Simultaneous saccharification and fermentation of empty fruit bunches of palm for bioethanol production using a microbial consortium of S. cerevisiae and T. harzianum

ABSTRACT

A simultaneous saccharification and fermentation (SSF) optimization process was carried out on pretreated empty fruit bunches (EFBs) by employing the Response Surface Methodology (RSM). EFBs were treated using sequential acid-alkali pretreatment and analyzed physically by a scanning electron microscope (SEM). The findings revealed that the pretreatment had changed the morphology and the EFBs' structure. Then, the optimum combination of enzymes and microbes for bioethanol production was screened. Results showed that the combination of S. cerevisiae and T. harzianum and enzymes (cellulase and β-glucosidase) produced the highest bioethanol concentration with 11.76 g/L and a bioethanol yield of 0.29 g/g EFB using 4% (w/v) treated EFBs at 30 °C for 72 h. Next, the central composite design (CCD) of RSM was employed to optimize the SSF parameters of fermentation time, temperature, pH, and inoculum concentration for higher yield. The analysis of optimization by CCD predicted that 9.72 g/L of bioethanol (0.46 g/g ethanol yield, 90.63% conversion efficiency) could be obtained at 72 h, 30 °C, pH 4.8, and 6.79% (v/v) of inoculum concentration using 2% (w/v) treated EFBs. Results showed that the fermentation process conducted using the optimized conditions produced 9.65 g/L of bioethanol, 0.46 g/g ethanol yield, and 89.56% conversion efficiency, which was in close proximity to the predicted CCD model.