STUDY OF INTERFACIAL PROPERTIES BETWEEN METAL NANOPARTICLES AND INSECT-DERIVED MOLECULES AND EVALUATION OF THEIR BIOLOGICAL EFFECTS ON MODEL SYSTEMS

Iolanda Landi[1], Carmen Scieuzo[1,2], Rosanna Salvia[1,2], Vincenzo De Feo[3], Angela De Bonis[1]*, Patrizia Falabella[1,2]*

[1]Department of Basic and Applied Sciences, University of Basilicata, Via dell'Ateneo Lucano 10, 85100, Potenza, Italy

[2]Spinoff XFlies s.r.l, University of Basilicata, Via dell'Ateneo Lucano 10, 85100, Potenza, Italy

[3]Department of Pharmacy, University of Salerno

Introduction

Gold nanoparticles (AuNPs) are promising nanobiotechnological tools due to their biocompatibility, stability, distinctive nanoscale properties, and ease of functionalization[1,3]. Insect-derived antimicrobial peptides (AMPs) represent innovative bioactive molecules with relevant antimicrobial potential and biological activity[4,5]. Surface functionalization with bioactive compounds can improve nanoparticle selectivity, biocompatibility, and interaction with biological targets[3,6]. The combination of AuNPs and AMPs may therefore represent a promising strategy for the development of advanced nanobiotechnological systems with potential biological applications[2,3,6].

Methods

Three peptides were selected based on key physicochemical features, including amino acid sequence length and the presence of cysteine residues, which may influence peptide–nanoparticle interactions and conjugation efficiency. Their antimicrobial activity was evaluated by agar diffusion assay against representative bacterial strains.
AuNPs were synthesized by pulsed laser ablation in liquid using a Q-smart 850 nanosecond laser. The gold target was weighed before and after ablation to estimate the amount of gold released into the liquid. Ablation was performed in water through 30-minute cycles under magnetic stirring to ensure homogeneous nanoparticle dispersion.
The synthesized AuNPs were characterized by UV–Vis spectrophotometry and DLS analysis. For DLS, the AuNP suspension was diluted 1:2 in order to avoid measurement interference from overly concentrated samples. Hydrodynamic diameter and zeta potential were then evaluated.

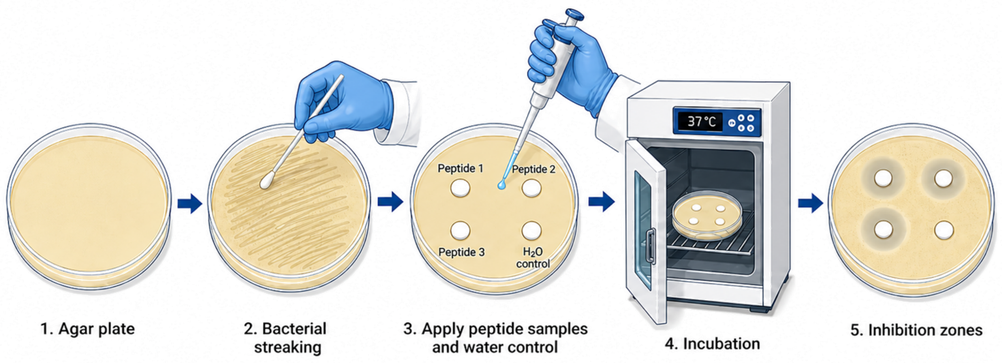

Figure 1: workflow of the agar diffusion assay used to evaluate peptide antimicrobial activity.

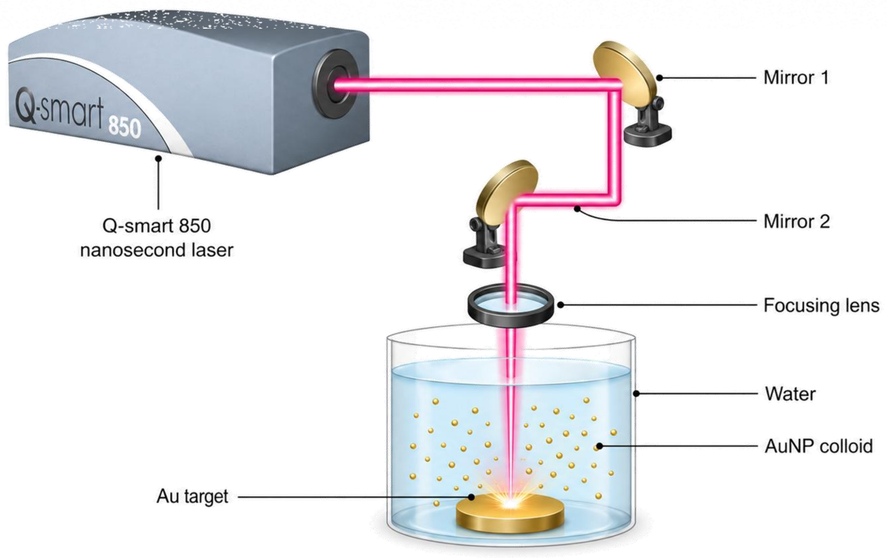

Figure 2: schematic representation of AuNP synthesis by pulsed laser ablation in liquid using a Q-smart 850 nanosecond laser.

Conclusions

The preliminary results confirm the successful synthesis of AuNPs by pulsed laser ablation in liquid. UV–Vis analysis showed the characteristic plasmonic band, while DLS indicated a moderately polydisperse colloidal suspension. The negative zeta potential value (−28.7 ± 3.0 mV) suggests moderate electrostatic stability, close to the range generally associated with stable colloidal systems.
The observed hydrodynamic diameter may reflect the presence of nanoparticle aggregates or clusters; therefore, TEM analysis will be performed to directly assess nanoparticle morphology and primary size. Future work will focus on the first conjugation assays with the selected peptides, representing a key step toward the development of biofunctional AuNP-based systems.
Overall, this approach may provide a promising platform at the interface between nanotechnology and bioactive molecules, opening new perspectives for the design of advanced nanobiotechnological tools.

Results

Figure 3: agar diffusion assay showing inhibition areas produced by the selected peptides against *Micrococcus flavus*.

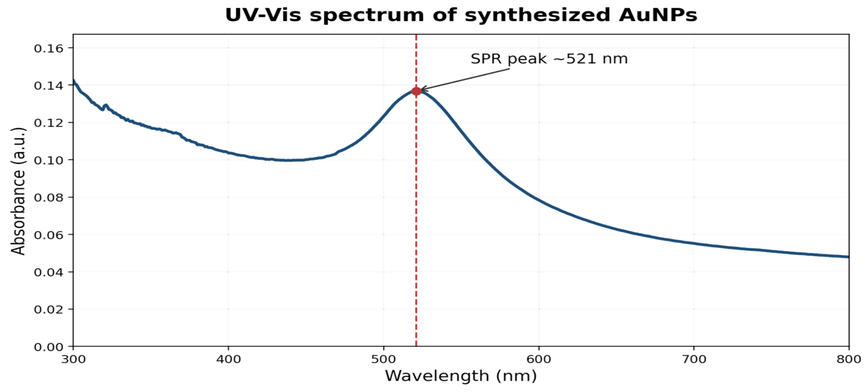

Figure 4: UV–Vis spectrum of AuNPs showing the characteristic plasmonic absorption band at approximately 521 nm.

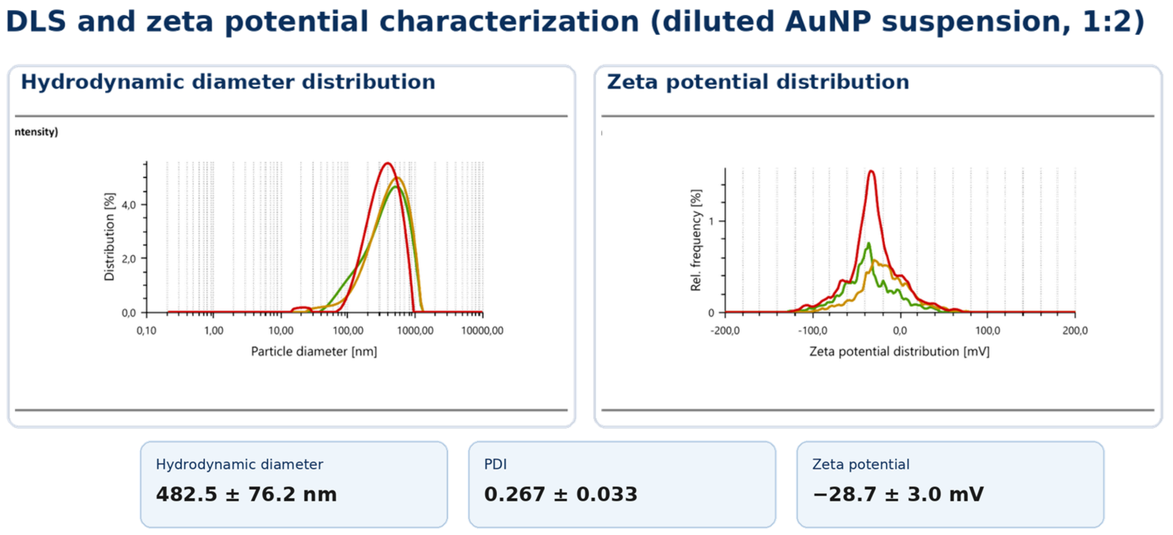

Figure 5: DLS and zeta potential analysis showing the hydrodynamic diameter, PDI, and surface charge of the synthesized AuNPs.

The agar diffusion assay showed antimicrobial activity of the selected peptides against *Micrococcus flavus*, as indicated by inhibition areas on the agar plate.
AuNPs were successfully synthesized by pulsed laser ablation in liquid. Based on the weight difference of the gold target before and after ablation, approximately 7.5 mg of gold were ablated into 350 mL of water, corresponding to about 21.4 µg/mL.
UV–Vis analysis confirmed AuNP formation, showing a characteristic surface plasmon resonance band at approximately 521 nm. DLS analysis of the diluted AuNP suspension showed a hydrodynamic diameter of 482.5 ± 76.2 nm and a PDI of 0.267 ± 0.033, while zeta potential analysis showed a mean value of −28.7 ± 3.0 mV.

References

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