



Plant and Microbial Polysaccharides as Sustainable Wall Materials for Probiotic Microencapsulation: Structural Properties and Protection Mechanisms

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Abstract

Probiotics are live microorganisms that offer crucial health benefits, such as regulating gut microbiota and immune responses, provided they reach the host intestine at an effective concentration typically between one million and one billion viable colony-forming units per gram. However, probiotics suffer severe activity losses due to metabolite accumulation during production, as well as adverse conditions during processing, storage, and digestion, making it difficult to achieve desired therapeutic outcomes. Currently, encapsulation technology using plant and microbial extracellular polysaccharides serves as the primary method to maintain probiotic viability by providing exceptional gelation, film-forming, and biocompatible wall materials that protect organisms from destruction and enhance colon stability. This review systematically evaluates recent breakthroughs in food-grade microencapsulation technology, focusing specifically on the structure-function relationships of plant and microbial extracellular polysaccharide wall materials, their structural characteristics, and application trends. Furthermore, the scope of this work encompasses an overview of emerging delivery technologies, including material modification strategies and genetic engineering approaches, alongside the current applications and industrial challenges of polysaccharide-based encapsulation in foods. In conclusion, while broad encapsulation technologies exist, this review highlights the integration of novel material modifications and genetic engineering to understand polysaccharide structures. It serves as a comprehensive resource for researchers developing next-generation probiotic delivery systems, ultimately promoting further technological innovation and addressing market demands for functional synbiotic products.

Keywords: Plant Polysaccharides, Microbial Polysaccharides, Probiotic Microencapsulation, Wall Materials, Structural Characteristics

