Chapter 10
Review on Microbial Analysis Tools in POME treatment

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ABSTRACT

Palm oil mill effluent (POME) is one of the major sources of water pollution in Malaysia. POME is produced in large volumes by many palm oil mills and has acidic pH and high concentrations of COD, BOD, and suspended solids, which have adverse effect to the environment. Currently, the technology to treat POME is either physical, chemical, or biological. About 80% of palm oil mills treat their POME by using biological method. Recent studies have indicated that understanding the microbial community structure is of great importance to improve and control the biological treatment performance. Currently, the most popular molecular biology tools for microorganism community analysis are fluorescence in situ hybridisation (FISH), cloning of 16S rDNA, and denaturing gradient gel electrophoresis (DGGE). This chapter aims to review the current and ongoing treatments of POME (mainly anaerobic, aerobic, physicochemical, and membrane separation) and discuss the potential of using the molecular biology techniques in POME treatment. The importance and effectiveness of the microbiology tools are also discussed. The ability to monitor microorganisms and understand their ecology is essential to effectively control the startup and operation of biological treatment system in treating POME and eventually producing effluent of acceptable quality.

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INTRODUCTION

Palm oil is an important commodity especially in Malaysia and Indonesia. The global production of palm oil in 2014 was 62.34 million tonnes and 85% of the productions came from these two countries. In 2016, the palm oil industry in Malaysia generated approximately 58 million tonnes of palm oil mill effluent (POME) which arose from the processing of oil palm fresh fruits bunch (OPFFB) for palm oil extraction (Zainal et al., 2017). Currently, Malaysia has produced 21,000 metric tonnes of palm oil (Mundi, 2017). Table 1 shows the world palm oil production in 2017 (Mundi, 2017). The demand for palm oil will increase steadily with the increasing world population that is predicted to grow from 7 billion tonnes in 2011 to 9 billion tonnes by 2043. Therefore, the world demand for fats and oils will reach 360 million tonnes by 2043 (Basiron, 2013). Palm oil have been recognised as the most utilised vegetable oil globally with the total production reaching up to 40% compared to other vegetable oils (Hansen et al., 2015; Oosterveer, 2015).

The different steps in palm oil extraction process generate various types of waste by-products such as oil palm shell (OPS), fibres, empty fruit bunches (EFB), palm oil clinker (POC), palm oil fuel ash (POFA), and palm oil mill effluent (POME). Figure 1 shows a simplified flow diagram of palm oil extraction processes. The approximate generation of POME is also depicted in Figure 1. POME is a thick brownish liquid discharged at temperature between 80 and 90 °C, with pH ranging from 4.0 to 5.0, biological oxygen demand (BOD) in the range of 10.25–43.75 g/L, chemical oxygen demand (COD) in the range of 15–100 g/L, high salt content, and high suspended solids (SS) around 5–54 g/L (Ahmad et al., 2003; Baranitharan et al., 2013). If not managed properly, POME could have a great impact on the environment (Kanadasan & Razak, 2015). About 1.5 m^3 of water is used for processing of 1 tonne of fresh fruit bunches (FFB). A study has shown that half of the processing water used ends up as POME (Chang, 2014). In Malaysia, palm oil mills have been recognised as the second largest source for the greenhouse gas (38%) next to waste landfills (53%) (Chan & Chong, 2019). The treatment of POME is crucial to conserve the environment due to the emissions of biogas and the concern on the quality of the final discharge to the watercourse, which might cause environmental deterioration (Basri et al., 2010; Harsono et al., 2014).

The information of microbial profiling of biological treatment could improve treatment performance and control strategy of wastewater treatment plant. Modern molecular biology techniques have replaced traditional microbiological methods. Traditional methods possess several disadvantages such as the impossibility to isolate pure cultures and cultivate certain kinds of bacteria in artificial conditions, e.g., activated sludge bacteria. Bacterial strains grown using the traditional methods do not possess particular phenotypes, grow slowly, and are affected by environmental factors. In addition, studies in natural biodiversity and engineered ecosystem are not adequate because the procedures in conventional methods need more laborious characterisation experiments (Sanz & Kochling, 2007). On the other hand, modern molecular biology techniques are easier and faster compared to conventional methods. In modern techniques, growth medium is not required, because the probes used in the analysis are taken directly from the environment. These tools enable researchers to study all types of bacteria, including nonculturable ones, under laboratory conditions. Moreover, samples for analysis are small and results are repeatable. Thus, molecular methods have become more popular in technological and microbiological laboratories, and can be used to monitor the biological community in activated sludge and other biological research systems.

Related Content