[ID-21]
Extraction of lignin from oil palm empty fruit bunches as filler in polylactic acid (PLA) bio-composite for 3D printing application

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Abstract

The usage of biodegradable PLA was preferable in 3D printing applications due to environmental concerns. However, the linear microscopic structure of PLA had limited its mechanical strength. The potential use of complex structure lignin from OPEFB could increase the stiffness of PLA. This study aimed to extract the lignin from OPEFB and reinforced it into PLA for 3D printing applications. The lignin was extracted by using 1,4-dioxane with hydrochloric acid as an acid catalyst. After the purification by diethyl ether, the lignin was mixed with PLA for the preparation of filament and used for 3D printing. The 3D printed PLA/lignin bio-composite proceeded with a mechanical test. The yield extraction of lignin from OPEFB by 1,4-dioxane was 8.32%. The Fourier Transform Infra-Red (FTIR) spectrum confirms the carbonyl, methoxy, and hydroxyl group in the extracted lignin. Scanning electron microscopy (SEM) also confirms the extraction of lignin occurs on the surface of OPEFB. The stress-strain graph shows the increase in mechanical strength of PLA after the reinforcement with the addition of lignin. Young's modulus of PLA/lignin bio-composite increases to 9.07% proximately compared to PLA.

Keywords: polylactic acid, lignin, bio-composite, 3D printing, mechanical strength