Biotechnological Approach for Valorisation of Shrimp Shell Waste into α-Chitin and Probiotics-based bioproducts

Benjamas Cheirsilp
Professor and Researcher, International Program of Biotechnology, Center of Excellence in Innovative Biotechnology for Sustainable Utilization of Bioresources, Faculty of Agro-Industry, Prince of Songkla University, Hat Yai, Songkhla, Thailand

Jariya Ruangwicha
International Program of Biotechnology, Center of Excellence in Innovative Biotechnology for Sustainable Utilization of Bioresources, Faculty of Agro-Industry, Prince of Songkla University, Hat Yai, Songkhla, Thailand

Abstract:
Shrimp shell waste (SSW) is produced annually in large quantities by the seafood industry, which may cause environmental issues if without proper management, despite its high-value compositions including α-chitin, bio-calcium, pigments, and protein. Chemical extraction is a traditional method to extract α-chitin from SSW. However, this method negatively affects α-chitin quality, is an environmental hazard, and has a low possibility of recovering other components in the SSW. This study focuses on the biotechnological approach to recover α-chitin and all other components from SSW. Lactic acid fermentation (LAF) using probiotic strain, *Lactobacillus plantarum* 299v, was employed to extract α-chitin by simultaneously demineralizing and deproteinizing SSW in a stirred-tank bioreactor. The bio-extracted α-chitin (solid fraction after LAF) was further purified using enzymatic post-treatment. The liquid fraction, which contained probiotics, soluble calcium, and carotenoprotein, was subjected to freeze-drying to produce probiotic-calcium-carotenoprotein powder supplemented with maltodextrin as a supporting material and inulin as a prebiotic. This process resulted in high probiotic encapsulation efficiency (97.12 ± 2.43%) and maintained probiotic viability of 9.87 ± 0.30 log CFU/g. The probiotic-calcium-carotenoprotein powder exhibited excellent probiotic survival rates *in vitro* gastrointestinal tracts, and preserved high probiotic viability during 12 weeks of storage, particularly at 4 °C and -20 °C. The probiotic-calcium-carotenoprotein powder also exhibited high antioxidant activities across DPPH and ABTS scavenging, FRAP, and ORAC assays. Their amino acid profiling also confirmed their potential health benefits. This study has shown the efficient integration of fermentation, enzymatic processing, and formulation to valorize SSW into α-chitin and high-value functional bioproducts.

Keywords:
chitin biomaterials, microbial fermentation, probiotics, bioactive compounds, waste valorization.