Decapod digestive enzymes as aids for marine polysaccharides degradation

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Abstract

Marine macroalgae and cultivated crustaceans can generate problematic biomass, either through excessive blooms washing ashore or as aquaculture residues, both typically considered waste. However, fisheries and aquaculture discards of decapod crustaceans contain diverse endogenous digestive enzymes, offering an opportunity for recovery and utilization. This study explored repurposing crustacean waste and brown algae to create value-added products. Crude digestive enzyme extracts from shrimp (*Penaeus vannamei*), lobster (*Homarus americanus*), and crayfish (*Cherax quadricarinatus*) were assessed for their ability to hydrolyze β-glucans. Shrimp extracts effectively degraded β-1,3-glycosidic bonds (laminarin), while crayfish and lobster extracts hydrolyzed β-1,4-glycosidic bonds (cellulose). Optimal enzymatic activity occurred at pH 4–6 and 50–60 ∘C, with peak efficiency at 30–40 ∘C. Then, their ability to degrade complex carbohydrates found in brown macroalgae was tested; pre-treated brown macroalgae (*Sargassum horridum*) was incubated with the extracts, successfully releasing glucose. A combination of shrimp and crayfish extracts proved more effective than shrimp extracts alone. The liberated glucose was fermented by yeast to produce bioethanol. This proof-of-concept study demonstrates that marine bio-waste can serve as a source of active enzymes and viable substrates for bioethanol production. By integrating these waste streams into a complementary process, this approach may help mitigate biomass accumulation and provide valuable feedstock for biotechnological applications.

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