MOLECULAR SHIELDING OF BIOACTIVE PEPTIDES VIA PLANT-PROTEIN SELF-ASSEMBLY NANOCARRIERS

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The functional performance of bioactive peptides is strictly dependent on their sequence integrity and conformational stability. Their susceptibility to proteolytic degradation and their flexibility critically limit their application in human nutrition and plant protection. Within the 4EU+ BIOnanoDELY project, we investigate the protein structure–function relationship while developing plant-protein-based nanocarriers to provide structural shielding for bioactive polypeptides.

Two legume-derived sources of bioactive polypeptide were explored: (i) β-vignin from cowpea (*Vigna unguiculata*), a 7S vicilin-type storage globulin hydrolyzed by in vitro gastrointestinal digestion, and (ii) soybean (*Glycine max*) okara, a protein-rich agro-industrial by-product, hydrolyzed to obtain antifungal peptides[1].To stabilize these molecules, self-assembled nanoparticles were obtained from maize zein and globulin-rich pea protein isolate via anti-solvent precipitation[2]. These biopolymeric matrices are designed to modulate protein-peptide interactions at the nanoscale, aiming to create a protective microenvironment that enhances resistance to proteolytic and environmental stress.

The effectiveness of this platform is currently being evaluated along two complementary axes: the improvement of gastrointestinal stability and intestinal bioaccessibility of β-vignin-derived peptides - assessed through the standardized INFOGEST model for in vitro protein digestibility and Caco-2 cells - and the preservation of the antifungal efficacy of okara-derived formulations against relevant phytopathogenic strains.

Elucidating how the nanoscale architecture of protein carriers dictates the functional fate of encapsulated peptides is key to overcoming current delivery bottlenecks. This research establishes a bio-derived platform where molecular precision meets sustainability, offering a scalable strategy to harness the potential of bioactive polypeptides for the evolving demands of the agro-food and biodefense sectors.

[1] S. De Benedetti, V. Girlando, M. Pasquali, A. Scarafoni. Molecules (2021), 26, 4858.

[2] A. Massironi, M. Toccaceli, A. Marinelli, D. Maggioni, C. Scapuzzi, D. Emide, A. Scarafoni, L. Verotta, K. Petroni, S. Marzorati, J. Drug Deliv. Sci. Technol. (2025), 105, 106624.