



Comparison of acid and alkaline pre-treatment on methane production from empty palm oil fruit bunches (OPEFB): Effect on characteristics, digester performance, and correlation of kinetic parameters

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ABSTRACT

This paper focused on comparing the impact of two different chemical pretreatments on various characteristics of OPEFBs (i.e., physical, structural, and morphological properties), methane production, digestate characteristics, and kinetic modelling. The biochemical methane potential (BMP) test showed that alkaline-treated OPEFBs produced higher methane yields than acid-treated OPEFBs. Accordingly, the methane yields became far higher after NaOH pretreatment, showing 0.186–0.224 m³CH₄/kg VS_{added} compared with 0.102 m³CH₄/kg VS_{added} and 0.093–0.115 m³CH₄/kg VS_{added} from untreated and acid-treated OPEFBs. The best treatment was alkaline pretreatment of P2N3, which gave the highest methane yield increase (by 1.2-fold). The Scanning Electron Microscopy and Energy Dispersive X-ray (SEM-EDX) results of acid-treated OPEFBs indicated disruption of cell wall and loss of some minerals. However, alkaline-treated OPEFBs have more pores due to silica and other chemicals releases (i.e., lignin, hemicellulose, etc.). The kinetic study showed that all models (i.e., modified Gompertz, logistic, and transference) were in good agreement with the experimental data. Both experimental data and models confirmed P2N3 (i.e., NaOH concentrations of 3.8%) as the best results, indicated by the highest lignin reduction and methane production. This study showed an excellent opportunity to digest alkaline-treated OPEFBs, yet more in-depth investigations with sustainability and circular economy perspectives are needed.

1. Introduction

Production of oil palm (*Elaeis guineensis*) in Indonesia continues to increase from 42.88 million tons (in 2018) to 49.12 million tons (in 2020) [1]. Suhartini et al. [1] stated that, particularly in Indonesia, a ton

of fresh fruit bunches (FFB) produces 21.8% of crude palm oil (CPO), 22.5% of oil palm empty fruit bunches (OPEFBs), 14.3% of oil palm fibre (OPF), 6.7% of oil palm shells (OPS), and 5.4% of oil palm kernel (OPK) from any palm oil mills (POMs). Among them, OPEFBs are accounted as the most generated solid waste from POMs. Therefore, based on the above data, it can be estimated that the potential of OPEFBs is increasing

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