UNIVERSITI TEKNOLOGI MARA

DEVELOPMENT AND CHARACTERISATION OF BIODEGRADABLE POLYMER DERIVED FROM *TACCA LEONTOPETALOIDES* STARCH AND BIOCHAR RICE HUSK

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ABSTRACT

Biodegradable polymer such as starch has the potential to be a substitute for non-biodegradable petroleum-based polymer. Besides, starch is relatively cheap and available from a broad range of plants. In addition, the crop residue can be utilised as the feedstock, raw material or filler in the production of biodegradable polymer. In Malaysia, the major crop residue such as the generation of rice husk due to the harvesting and processing of paddy rice could be utilised as the bio-filler in biodegradable polymer. The availability of rice husk could be sustained because Malaysia is one of the prominent producers of paddy rice. Therefore, the current research has opted *Tacca leontopetaloides* as the base of material while biochar from rice husk was chosen as the reinforcing material to develop the biodegradable polymer which was denoted as thermoplastic starch (TPS). The objectives of this research are to develop the optimum formulation of TPS by varying the glycerol content addition with acetic acid and biochar rice husk and study its performance in chemical, morphological, mechanical and water absorption. The preparation of TPS was done through double-step processing which are solution casting and roll-milling. In chemical properties, the increment of glycerol content slightly altered the chemical structural of TPS. The morphological study showed that TPS and TPS/BCRH had smoother surface and were homogenous with increasing glycerol content. However, the increase of glycerol tended to increase the affinity of water due to the hydroscopic properties. With the addition of BCRH, TPS showed lower water uptake because the biochar had an aliphatic group that induced TPS/BCRH to be more hydrophobic. Moreover, the incorporation of BCRH also significantly improved the properties of TPS in tensile strength (TS) and elongation at break (EAB). This research also studied the biodegradability of TPS and TPS/BCRH. The study found that TPS/BCRH promoted faster degradation at 54.05% (Titration-Method A) and 50.12% (Carbon Dioxide Detector - Method B) for over 45 days of composting compared to TPS. In order to study the capabilities of TPS, the chemical, morphological and tensile properties were tested after the degradation. The study found that biodegradation had altered the chemical structural of TPS/BCRH which was confirmed through the morphology study as the erosion of structural material was found on the surface of TPS/BCRH. Meanwhile, the significant deterioration of TS and loss of flexibility of EAB proved that TPS and TPS/BCRH were undergoing a biodegradation reaction. The biodegradation reaction onto the TPS materials was caused by the microorganisms' activity. This study found that the fungi, Aspergillus species, from composting soil were responsible in degrading the TPS materials during aerobic degradation under controlled composting conditions.

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CHAPTER ONE
INTRODUCTION

1.1 Research Background

Malaysia is a modern and fast-developing country in terms of economic performance and development. Steady economic growth and rapid industrialisation with Malaysia's rising population caused an adverse effect on the environment such as the increment in solid waste generation. Population growth and solid waste generation are said to have a direct relationship. According to Alias et al. [1], a daily waste generation 30,000 tonnes was found from landfill site and this had produced about 10.9 million tonnes of solid waste generated in year 2012. In addition, in year 2015, the solid waste generation has increased to 38,000 tonnes with 12.8 million tonnes of solid waste generated per year and predicted to increase to 15.6 million tonnes of solid waste in year 2020. In another report by Zainu and Sungip [2], only 25% of solid waste was collected and transported to the disposal site while the remaining 75% of solid waste was left to be eaten by animals, burned or illegally dumped which caused a potential threat to environmental dilapidation. In fact, there is about 24% composition of plastic waste per 100 kg per day found from the collected solid waste [2]. A conventional plastic is derived from petroleum-based products and resists physical and chemical degradation. In addition, the degradation of plastic is only broken into microscopic particles and requires decades to deteriorate after no longer used. In the worst case, the home-burning of plastic waste could give detrimental effects on the environment, health and ecosystem. Previous research revealed that backyard-burning of plastic waste is far more harmful to our health as it may increase the risk of cancer, heart disease and aggravate respiratory ailments [3]. Therefore, the introduction of biodegradable polymer is an appropriate approach to solve the problem in handling the plastic waste disposal route.

The overwhelming demand of plastic materials made from bio-based sources has been spurred in the last few years. Much work have been devoted on the production of bio-based plastic as partial or intermediate materials and some productions have blended it with conventional polymer. This is because bio-based materials are said to