Optimization of the Enzymatic Saccharification Process of Empty Fruit Bunch Pretreated with Laccase Enzyme

Samiur Rashid Shah, Ukaegbu Chinonso Ishmael*, Jaya Vejayan Palliah, Mohammed Fazli Farida Asras, and Sharifah Suhaiza Binti Nik Wan Ahmad

The saccharification of laccase-pretreated empty fruit bunch (EFB) was optimized in a lab-scale experiment using one-factor-at-a-time (OFAT) and response surface methodology (RSM). After pretreatment, the degree of delignification was checked by noting the weight loss (%) after pretreatment, and also by the quantity of total sugar produced after saccharification with cellulase enzyme. OFAT studies of saccharification of the pretreated EFB showed that the biomass was best saccharified using cellulase enzyme at the following conditions: enzyme concentration of 30 IU/g of EFB, substrate concentration of 5.0% w/v, 50 °C, saccharification time of 24 h, and pH 5. This combination exhibited the highest yield of total sugar (28% w/w). Although 29% w/w yield was achieved with an enzyme concentration of 40 IU/g of EFB, this increase in yield was not proportional to the increased enzyme concentration and, therefore, was considered insignificant. Statistical analysis of the combined effects of pH and temperature showed that pH had a more significant effect than the temperature on the saccharification process, based on a $P < 0.05$ significance level. The effect of pH on total sugar production was more significant than the temperature in both linear and quadratic functions. In sum, the saccharification of laccase-pretreated EFB should follow the optimized process conditions achieved in the current study.

Keywords: *Empty fruit bunch; Laccase enzyme; Saccharification; Sugar*

Contact information: Faculty of Industrial Science and Technology, University Malaysia Pahang Lebuhraya Tun Razak, 26300, Gambang, Kuantan Pahang Darul Makmur;
** Corresponding author: chinoreal1456@yahoo.com*

INTRODUCTION

The production of sugar from lignocellulosic biomass requires delignification of the substrate (Venkatesh and Pradeep 2013). Cellulose and hemicellulose are the major sugars in empty fruit bunch (EFB), a residue in the palm oil industry. Lignocellulosic biomass is a preferred raw material for the production of bioethanol (Sudiyani *et al.* 2010). A major problem with the conversion of lignocellulosic biomass to bioethanol is the high percentage of lignin in cell walls, which protects cellulose and hemicellulose from cellulolytic enzymes (Havannavar and Geeta 2010). Different pretreatments have been employed to enhance the recovery of sugar from lignocellulosic biomass, with varying success in delignification. Chemical pretreatment with acids and bases is the method of choice because of its effectiveness (Iroba *et al.* 2013).

Although chemical pretreatment methods have been successfully adopted, they have many drawbacks including the formation of inhibitory factors such as furfural and hydroxymethyl furfural, low digestibility of produced sugar, and enzyme inhibition during hydrolysis (Sun and Cheng 2002). These factors contribute to the low yield of bioethanol from mostly chemically pretreated biomass. Thus, other ways of pretreating biomass for