Co-Lactic Acid Fermentation and Enzymatic Post-Treatment for Bio-Extraction of Chitin from Shrimp Shell Waste

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Abstract:
Shrimp shell waste (SSW) is generated annually in huge amounts due to the rising demand from the frozen seafood industry. The underutilization of SSW and its associated environmental issues need to be addressed, as SSW contains chitin as a major component along with minerals, proteins, and pigments with high potential for biotechnological valorization. Chitin and its derivatives possess various biological properties with potential biomedical applications. Traditional chitin extraction using strong acid and alkaline is environmental unfriendly and cause negative effect on chitin quality. This study established a sustainable biorefinery process integrating co-lactic acid fermentation (Co-LAF) using Lactobacillus plantarum and Streptococcus thermophilus with alkaline protease post-treatment to extract high-purity chitin from SSW. Both boiled shrimp shell powder (BSSP) and fresh shrimp shell powder (FSSP) substrates achieved high demineralization efficiency (DM) after 3 days (96.49–97.79%), with comparable chitin yields (61.93–62.55%). FSSP retained higher carotenoids (54.32±0.29 µg/g-SSP) and antioxidant activity (10.51 ± 0.18 µmol TE/g-protein), whereas BSSP exhibited greater protease activity (0.10 ± 0.007 U/mL) and deproteinization efficiency (DP). Optimization of alkaline protease post-treatment demonstrated that a 50× (v/w) liquid to solid ratio effectively enhanced DP to 98.21 ± 0.12% and DM to 99.4–99.8%. Scale-up in a 5-L stirred-tank bioreactor (3-L working volume) results comparable to flask-scale fermentation, achieving 99.8 ± 0.11% DM, 98.09 ± 0.26% DP, and a chitin yield of 25.1 ± 0.04%. Overall, this process provides high-purity chitin and valuable co-products, supporting scalable and environmentally friendly marine biowaste valorization.

Keywords:
Biorefinery, chitin extraction, low-cost substrate, probiotics, seafood waste.