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Acid-Base Pretreatment and Enzymatic Hydrolysis of Palm Oil Mill Effluent in a Single Reactor System for Production of Fermentable Sugars

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Abstract

Palm oil mill effluent (POME) is one of the main agro-industrial wastewaters in Malaysia. Highly polluting POME is a serious threat to the environment. In recent years, the methods used to treat POME are inefficient and complex in terms of cost or environmental preservation. The main object of this research is to propose a single reactor system (SRS) obtained from POME wastewater discharge as a promising low-cost treatment and high-energy method for harvesting the fermentable sugar by applying acid-base-enzyme pretreatment and hydrolysis of POME by locally produced cellulase enzymes to enhance biofuel production. Several experiments were conducted to produce fermentable sugars through the statistical methods, including the characterization of POME, acid-base pretreatment, and enzymatic hydrolysis process for reducing sugar production. The one-factor-at-a-time (OFAT) results showed that the highest reducing sugar yield, 23.5 mg/mL of POME, was achieved by enzymatic hydrolysis in an SRS without having a separation and purification. Based on OFAT performance, optimization of two factors such as substrate concentration (total suspended solids, TSS %w/v) and enzyme loading ($\mu\text{mol}/\text{min}$) was carried out by applying face-centered central composite design (FCCCD) under the response surface methodology (RSM) to develop a second-order regression model. The optimum reducing sugar production was 26.6 mg/mL (53.14%) with the conditions of 5% w/v, TSS, and 80 $\mu\text{mol}/\text{min}/\text{mL}$ of the enzyme dose. In addition, the results of this research can be further considered in biofuel production using other wastewaters to enhance biofuel production as well as wastewater treating functions and minimize the negative environmental impacts. © 2023 Nibedita Deb et al.

Index Keywords

Biofuels, Effluents, Oil shale, Palm oil, Regression analysis, Sugars, Wastewater treatment; Acid base, Biofuel production, Fermentable sugars, Industrial wastewaters, Malaysia, One-factor, Palm oil mill effluents, Pre-treatments, Reducing sugars, Single reactor systems; Enzymatic hydrolysis

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