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The design of peptide-based hydrogels and the characterization of their physiochemical and release kinetic properties for applications in austere food environments

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Introduction: Nutritive and bioactive compounds that are purported to promote health, prevent disease, and preserve food are highly reactive to food matrices and environmental stressors which lead to degradation. A hydrogel is a type of encapsulation technology which is a networked structure capable of holding a large amount of water while forming a three-dimensional protective network capable of swelling or diffusing reversibly in water. They can be designed to shrink or expand in response to changes in the external environment to protect the compounds from stressors and then release them at the intended biological target. Here, we created novel hydrogels produced from electrostatic peptides found in human muscle, one rich in negatively charged glutamic acid and the other in positively charged lysine. Due to their amphiprotic peptide base, these hydrogels can be tailored to accommodate individual compounds and/or food matrices.

Concept: Although diffusion of the compounds is thermodynamically driven by concentration, it can be kinetically controlled. Further, the diffusion of core compounds in and out of the hydrogel will be a function of charge. Less diffusivity and stronger tortuosity result with crosslinked hydrogels with varying charges and peptide concentrations.

Methodology: The hydrogels are engineered in highly purified water with varying peptide concentrations, salt triggers and crosslinkers. Properties were measured via stress and strain curves, elastic modulus, viscous modulus, FTIR, swelling studies, and release rates. Enthalpy/crosslinking degree, thermal decomposition, and phase transition were measured via TGA and DSC.

Results: The peptides are excellent shell materials in creating robust, tunable hydrogels. The diffusivity and tortuosity can be kinetically controlled by varying the peptide concentration, as well as customized to different charged compounds. The increase in G enthalpy, Amide I bond shifts, and transition temperatures corroborated the mechanical strength increase of the higher concentration hydrogels.

Biography

Nicole Favreau-Farhadi is pursuing her PhD at the University of Massachusetts/Lowell researching novel hydrogels. She has served as Project Officer, Primary Investigator, Lab Manager and Analytical Chemist for 15 years for the Department of Defense (DoD) and is a subject matter expert in non-thermal processing, phenolic activity, browning mechanisms and preservation technologies. Her research and scientific contributions to the Department of Defense (DoD) Combat Feeding Research and Engineering Program have been pivotal to the DoD's mission of novel food processing, preservation and performance nutrition. Her many accomplishments have been documented in peer-reviewed journal publications, book chapters, multiple patents, notable accolades, industry interviews and numerous professional briefings.

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