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Flavor controlled release behavior from novel high internal phase Pickering emulsion gels stabilized by zein-chitin nanocrystals complex coacervates: the models on phase equilibria and mass transfer

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Abstract

Emulsion encapsulation techniques integrated with modeling analysis offer an innovative solution for flavor retention and release. Here, we used coacervate materials to improve the interfacial properties of a novel high internal phase Pickering emulsion (HIPPE) gel, facilitating retention and controlled release of five different flavors. We then elucidated the structure-function relationship using phase equilibrium and mass transfer models. At pH 6.5 and 7.5, the interdigital chitin nanocrystals (CNCs) combined with zein, forming zein-CNCs complex coacervates. Novel high internal phase emulsion (HIPPE) gels stabilized by coacervates had unique interwoven structures, smaller sizes (47.58 μm, 49.58 μm), and greater rheological properties (thixotropic recovery rate: 80.42%, 85.24%). The release behavior of emulsion with five flavors was monitored by gas chromatography in a homemade mouth model. Through partition coefficients and Harrison`s mathematical equation analysis, novel HIPPE gels exhibited a lower partition coefficient K_{ge}, mass transfer coefficient h_D, and higher effective partition coefficient K_{ge}^{eff}. The results indicated that the coacervation layers promoted affinity with flavors, and slowed down vortex-induced diffusion, thereby moderating flavor outbursts and controlling long-term release of hydrophobic flavors. This study presents potential applications of coacervate-structured emulsions as innovative flavor delivery systems to enhance flavor retention and controlled release.

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