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Formulation and Characterization of NaCS-PDMDAAC Capsules with Immobilized Chlorella vulgaris for Phycoremediation of Palm Oil Mill Effluent

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Abstract : Cultivation of immobilized microalgae cells is on the rise for biotechnological applications. In this study, cultivation of Chlorella vulgaris was carried out in the form of suspended free-cell and immobilized cells system. NaCS-PDMDAAC capsules were used to immobilize C. vulgaris. Initially, the synthesized NaCS with C. vulgaris culture were prepared at various concentration of 5- 20% (w/v) using a 6% hardening solution (PDMDAAC) to investigate the capsules' gel stability and suitability for microalgae cells growth. Then, the capsules produced from 15% NaCS with C. vulgaris culture were furthered investigated using 5%, 10%, and 15% (w/v) of PDMDAAC solution. The capsules' gel stability was evaluated through dissolution time and loss of uniform spherical shape of capsules, while suitability for microalgae cells growth was evaluated through the optical density of microalgae. In this study, the 15% NaCS-10% PDMDAAC capsules were found to be the most suitable to sustain the capsules' gel stability and microalgae cells growth in MLA. For that reason, the C. vulgaris immobilized in the 15% NaCS-10% PDMDAAC capsules were further characterized using physicochemical analysis in terms of morphological, carbon (C), hydrogen (H) and nitrogen (N), Fourier transform-infrared (FT-IR), scanning electron microscopy-energy dispersive X-ray (SEM-EDX), zeta potential and Brunauer-Emmet-Teller (BET) analyses. The results revealed that the presence of sulfonates in the synthesized NaCS and NaCS-PDMDAAC capsules without and with C. vulgaris proves that cellulose alcohol group was successfully bonded by sulfo group. Besides that, immobilized microalgae cells have a smaller cell size of 6.29 ± 1.09 µm and zeta potential of -11.93 ± 0.91 mV than suspended free-cells microalgae culture. It can be summarized that immobilization of C. vulgaris in the 15% NaCS-10% PDMDAAC capsules are relevant as a bioremediator for wastewater treatment purposes due to its suitable size of pore and capsules as well as structural and compositional properties.

Keywords : biological capsules, immobilized cultivation, microalgae, physico-chemical analysis
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