Utilization of oil palm frond (OPF) juice for the production of bioethanol

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Abstract

Malaysia is the world's second largest palm oil producer and occupied huge plantations area up to 5.038 million hectares (MPOB, 2012). The oil palm industry has become the backbone of Malaysia's economy hence, generate large quantity of biomass (Zahari *et al*., 2014). Oil palm estates generate large production of dry weight biomass such as trunks, fronds, empty fruit bunches and other biomass fractions estimated 80 metric tons (Mmtons). Zahari *et al.,* (2012) proposed, oil palm frond (OPF) is the most generated biomass which left during pruning and harvesting of fresh fruit bunches. OPF has been identified as a good candidate to replace commercial sugars for the production of value-added products such as poly (3-hydroxybutyrate), P (3HB) and bioethanol. However, the research to date has tended to focus on oil palm trunk (OPT) sap rather than OPF juice. Previous research study on OPF as a roughage feed source for ruminants (Hassan *et al*., 1994), based diets for beef and dairy production (Wan Zahari *et al*., 2003) and feed for herbivores (Dahlan, 2000). The potential of OPF as a feedstock for the bioethanol production has been examined by (Zahari *et al.,* 2012). In this study, potential of OPF juice for the production of bioethanol in shake flasks experiment was investigated using *Saccharomyces cerevisiae* Kyokai No. 7. *S. cerevisiae* is ethanologenic microorganisms often chosen for the ethanol production due to capability to ferment the sugars from sucrose containing feedstock directly, grow under anaerobic condition and tolerance to environmental condition. In this research, one-factor-at-time (OFAT) was employed to screen the best condition of parameters which affecting the production of bioethanol. The best conditions for OPF juice can be determined by investigating the influence of several parameter such as effect of sterilization (autoclaved and non-autoclaved) and agitation speed. Fresh OPF was extracted using sugarcane pressing machine to obtain OPF juice and separated into two shake flasks. One flask which containing OPF juice was autoclaved at 121°C for 20 minutes and another juice was used directly prior for fermentation. Another set of experiment was conducted to study the effect of agitation on ethanol production by testing several agitation speed at 0, 50, 100, 150 and 200 rpm by using autoclaved OPF juice throughout the study. The cultures were incubated at 32°C under anaerobic condition. Equation 1 and 2 (Nasir *et al*., 2014) shows the equation employed to determine percentage sugar utilized and ethanol yield whereas, Table 1 shows effect of agitation speed on the bioethanol production. Agitation is required for constantly mixing of the medium components to enhance well mixing and oxygen transfer rates. Ethanol concentration and yield also can be enhance by using best condition of agitation speed (Yan *et al*., 2009). The effect of agitation speed is necessary to enhance fermentation yield by providing adequate mixing, mass transfer and heat transfer (Rodmui *et al.,* 2008). Best agitation speed will enable uniform suspension of microbial cells in homogenous nutrient medium. Agitation speed of 100 rpm showed highest ethanol yield compared to others. High agitation speed might resulted in least ethanol yield by causing morphological changes and disruption of cell structure (Mittal, 1992). Bakri *et al*., (2011) proposed, high agitation speed contributes to the effect of hydrodynamic stress which causing leakage of intracellular compounds.

$$Percentage\ sugar\ utilized = \frac{100 \times (Initial\ sugar - final\ sugar)\ g/l}{(Initial\ sugar)\ g/l} \quad (1)$$

$$Ethanol\ yield\ (\%) = \frac{[Ethanol\ (\frac{g}{l})]}{[Total\ sugar\ (\frac{g}{l})]} \times 100 \quad (2)$$

Table 1: Effect of agitation speed on the bioethanol production

Agitation speed (rpm)	bioethanol yield (%)
0	55.3826
50	57.0116
100	66.0430
150	55.1952
200	53.6990

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