UNIVERSITI TEKNIKAL MALAYSIA MELAKA

INVESTIGATION ON THE CHARACTERISTIC OF THERMOPLASTIC CORNSTARCH COMPOSITE REINFORCED SHORT PINEAPPLE LEAF FIBER (PALF) BY USING MIXER METHOD OF PREPARATION

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (Maintenance) with Honours.

By

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APPROVAL

This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Maintenance) with Honours. The member of the supervisory is as follow:

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ABSTRAK

Serat daun nanas (PALF) yang kaya dengan selulosa, murah, dan banyak didapati mempunyai potensi untuk mengukuhkan polimer. Tujuan kajian ini adalah untuk mengkaji sifat mekanikal, fizikal dan alam sekitar pada komposit jagung termoplastik (TPCS) yang diperkuat oleh PALF yang menggunakan kaedah pengadunan. Kajian ini menyiasat ujian seperti tegangan, lenturan, impak ketumpatan, kandungan lembapan, penyerapan air, kelarutan air dan reaksi di dalam tanah terhadap komposit tepung jagung termoplastik (TPCS) diperkukuh dengan PALF pada perbezaan kandungan serat . Kajian ini menggunakan PALF yang pendek dan kandungan serat sebanyak 30%, 40%, 50%, 60% dan 70%. TPCS diperbuat menggunakan pengadunan tangan dan pengaduan berkelajuan tinggi dengan mencampurkan TPCS sebanyak 70% dari tepung jagung asli dicampurkan dengan 30% gliserol. PALF dan TPCS dicampur dan berat sampel adalah 40g. Kekuatan tegangan dan modulus Young composites didapati meningkat apabila peningkatan kandungan serat. Keputusan tegangan adalah paling optimum pada serat 60%. Kekukuhan dan kekuatan lenturan komposit adalah paling tinggi pada kandugan serat 50%. Kekuatan komposit pula tertinggi pada kandungan serat 30% . Pada ujian fizikal iaitu ujian ketumpatan tertinggi, kandungan lembapan dan penyerapan air paling tinggi pada kandungan serat 20%. Sama seperti ujian fizikal, hasil ujian alam sekitar juga direkodkan tertinggi pada 20%. Komposit TPCS PALF mempunyai ciri-ciri mekanik yang lebih baik berbanding komposit serat semulajadi yang berasaskan selulosa yang lain dan berpotensi tinggi untuk diperkembangkan pada masa akan datang.

ABSTRACT

Pineapple leaf fiber (PALF) is rich in cellulose, is cheap, and is widely found to have the potential to stabilize polymers. The purpose of this study was to study the mechanical, physical and environmental properties of thermoplastic cornstarch (TPCS) reinforced by PALF using mixing method. This study investigates tests such as tensile, flexural, impact, moisture content, water absorption, water solubility and soil burial reaction against thermoplastic cornstarch (TPCS) composite reinforced with PALF on fiber content differences. This study used short PALF and fiber content of 30%, 40%, 50%, 60% and 70%. TPCS is made using high-speed mixer and hand mixing by mixing TPCS of 70% of the original corn flour with 30% glycerol. PALF and TPCS were mixed and the sample weight was 40g. The tensile strength and modulus of Young composites were found to increase with increasing fiber content. The results are optimum at 60% fiber. The flexural and strength of composite bending is highest at 50% fiber weight. Composite strength for impact test was highest at 30% fiber content. On physical tests which are density measurement, moisture content and water absorption highest at 20% fiber content. Similar to physical tests, environmental test results were also recorded highest at 20%. TPCS PALF composites have better mechanical properties than other cellulose-based natural fiber composites and are potentially high in the future.

DEDICATION

This thesis is dedicated to my dad, M. Azman Bin Mohamed, who taught me that what is learned for his own sake is the best kind of intelligence to have. It is also dedicated to my mom, Asmah Binti Awang, who taught me that if it is taken one step at a time, even the most important mission can be accomplished. All inspired a deep love of learning and a deep appreciation for education in me. Their sponsorship, love, sacrifices, and motivation have led to my success. I express my deepest gratitude to the participants of my study for their constant support, through feedback and great care in encouraging me to stretch and achieve on an ongoing basis. Finally, I am grateful to Allah S.W.T for giving me the mind, spirit and personal drive to achieve my goals.

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LIST OF SYMBOLS

E	Elongation at break
UTS	Ultimate tensile stress
v	Volume
m	Mass
W_i	Weight initial
W_f	Weight final
Wloss	Weight loss
Ws	Water solubility
M_i	Moisture initial
M_f	Moisture final
MPa	Megapascal unit

LIST OF ABBREVIATIONS

PALF	Pineapple Leaf Fibre
TPCS	Thermoplastic Cornstarch
TPS	Thermoplastic Starch
PMCs	Polymer Matrix Composites
MMCs	Metal Matrix Composites
CMCs	Ceramic Matrix
SEM	Scanning Electron Microscope
UTM	Universal Testing Machine
ASTM	American Society for Testing and Materials
PLA	Polylactic acid
LDPE	Low density polyethylene
TAPPI	Technical Association of the Pulp and Paper Industry
MRFs	Material Recovery Facilities

CHAPTER 1

INTRODUCTION

1.1 Background

Green composites are an idea to mix somewhere around two common fiber / reinforced materials and matrix / binding resource materials. This mix will provide brilliant properties, especially in mechanical properties where the refining of each material, especially in mechanical properties, is as necessary properties. Instances of fiber / reinforced materials are natural fiber extraction from different sources such as banana leaf, pineapple leaf, kenaf, bamboo, and coconut. Instances of network materials are starch, epoxy and polypropylene (Wahyuningsih, Iriani, and Fahma 2016).

The use of natural fibers as a substitute for man-made fiber in fiber-reinforced composites has now expanded and opened up other potential outcomes of modernity. The use of natural fibers as reinforcement has dramatically increased the processing of plastic composites in later years. Fiber reinforced composites consist of reinforcing fiber and matrix polymer. Traditional composites reinforced by fiber used as reinforcing components various types of glass, carbon, aluminum oxide, and many others. Natural fibers, especially bark fibers, such as flax, hemp, jute, henequen and many others, as a consequence, several others have been useful as a strand underpinning composites in these years as a result of particular investigators (Ali Munawar 2007).

Fiber reinforced composite substances include high-strength fibers and modules embedded or bonded to a matrix with marvelous interface boundaries between them. Each fibers and matrix retains their physical and chemical identities in this shape, but they produce a combination of properties that can not be finished with both components performing alone. Fibers are the imperative load-bearing participants in widespread, although the comprehensive matrix endures them within the preferred region and orientation, acts as a load-bearing medium between them and protects them as an example from mutilation to the environment due to accelerating temperatures and humidity. Thus, while the fibers reinforce the matrix, the latter also serves some of the valuable functions in a material of composite fiber (John and Anandjiwala 2008).

Using fiber-enhanced composites is available in many engineering fields. Putting them to practice cautious design practices and appropriate manner development entirely based on their precise mechanical, body and thermal information. In many engineering fields, the use of fiber-reinforced composites is available. Putting them into actual use calls for cautious design practice and appropriate manner development based entirely on their precise mechanical, body and thermal characteristics information (Xie et al. 2010).

1.2 Objectives

The specific objectives of this study such as:

1. To fabricate the pineapple leaf fiber (PALF) reinforced by the thermoplastic cornstarch (TPCS) composites.
2. To find the characteristic of pineapple leaf fiber (PALF) reinforced by the thermoplastic cornstarch (TPCS) composites.

1.3 Problem Statements

Selamat, Razi, et al. (2016) mentioned that PALF from Malaysian cultivars has an enormous ability to be used in natural composite goods or textile materials as a reinforcing fabric. This is because Malaysia is one of the main international pineapple manufacturers, however simplest the fruit is used at the same time as the leaf, the primary material of which is fiber, is burned or thrown away, causing pollutants and wasting natural fiber's first-rate capacity resources (Selamat, Razi, et al. 2016).

In any case, Zhang, Rong, and Lu (2005) said it is significant that ordinary plant and natural fiber composites have been combined with the accompanying disadvantages that the vast majority of industrially accessible polymers are produced using oil and are therefore non-biodegradable, dependent on composites that are still a natural weight. In addition, the inborn hydrophilicity of plant filaments resulted in poor interface communication with hydrophobic polymer lattices and subsequently decreased composite mechanical properties (Zhang, Rong, and Lu, 2005).

As solutions, Faruk et al. (2012) article said due to the growing ecological awareness, the use of characteristic fiber composites is gradually winding up. In addition, the materials ' generally minimal effort and low thickness, adequate explicit properties, partition simplicity, upgraded vitality recovery, lack of CO_2 bias, biodegradability, and recyclable properties have focused on the common use of composite fiber. Materials that are solid, reliable, lightweight and with fantastic mechanical properties that are fundamentally superior to those of conventional materials stimulate the growing interest of common fiber in various undertakings, such as cars, construction and development, it is important that the ordinary plant and natural fiber composites have been combined with the accompanying disadvantages In addition, the inborn hydrophilicity of plant filaments resulted in poor interfacial communication with hydrophobic polymer lattices and subsequently decreased composite mechanical properties (Faruk et al. 2012).

Bogoeva-Gaceva et al. (2007) also stated these eco-composites led to the development of new pathways combining modest biodegradable polymers with enhanced mechanical and warm properties. The brilliant change in NFs because the primary market fascination of eco-composites is the aggressive expense of NFs (Bogoeva-Gaceva et al. 2007). The use of PALF in the natural composite industry can therefore reduce environmental pollutants, waste disposal problems and environmental concerns, especially in Malaysia (Selamat, Kasim, et al. 2016).

1.4 Scope

This research will fabricate the PALF reinforced by the thermoplastic cornstarch (TPCS) composites. The PALF length will be fixed to short PALF. The different PALF / TPCS composite ratios will be selected and the PALF / TPCS composite composition ratio has been set at 30:70, 40:60, 50:50, 60:40 and 70:30. An investigation into the properties of PALF / TPCS composites on the characteristics of short PALF. The mechanical properties of PALF/TPCS composite will be determined using the mechanical testing which are tensile test, impact test and flexural test. Other than that, physical testing also will be conducted with density measurement, water absorption, moisture absorption and moisture content. For the environmental testing, a test on the soil burial and also water solubility. The other testing will be morphological testing using SEM.