Water Solubility of TPCS reinforced OPEFB Fiber Composite

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ABSTRACT: The increase of environmental awareness has encouraged sustainable, biodegradable materials to replace traditional non-biodegradable materials in numerous applications. This study aims to develop thermoplastic corn starch (TPCS) reinforced oil palm empty fruit bunch (OPEFB) fiber composite and investigate its environmental properties. The TPCS acts as a matrix that combines corn starch and glycerol with the TPCS blending ratio of 30:70. The manufacturing of TPCS reinforced OPEFB fiber was achieved by combining different amounts of OPEFB fiber (10 to 80 wt.%). The water solubility result showed that the specimen of 10 % of fiber content had undergone the highest weight loss as much as 66 %. The specimen with the lowest weight loss was recorded for 80 wt.% fiber with a value of around 15 %.

Keywords: *Oil palm empty fruit bunch; Thermoplastic corn starch; Water Solubility*

1. INTRODUCTION

Natural fiber-reinforced composites have attracted the analyst's attention mainly because they provide an option to the greatly diminished petroleum sources. To manufacture entirely natural fiber-based materials as a substitution for petroleum-based products is not an efficient solution. A more practical solution is by blending natural fiber-based materials with petroleum-based resources to create cost-effective products for various applications [1].

Possible alternatives for the petroleum-based polymer are thermoplastic starch (TPS) due to its low density, low price, resource availability, and biodegradability. Studies on TPS are mostly done with starch sources such as cassava, potatoes, and corn [2]. Corn starch has the highest amylose content as compared to the other starches [3]. Due to this behavior, corn starch shows vast potential to become a suitable matrix in the natural fiber composite.

OPEFB fiber is a waste material in oil factories. Recent researchers have tested the OPEFB fiber reinforced polymer composite and discover that it offers much better properties. Other than the advantages of the OPEFB fiber such as being ecologically friendly, renewable, inexpensive, low density, improved heat and insulating performance, the processes of turning OPEFB's fiber into composite only require low energy consumption [4].

Therefore, this study aims to develop and investigate the environmental properties of TPCS reinforced OPEFB fiber composite. The composite mixture was compacted into a 3 mm thick plate mold through a hot press machine. Then, the environmental properties were investigated by conducting a water solubility test.

2. METHODOLOGY

2.1 Raw Materials

Corn starch and glycerol were procured from Polyscientific Enterprise Sdn. Bhd. The OPEFB fiber as shown in Figure 1 was purchased from Palm Oil Mills in Taiping, Perak, Malaysia.

Figure 1 Oil palm empty fruit bunch (OPEFB) (left) and OPEFB fibers (right)

2.2 Sample Preparation

The TPCS preparation was performed according to the previous study by Nazri et al. [5]. The fabrication of TPCS reinforced OPEFB fiber was achieved by combining different OPEFB fiber amounts from 10 to 80 wt.%. The TPCS/OPEFB fiber composite was compacted into a mold of 3 mm thick plates using a hot press machine. Next, the composite needed to undergo approximately 45 minutes of heating at 165 °C and cooled for 15 minutes. Finally, the composite specimen was removed from the mold and prepared for the cutting process.

2.3 Water Solubility Testing

A sample size (13 x 13 x 3 mm) was cut and surged dried before immersing in 50 ml of distilled water at 105 °C ± 2 for 24 hours. The original sample weight, W_o, was measured before the immersion. The rest of the sample section was taken from the beaker after 24 hours of immersion, and filter paper was used to absorb the excess surface water. Then, the samples were dried at 105 °C ± 2 for 24 hours to assess the final weight. The sample W_f was computed as follows:

$$\text{Water solubility } \% = \frac{W_o - W_f}{W_o} \times 100 \qquad (1)$$

3. RESULT

Water solubility testing is an actual experimental result that needs to be investigated to study the composite's biodegradable behavior. Based on the result as shown in Figure 2, the specimen of 10 wt.% fiber content has undergone the highest weight loss, which is as much as 66 %. The specimen with the lowest weight loss is recorded by a specimen of 80 wt.% fiber with a value of 15 %. The graph's pattern indicates that with the increasing fiber content, the weight loss of the specimen decreases.

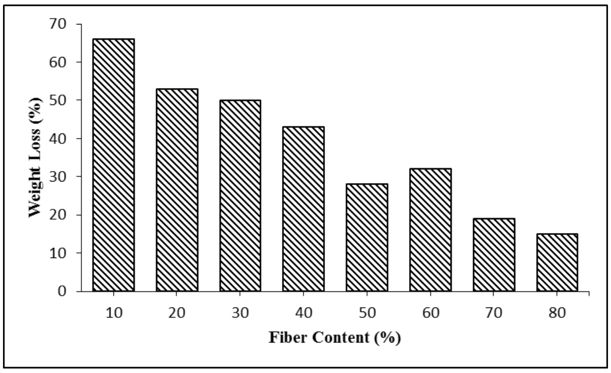

Figure 2 Result of water solubility

Jumaidin et al. [6] showed similar trends in their studies where lower water solubility of the hybrid composites than seaweed composites can be ascribed to more excellent water-resistance of sugar palm fiber. It aids in hindering the water absorption that can lead to the disintegration and dissolution of the materials. Besides, fiber inclusion also leads to the prevention of material breakdown by developing a fiber network in composites. This effect is due to the fiber's role in avoiding the disintegration of composite films by providing a network that tightly binds the composites and decreases the films' solubility [7].

4. CONCLUSION

The biocomposite from TPCS and OPEFB fiber mixture was successfully prepared by a hot press machine. The water solubility test showed that the composite with lower fiber content was more soluble and experienced more weight loss than higher fiber content. Overall, the reinforcement of OPEFB fiber into TPCS had a significant influence on the environmental properties (water solubility). Further tests such as soil burial, density, water absorption, water content, and moisture content can be performed to investigate other biodegradable properties of TPCS/OPEFB fiber composites to expand the potential use of these biodegradable materials.

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