Essential-oil-driven self-assembly of Diphenylalanine: A new platform to biofunctional peptide nanomaterials

***Sara Stefani**[a], *Valeria Libera*[a], *Marco Minicucci*[b], *Alessandro Di Michele*[a], *Caterina Petrillo*[a], *Paola Sassi*[c], *Alessandro Paciaroni*[a], *Lucia Comez*[d]

[a] *Department of Physics and Geology, University of Perugia (Italy)*

[b] *Department of Physics, University of Camerino (Italy)*

[c] *Department of Chemistry, Biology and Biotechnology, University of Perugia (Italy)*

[d] *Consiglio Nazionale delle Ricerche, Istituto Officina dei Materiali - IOM (Italy)*

* *sara.stefani@unipg.it*

Diphenylalanine (FF), the simplest aromatic dipeptide moiety and a key structural motif within amyloid-β fibrils, is widely recognized for its remarkable ability to self-assemble into highly ordered nanostructures such as nanotubes, nanofibers, and microcrystals. These assemblies exhibit exceptional mechanical rigidity, thermal stability, tunable wettability, piezoelectricity, and intrinsic biocompatibility, making FF-based architectures promising candidates for applications in biosensing, drug delivery, nanoelectronics, and antimicrobial materials.[1]
The applicative challenge lies in exploiting the versatility of these systems to create new scaffolds with multiple properties. Of particular interest are matrices based on essential oils, complex mixtures of naturally occurring volatile compounds extracted from aromatic plants. Due to their characteristic fragrances and intrinsic bioactive properties, they are broadly employed in cosmetics, food products, and household formulations. Many essential oils also display well-documented antimicrobial, antifungal, and antioxidant activities, largely attributed to their terpenoid and phenolic constituents.[2]
In this study, oregano and tea tree oils were explored as unconventional solvents for driving the self-assembly of FF. The aim was to combine the intrinsic antibacterial activity of these oils with the structural and functional properties of FF aggregates, thereby promoting the formation of hybrid peptide-essential oil architectures with enhanced bioactivity. Moreover, this work includes a comprehensive physicochemical characterization, which is essential given that such FF–essential-oil structures have never been previously reported. The samples were examined using a multi-technique analytical approach combining scanning electron microscopy (SEM), infrared spectroscopy (IR), and X-ray diffraction (XRD).[3] This integrated characterization framework provides fundamental insights into the morphology, molecular organization, and crystallographic features of the newly formed assemblies, enabling a rigorous assessment of their structural properties and potential biomedical relevance.

Diphenylalanine aggregates, FTIR, XRD

References

[1] G. Domingos da Silveira, C. Izabelle, B. Saubamea, A. Varenne, F. d'Orlyé, *International Journal of Pharmaceutics,* **2023**, *648*.
[2] M. Walasek-Janusz, A. Grzegorczyk, A. Malm, R. Nurzyńska-Wierdak, D. Zalewski, *Molecules* **2024,** *29(2), 435*.
[3] S. Catalini, F. Bagni, S. Cicchi, M.Di Donato, A. Iagatti, A. Lapini, P. Foggi, C. Petrillo, A. Di Michele, M. Paolantoni, G. Schirò, L. Comez, A. Paciaroni, *Materials Advances,* **2024***, 5, 3802.*