to the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code 001, the Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP) (2017/50332-0) and Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) (442527/2019-5 and 406923/2021-3).