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Influence of particle size on the stability and bioaccessibility of polyphenols encapsulated in liposomes

Influența dimensiunii particulelor asupra stabilității și bioaccesibilității polifenolilor încapsulați în lipozomi

Polyphenols are a diverse group of plant-derived bioactive compounds extensively studied for their antioxidant capacity and broad spectrum of physiological benefits. Nevertheless, their practical incorporation into food systems remains challenging due to their sensitivity to light, oxygen, temperature fluctuations, and pH variations, as well as their limited stability and transformation during gastrointestinal digestion. These factors significantly affect their bioaccessibility and, consequently, their biological efficacy. In recent years, liposomal encapsulation has emerged as a promising delivery strategy to improve the stability and functional performance of polyphenols. Liposomes, composed of phospholipid bilayers, are capable of entrapping both hydrophilic and lipophilic compounds, thereby providing physical protection against environmental stressors and modulating their release under digestive conditions. Among the various structural characteristics of liposomal systems, particle size has been identified as a critical parameter influencing dispersion stability, interaction with digestive enzymes, and release kinetics. Reduced particle size increases the specific surface area of liposomes, facilitating enzyme–substrate interactions under simulated gastrointestinal conditions and promoting enhanced intestinal release of polyphenols. This effect contributes to improved bioaccessibility and preservation of antioxidant activity compared to non-encapsulated systems. Furthermore, particle size significantly influences colloidal stability, modulating aggregation phenomena and physical destabilization during storage. Encapsulation efficiency and retention capacity are critical parameters for assessing liposomal performance. High encapsulation efficiency indicates effective incorporation of polyphenols within the phospholipid bilayer, while sustained retention during storage reflects limited membrane permeability and reduced oxidative degradation. Overall, liposomal encapsulation provides superior physicochemical protection relative to free polyphenols. Overall, current evidence highlights the importance of controlling particle size in order to optimize the technological stability, retention behavior, and digestive performance of polyphenol-loaded liposomes. These considerations support the growing interest in liposomal delivery systems for the development of fortified and functional food products with improved bioactive compound stability and bioavailability.

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