UNIVERSITI TEKNOLOGI MARA

EFFECT OF OIL PALM FIBRE AND PINEAPPLE LEAVES FIBRE ON BIODEGRADABILITY, TENSILE AND WATER ABSORPTION PROPERTIES OF POLYLACTIC ACID BASED FIBRE COMPOSITE

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ABSTRACT

Fabrication and analysis of polymer composites from Polylactic Acid (PLA) on two types of fibre, oil palm fibre (OPF) and pineapple leaf fibre (PALF), with three different percentages of fibre loading were investigated in this work. In this study, the effect of biodegradable PLA with the incorporation of these fibres on tensile, biodegradability, water absorption, thermal, and morphological analysis was performed. Initially, different OPF and PALF fibre compositions of 10%, 50%, and 60% with PLA were compounded using a Haake twin screw compounder. In addition, a hybrid composition containing 40% starch, 10% PLA, OPF, and PALF fibre 50% was tested. The tensile properties test shows that increasing the fibre loading will reduce the tensile strength of the composites. The highest tensile strength value (17MPa) was found for OPF with a composition of 10% compared to other composites. Soil burial testing for three months and water absorption testing for one month at RT and 50℃ were used to assess the biodegradability of the OPF and PALF composites. The degradability of composites was observed to increase with high fibre loading due to the enzymatic attack of microorganisms on the composites. The composite PLA50/OPF50/Lubricant (PLAOPF50L) shows a high degradation rate at moderate tensile strength (7MPa) and lost tensile properties within two months. For PALF composites, the degradation rate is fastest for 60% fibre loading within one month, with a strength of 5.5 MPa. For highest filled fibre loading, these composites also possessed a high water absorption rate. Based on this result, PLA50/OPF50/L has better result as compared to PLA50/PALF50/L. This is due to OPF composite has sufficient tensile properties for straw making and consider as faster degradation rate. From the FTIR spectrum displayed after three months of soil burial, the intensity of the peak significantly decreased and broadened at peak $3426 cm^{-1}$ due to the OH group as a result of degradation. Morphological analysis of OPF and PALF composites was carried out using SEM, showing that after three months of soil burial, many voids and cracks took place as higher fibre loading was used. The OPF composites are recognised to be the recommended composites since they provide better tensile properties and similar fast degradation as PALF composites. The optimum fibre content was found to be 50% (PLAOPF50L), which dropped in mechanical properties, showing high degradability. The high fibre loading fibres conferred easy biodegradability for composite applications. Higher immersion temperature (50℃) seems to accelerate the moisture uptake behaviour at maximum 18% compared to RT (10%). After 1 month of immersion at 50℃ increased less than double than RT. This may be attributed to different diffusivity of water into the composites, leading to interfacial cracks induced by moisture at an accelerated rate due to the degradation in the fibre-matrix interface region and the presence of water molecules in the OPF and PALF composites. Hence, composite PLAOPF50L is a useful formulation for biodegradable straw applications.

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CHAPTER ONE
INTRODUCTION

1.1 Research Background

Over the past few years, plastic waste has had a detrimental effect on the ecosystem, habitats, human health, and sustainable development. Despite these issues being considered as a huge problem, the general public and other significant stakeholders have not been sufficiently engaged and educated on how they can contribute to the solution. This issue is alarming since the production of plastic has increased exponentially and is expected to double by 2050. These situations become critical once most of the plastic waste escapes into the landfills, oceans, or rivers, and plastics that contain additives that are used to make the plastic durable, stronger, and flexible end up extending the life of products if they become litter, with estimates ranging from at least 400 years to break down. Plastic waste is non-biodegradable and does not completely disintegrate (Dwivedi et al., 2019). This non-degradable plastic has led to white pollution that is able to kill wildlife and our marine ecosystem. In fact, this led to Malaysia's being ranked as the eighth-worst country worldwide for the improper management of plastic waste.

The most prevalent type of plastic waste is plastic drinking straws. Hence, in order to move towards a green country, General Datuk Seri Adnan Md Ikhsan, the Federal Territories Ministry Secretary of Malaysia, made a potential solution to the problems associated with discarded waste by banning the use of plastic drinking straws. This became effective on 1st January 2020 and will be included in the conditions for business licences starting from 1st January 2019. Hence, researchers are interested in developing a biodegradable or green material that could be used as a replacement for conventional plastic (Motru et al., 2020). This research therefore focused on developing and characterization of a new class of biodegradable material for biodegradable straw products as a replacement for existing non-degradable plastic straw.

Biodegradable plastic is a material that is decomposed naturally by the action of living organisms, usually microorganisms, when introduced into the environment. Compared with conventional plastics, biodegradable plastic is eco-friendly. In addition,