Optimization and Scale-Up of Solid-State Bioconversion for Microbial Coagulant Production toward Sustainable Water Treatment

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Fellah, Maroua [a] ; Alam, Md Zahangir [a] ; Al Mamun, Abdullah [b] ; Benoudjit, Abdelmohsen [c] ; Kabbashi, Nassereldeen Ahmed [a] ; +1 author

[a] Department of Biotechnology Engineering, Kulliyyah of Engineering, International Islamic University Malaysia, Jalan Gombak, Selangor, Kuala Lumpur, 53100, Malaysia

Abstract

Microbial coagulants are emerging as an eco-friendly alternative to chemical coagulants owing to their non-toxicity, biodegradability, and sustainability. However, their use is limited by high production costs linked to expensive nutrient media and scalability issues. To address these challenges, this study developed a cost-effective microbial coagulant based on a fungus using cocopeat as a substrate. Growth conditions (malt extract, glucose, and pH) were optimized using the Face-Centered Central Composite Design (FCCCD) under Response Surface Methodology (RSM) to maximize coagulant yield. The performance in water treatment was evaluated using jar tests, and large-scale production techniques were investigated using a tray bioreactor and an agitated drum bioreactor (ADB). The fungal strain used in this study was identified as Phanerochaete concrescens, which demonstrated high turbidity-reducing efficiency, achieving a maximum flocculating activity

of 93.06% in a standard jar test. These results were obtained under statistically optimized growth conditions, specifically 5 days of incubation at 25°C, 70% moisture content, 3% malt extract, 2.5% glucose, and pH 7, confirming model predictions. Phanerochaete concrescens was successfully scaled using a tray fermenter, achieving a flocculation rate of 92% after 5 days of incubation at 70% moisture, pH 7, and a 3 cm substrate thickness. However, in a 30 L agitated bioreactor drum, flocculating activity was recorded at 29% due to insufficient fungal growth at the tested agitation rate. This study confirms the feasibility of a cost-effective microbial coagulant that can be scaled appropriately, offering a sustainable and biodegradable alternative to chemical coagulants.

Author keywords

microbial coagulant; response surface methodology; scale-up; solid-state bioconversion; water treatment

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Corresponding authors

Corresponding author	M. Fellah
Affiliation	Department of Biotechnology Engineering, Kulliyyah of Engineering, International Islamic University Malaysia, Jalan Gombak, Selangor, Kuala Lumpur, 53100, Malaysia
Email address	fellahmaroua06@gmail.com

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