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Repeated-batch fermentation of microalgal biomass utilizing immobilized yeast cells for bioethanol production

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Abstract

Development of sustainable energy systems from renewable biomass feedstocks is now a global effort. The use of biomass in many technological processes is crucial for the development of biorefineries concerning energy, economy and environmental sustainability. Separate hydrolysis fermentation (SHF) and simultaneous saccharification fermentation (SSF) processes were studied for bioethanol production from microalgal biomass. SSF was selected as an efficient process to enhance the bioethanol yield through repeated-batches using immobilized yeast cells. Combined sonication and enzymatic hydrolysis of Chlamydomonas mexicana generated 10.5 and 8.48 g/L of ethanol in SSF and SHF, respectively. Yeast utilized maximum portion of total reducing sugar (TRS) reaching a consumption efficiency of 91-98%. A bioethanol yield of 0.5 g/g (88.2% of theoretical yield) and volumetric productivity of 0.22 g/L/h was obtained after 48 h of SSF. Immobilized yeast cells enabled repetitive production of ethanol for 7 cycles displaying a fermentation efficiency upto 79% for five consecutive cycles. The maximum ethanol production was 9.7 g/L in 2nd-4th cycles. A total energy recovery of 85.81% was achieved from microalgal biomass in the form of bioethanol. Repeated-batch SSF demonstrated the possibility of cost-effective bioethanol production.