Ultrasound-Assisted Dilute Acid Medium of Oil Palm Residues Toward Morphological and Thermal Properties

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Abstract. Biomass is widely recognized as an essential source of renewable energy. The most abundant organic resources in the plantation field are oil palm frond (OPF) and trunk (OPT). These lignocellulose biomaterials are rich in renewable biobased products. The recalcitrance of oil palm biomass directly linked with the cellulose, hemicellulose, and lignin structure remains a challenge. The pretreatment process is still a consideration because the recalcitrant lignocellulose structure prevents depolymerization from releasing the appropriate substrate to a new approach. This study is aimed to characterize the oil palm frond and trunk pretreated by a combination of ultrasonication with a dilute sulfuric acid medium. This study considers the morphological and thermal characteristics intending to explore their future potential application. The procedure in this research was that the raw OPF and OPT were weighed and transferred into a 1000 ml beaker containing a low acid concentration of H_2SO_4 in the ratio of 1: 25. The deionized water (DW) was used as a control. The mixture was stirred and incubated in an ultrasonic bath for 30 minutes at an ultrasonic frequency of 40 kHz and an ambient temperature of 80°C. The operating time and power were set at the start of the pretreatment. The ultrasonicated materials were characterized by Scanning Electron Microscope (SEM) and Thermogravimetric Analysis (TG-STA). The results demonstrated that the yield percentages of OPT's ultrasound-assisted low sulfuric acid (ULSA) are about 10% higher than the deionized water pretreatment. SEM results showed that the ULSA pretreatment of OPF and OPT revealed a significant disruption of their surface structures. The DTG analysis revealed that the maximum temperature degradation of ULSA pretreatment is shifted to a higher temperature than the raw material, which is 273.43℃ for OPF and 265.15 for OPT to 314.43℃ for ULSA-OPF (SOPF) and 318.88℃ ULSA-OPT (SOPT). The thermogravimetric data indicates that the ULSA pretreatment produced more thermal stability than untreated oil palm biomass. Thermal stability is an essential criterion for determining the best lignocellulose material for a particular application, including energy. Hence, ultrasound coupled with the low sulfuric acid medium in both oil palm frond and the trunk has potential as a renewable material for use in many future applications of the bio-based material.

INTRODUCTION

Oil palm lignocellulosic biomass materials are one of the vast reservoirs from which fuels and various necessary chemicals can be produced in a relatively simple, environmentally friendly, and cost-effective manner. Those materials are plentiful in Indonesia and Malaysia. The pretreatment approach has remained a consideration because the recalcitrant lignocellulose structure hinders depolymerization from releasing appropriate substrate to a new process. Pretreatment is a time-consuming and energy-intensive process. This step's goal is to disrupt the lignocellulosic matrix to remove lignin. Several biomass pretreatment techniques, including physical, chemical,

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