Bioremediation of palm oil mill effluent and lipid production by *Lipomyces starkeyi*: A combined approach

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\section*{Abstract}

The discharge of palm oil mill effluent (POME) on arable land causes large amounts of environmental distress due to its high concentration of phenolic compounds and chemical oxygen demand (COD). The approach of simultaneous microbial oil production and wastewater treatment is an attractive option to combine renewable energy production and environmental resilience. This study aims to produce cost-effective microbial lipids using the oleaginous yeast *Lipomyces starkeyi* through the bioremediation of POME. A moderately dilute solution (50\%) of POME showed higher microbial growth and lipid accumulation and offered a significantly higher degree of bioremediation. A lipid content of 21.32\% was achieved with 50\% POME, whereas the value was 15.14\% for 25\% POME. Three different techniques including ultrasonic treatment, Fenton’s reagent and Fenton’s + ultrasonic were employed to extract lipids from microbial biomass, and the maximum lipid concentration was obtained using the Fenton’s + ultrasonic treatment. The degree of bioremediation was evaluated by the calculating seed germination index (GI) values. Higher GI values were observed for the 25\% and 50\% dilutions compared to undiluted (100\%) POME. This combined approach can be a potential alternative technology that integrates bioremediation of POME with microbial lipid production.

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\section*{1. Introduction}

The modern world is confronting several issues such as energy crisis, wastewater generation, air pollution and global warming. However, excessive wastewater generation and depletion of energy are the most important issues for human society (Nayak et al., 2016). The increase in worldwide energy consumption is not sustainable due to population growth and economic development (Schneider et al., 2013). To meet our energy needs, industrialization is necessary and hence, an overwhelming amount of industrial wastewater will be generated (Baranitharan et al., 2015). Mostly non-renewable fossil fuels such as petroleum, coal and natural gas are being used to fulfill this demand (Nayak et al., 2016); however, recent studies have shown that fossil fuels are not adequate (Islam et al., 2017a). Therefore, the ideal solution would be to use wastewater as a source of renewable energy, which would address both wastewater treatment and energy depletion issues (Islam et al., 2017b).

Palm oil mill effluent (POME) is a high strength pollutant with a low pH (due to the organic and free fatty acids), arising from the partial degradation of palm fruits before processing (Iwuagwu and Ugwuanyi, 2014). Several reports have shown that these values are 100 times higher than those of municipal sewage (Iwuagwu and Ugwuanyi, 2014; Mamimin and Prasertsan, 2011). POME is often discharged directly from a mill, which is objectionable and could pollute streams, rivers, and the surrounding lands (Okwute and Isu, 2007). When POME is discharged into water bodies, it turns the water brown, smelly, and slimy, and causes de-oxygenation (Islam et al., 2017b) that may kill fish and other aquatic organisms (Ezemonye et al., 2008). The disposal of untreated POME into soil