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Peptide-functionalized Nanocoatings for Prevention of Biofouling and Device-Associated Infections

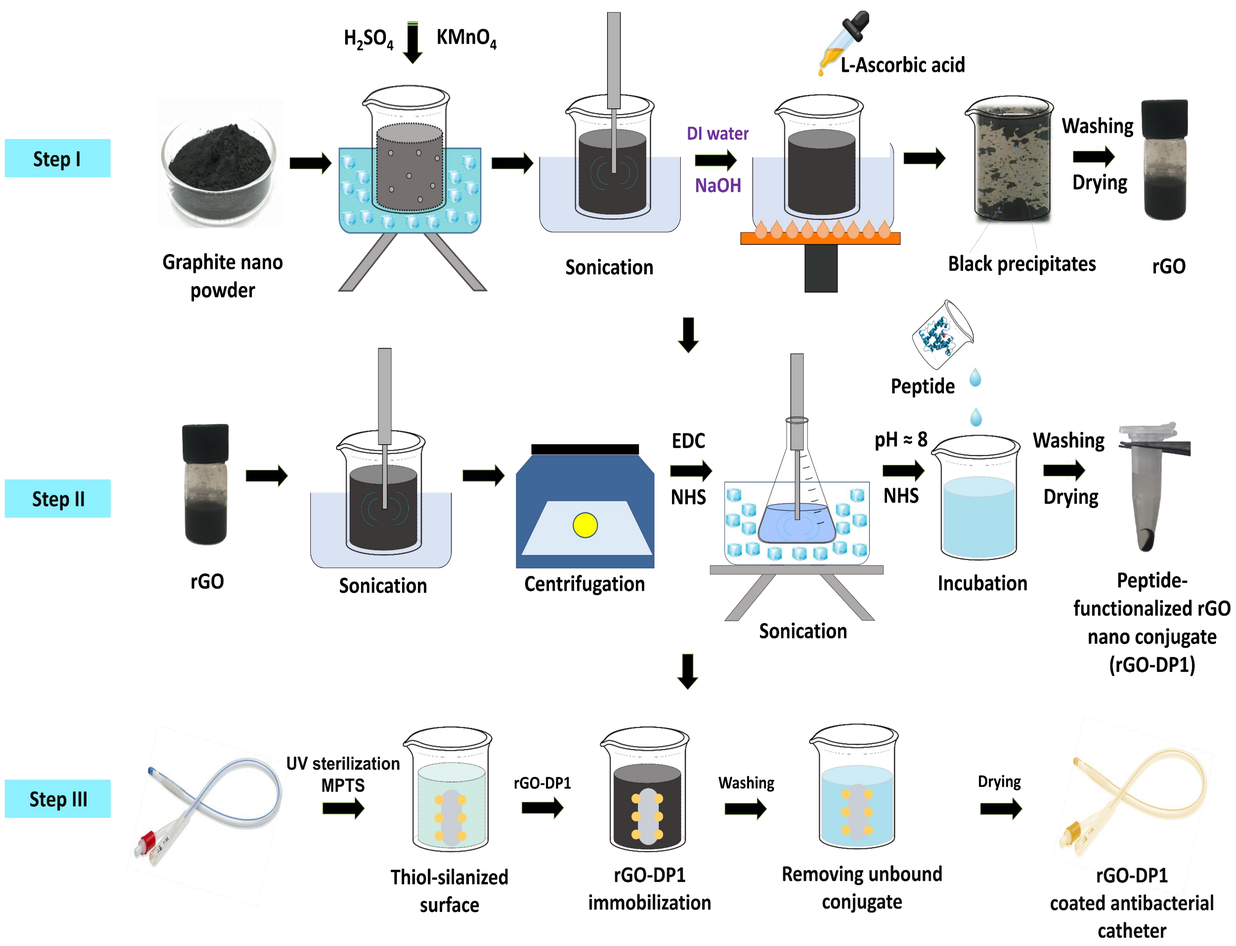
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Background

- Indwelling medical devices are highly susceptible to microbial colonization, with bacterial adhesion and subsequent biofilm formation contributing to device-associated infections.
- Catheter-associated urinary tract infections (CAUTIs) account for a substantial proportion of healthcare-associated infections, with approximately 75% of hospital-acquired UTIs associated with urinary catheters[1].
- Biofilm formation on device surfaces promotes persistent bacterial colonization and increases tolerance to antimicrobial treatment.
- Antimicrobial peptides (AMPs) are short, cationic and amphipathic biomolecules that exhibit potent antimicrobial activity through interactions with bacterial membranes. However, properties such as proteolytic instability, rapid clearance, structural degradation and concentration-dependent cytotoxicity reduces their biomedical applicability.
- Conjugation of peptides with nanomaterials results in the formation of peptide-functionalized nanoconjugates that combine the bioactivity of peptides with the physicochemical properties of nanomaterials, offering enhanced stability, surface association and biocompatibility for biomedical applications[2].
- **In this study, a novel synthetic antimicrobial peptide DP1 (RFGRFLRKILRFLKK)[3] was covalently conjugated with reduced graphene oxide (rGO) to develop a peptide-functionalized nano conjugate (rGO-DP1)[4], which was further developed as an antimicrobial and antibiofilm nanocoating for medical-device surfaces[5].**

Experimental design



Results

Synthesis and characterization of peptide-functionalized nanocoating

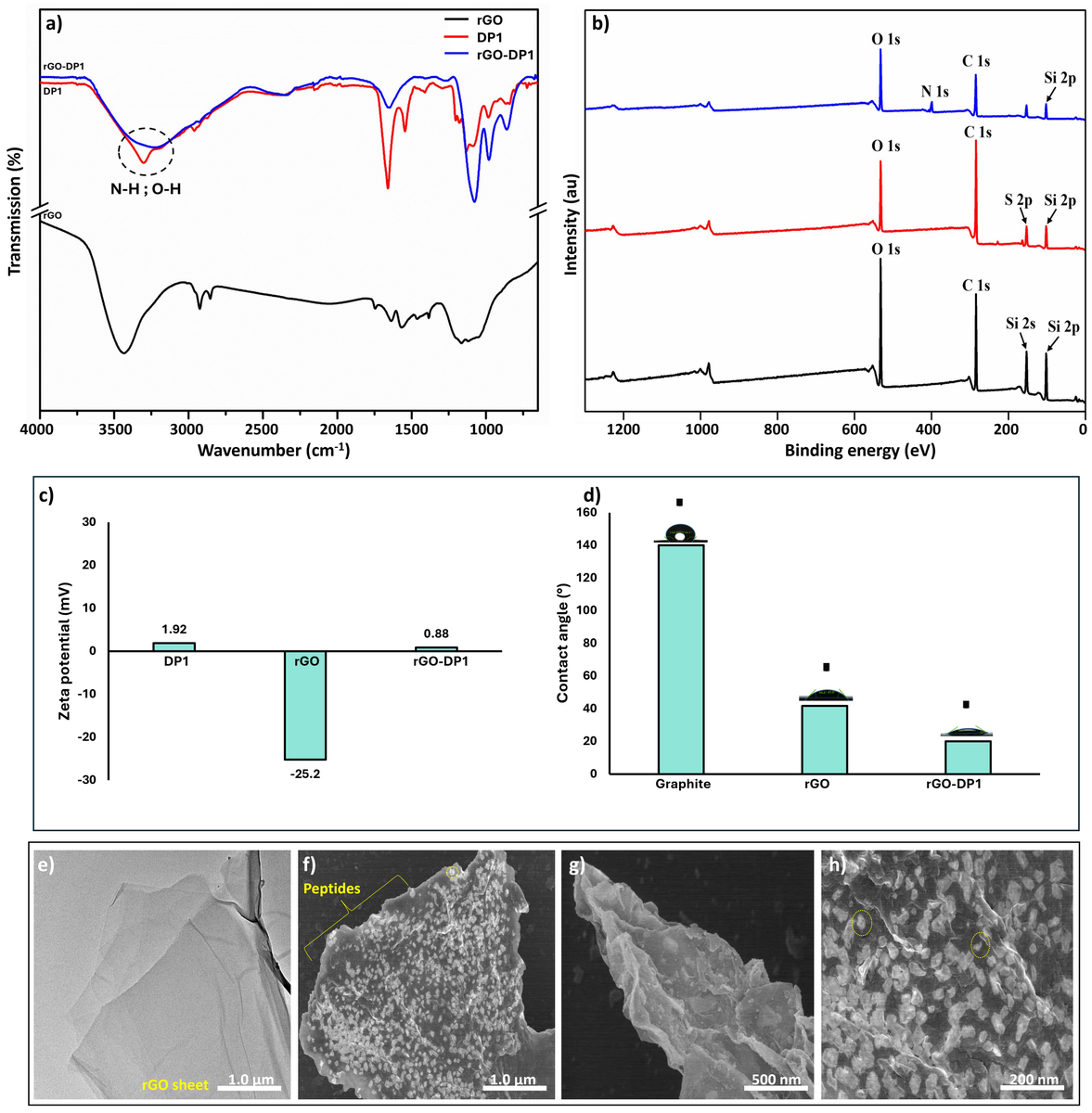


Fig. 1: Characterization of peptide functionalized nano conjugate by fourier-transform infrared spectroscopy (a), X-ray photoelectron spectroscopy (b), zeta potential (c), water contact angle (d) and High-Resolution Transmission Electron Microscopy images of rGO (e) and peptide functionalized nano conjugate (rGO-DP1) (f-h).

In vitro evaluation of peptide-functionalized nanocoating

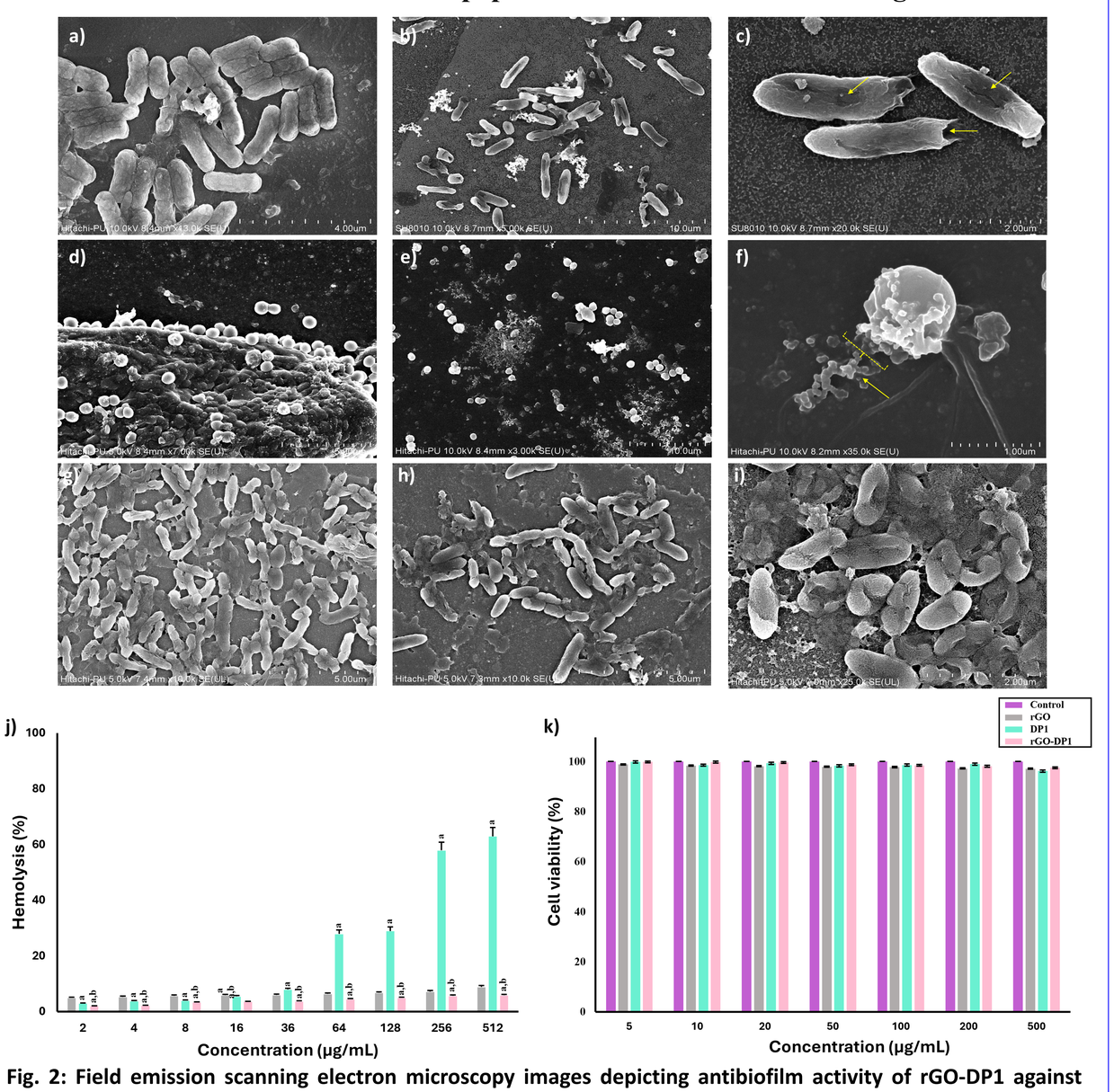


Fig. 2: Field emission scanning electron microscopy images depicting antibiofilm activity of rGO-DP1 against *Escherichia coli* (a-c), *Staphylococcus aureus* (d-f) and *Pseudomonas aeruginosa* (g-i). Percent hemolysis towards erythrocytes (J) and cell viability (%) of 3T3-L1 cells after incubation with rGO, DP1 and rGO-DP1 (k). Values are expressed as mean ± SD (n = 6).

Conclusion

- **Covalent conjugation of the novel synthetic antimicrobial peptide DP1 (RFGRFLRKILRFLKK) with reduced graphene oxide (rGO) resulted in the synthesis of peptide-functionalized nano conjugate (rGO-DP1).**
- **Biophysical and spectroscopic characterization confirmed peptide functionalization with retention of structural integrity and enhanced stability of the nano conjugate.**
- **rGO-DP1 exhibited broad-spectrum antibacterial and antibiofilm activity with enhanced membrane permeabilization and inhibition of early-stage bacterial adhesion.**
- **rGO-DP1 demonstrated minimal hemolytic activity and high mammalian cell viability, indicating good hemocompatibility and cytocompatibility.**
- **These findings establish immobilization of rGO-DP1 onto medical-device surfaces as an effective strategy to reduce bacterial attachment and biofilm maturation under simulated physiological conditions, supporting its application as a peptide-functionalized antimicrobial and antifouling nanocoating for medical devices.**

References

1. Centers for Disease Control and Prevention. (2025, June 27). *Catheter-associated urinary tract infection (CAUTI) basics*. https://www.cdc.gov/uti/about/cauti-basics.html
2. Joshi, S., Barman, P., Maan, M., Goyal, H., Sharma, S., Kumar, R., Verma, G., & Saini, A. (2024). Development of a two-dimensional peptide functionalized-reduced graphene oxide biomaterial for wound care applications. *Nanoscale, 16*(45), 20986–21001. https://doi.org/10.1039/D4NR02233E
3. Sharma, P., Sharma, S., Joshi, S., Barman, P., Bhatt, A., Maan, M., Singla, N., Rishi, P., Ali, M. E., Preet, S., & Saini, A. (2022). Design, characterization and structure–function analysis of novel antimicrobial peptides based on the N-terminal CATH-2 fragment. *Scientific Reports, 12*, 12058. https://doi.org/10.1038/s41598-022-16303-2
4. Joshi, S., Siddiqui, R., Sharma, P., Kumar, R., Verma, G., & Saini, A. (2020). Green synthesis of peptide functionalized reduced graphene oxide (rGO) nano bioconjugate with enhanced antibacterial activity. *Scientific Reports, 10*, 9441. https://doi.org/10.1038/s41598-020-66230-3
5. Joshi, S., Chadha, J., Harjai, K., Verma, G., & Saini, A. (2024). Synthetic peptide (DP1) functionalized graphene oxide: A biocompatible nanoformulation with broad-spectrum antibacterial and antibiofilm activity. *FlatChem, 44*, 100626. https://doi.org/10.1016/j.flatc.2024.100626

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