UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ENVIRONMENTAL PROPERTIES OF BIODEGRADABLE PACKAGING TRAY FROM COCONUT LEAF

SHAMSU HAZMIRULL BIN SHAMSUDIN
B091810011

BACHELOR OF MANUFACTURING ENGINEERING TECHNOLOGY (PROCESS & TECHNOLOGY) WITH HONOURS

2022

Faculty of Mechanical and Manufacturing Engineering Technology

ENVIRONMENTAL PROPERTIES OF BIODEGRADABLE PACKAGING TRAY FROM COCONUT LEAF

Shamsu Hazmirull Bin Shamsudin

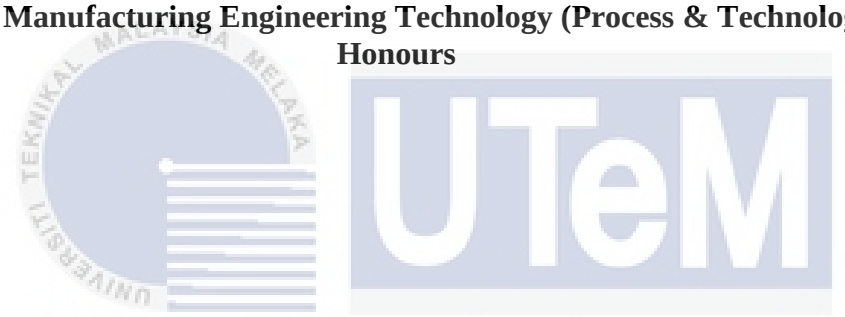
Bachelor of Manufacturing Engineering Technology (Process & Technology) with Honours

2022

ENVIRONMENTAL PROPERTIES OF BIODEGRADABLE PACKAGING TRAY FROM COCONUT LEAF

SHAMSU HAZMIRULL BIN SHAMSUDIN

A thesis submitted
in fulfillment of the requirements for the degree of
Bachelor of Manufacturing Engineering Technology (Process & Technology) with Honours



Faculty of Mechanical and Manufacturing Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2022

DECLARATION

I declare that this thesis entitled “Environmental Properties of Biodegradable Packaging Tray From Coconut Leaf ” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

Name : Shamsu Hazmirull Bin Shamsudin

Date : 18/01/2022

APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Manufacturing Engineering Technology (Process & Technology) with Honours.

Signature : 

Supervisor Name : Dr. Ridhwan Bin Jumaidin

Date : 18/01/2022

DEDICATION

To Al-Quran, the greatest source of knowledge

آتُونِي زُبَرَ الْحَدِيدِ حَتَّى إِذَا سَاوَى بَيْنَ الصَّدَفَيْنِ قَالَ انفُخُوا حَتَّى إِذَا جَعَلَهُ نَارًا قَالَ آتُونِي أُفْرِغْ عَلَيْهِ قِطْرًا

Bring me sheets of iron" - until, when he had leveled [them] between the two mountains walls, he said, "Blow [with bellows]," until when he had made it [like] fire, he said, "Bring me, that I may pour over it molten copper." (Al-Kahf:Verse 96)

&

To my beloved father and mother

&

To my beloved siblings

ABSTRACT

In recent, the demand for biodegradable materials has become a significant challenge due to the accumulation of non-biodegradable plastic waste. Among several biodegradable materials, thermoplastic cassava starch has been identified as the renewable, biodegradable, also has low-cost resources. However, thermoplastic cassava starch has some drawback such as poor dimensional stability due to highly hydrophilic character. Meanwhile, extensive fall of coconut trees has resulted in waste since only certain parts of the coconut tree were utilised, while other part such as the leaf were often discarded as waste. Hence, the aim of this study is to utilised the coconut leaf in the development of a biodegradable packaging from thermoplastic cassava starch reinforced with coconut leaf fibre. In this study, coconut leaf fibre will be used to enhance the shortcomings of cassava starch biopolymer in various fiber content i.e 0 wt%, 10wt%, 20wt%, 30wt% and 40wt% . The effect of coconut leaf fibre on the environmental, water affinity, and morphological properties will be investigated. All of the materials were blended together uniformly before being manufactured by utilizing hot compression moulding.Following that, the properties of TPCS/coconut leaf fibre biopolymer composites were investigated in order to assess their potential as biodegradable reinforcements. The finding shows that the highest percentage of fibre at 40wt% shows the the lowest moisture content which idicates indicates improvement in the stability of the materials. The incorporation of coconut leaf fiber was found to decrease the water absorption and thickness swelling of the composite. In terms of water solubility, it was discovered that the weight reduction decreases as the fibre content increases. Meanwhile, biodegradation was determined by the soil burial and results show decreased weight loss after increased loading of coconut leaf fiber in the polymeric matrix. According to the FTIR analysis, the result demonstrates the presence of bonding between the fiber and TPCS, while the SEM demonstrates the changing microstructure of the composite as the fibre concentration increases which is the appearance of more coconut leaf fibre and void on the surface. In term of development of packaging product, composite with fiber content of 20% was used. The product developed has length of 13 cm, thickness 0.3 cm and width of 8cm. Generally, the product was successfully developed and functioning as a tray. In conclusion, TPCS/coconut leaf fibre biopolymer composites have shown improved properties in terms of lower water affinity behavior and better dimensional stability compare to the TPCS matrix. This material has a wide range of potential particularly in packaging applications.Therefore, this material can become an alternative for non-biodegradable bioplastic in the future and the natural waste can be fully utilized.

ABSTRAK

Sejak kebelakangan ini, permintaan untuk bahan biodegradasi telah menjadi cabaran besar kerana pengumpulan sampah plastik yang tidak terbiodegradasi. Di antara beberapa bahan terbiodegradasi, termoplastik kanji telah dikenalpasti sebagai bahan terbaru, terbiodegradasi, dan mempunyai sumber kos rendah. Walaubagaimanapun, pati ubi kayu termoplastik mempunyai beberapa kekurangan seperti kestabilan dimensi yang buruk kerana sifat hidrofilik yang sangat tinggi. Sementara itu, sisa pohon kelapa yang gugur mengakibatkan sampah tatkala hanya beberapa bahagian pokok kelapa yang digunakan, sementara beberapa bahagian lain seperti daun sering dibuang sebagai sampah. Oleh itu, tujuan kajian ini adalah untuk memanfaatkan daun kelapa dalam pengembangan kemasan yang dapat terurai dari pati ubi kayu termoplastik yang diperkuat dengan serat daun kelapa. Dalam kajian ini, serat daun kelapa akan digunakan untuk memperbaiki kekurangan biopolimer pati ubi kayu dalam pelbagai kandungan serat iaitu 0% berat, 10% berat%, 20% berat, 30% berat dan 40% berat. Kesan serat daun kelapa terhadap persekitaran adalah seperti pertalian air, dan sifat morfologi akan diteliti. Semua bahan telah diadun bersama secara seragam sebelum dihasilkan menggunakan acuan mampatan panas. Berikutan itu, sifat-sifat komposit biopolimer gentian daun kelapa TPCS telah disiasat untuk menilai potensinya sebagai tetulang biodegradasi. Dapatan kajian menunjukkan peratusan tertinggi pada 40% berat menunjukkan kandungan lembapan yang paling rendah, yang menunjukkan peningkatan dalam kestabilan bahan. Penggabungan dengan serat daun kelapa didapati pengurangan penyerapan air dan bengkak ketebalan komposit. Dari segi ketelarutan air, apabila ujian keterlarutan air dilakukan, didapati bahawa pengurangan berat berkurangan apabila kandungan serat meningkat. Sementara itu, biodegradasi telah ditentukan melalui pengebumian tanah dan hasilnya menunjukkan penurunan berat sampel selepas memuatkan serat daun kelap dalam matriks polimer. Menurut analisis FTIR, menunjukkan kehadiran ikatan antara serat dan sampel, manakala SEM menunjukkan perubahan struktur mikro komposit apabila kepekatan gentian meningkat iaitu structur penampilan serat daun kelapa yang lebih banyak dan lompang di permukaan sampel. Dari segi pembangunan produk pembungkusan komposit dengan, sebanyak 20% berat gentian digunakan. Produk yang dibangunkan mempunyai dalam ukuran panjang produk mempunyai 13cm, ketebalannya 0.3cm dan lebar 8cm. Secara amnya, produk in telah berjaya dibangunkan dan berfungsi sebagai dulang. Kesimpulannya, komposit biopolimer gentian serat daun kelapa TPCS/daun kelapa telah menunjukkan sifat yang lebih baik dari segi tingkah laku pertalian air yang lebih rendah dan kestabilan dimensi yang lebih baik berbanding dengan matrik TPCS. Bahan ini mempunyai potensi yang luas, terutamanya dalam aplikasi pembungkusan. Oleh itu, bahan ini boleh menjadi alternatif untuk bioplastik tidak terbiodegradasi pada masa hadapan dan sisa semula jadi boleh digunakan sepenuhnya.

ACKNOWLEDGEMENTS

In the Name of Allah, the Most Gracious, the Most Merciful

In the name of Allah, the Most Merciful and Gracious. Alhamdulillah, I am grateful to Almighty Allah (Subhanahu Wa Taa'la) for providing me with the power and spirit I needed to complete this research. Thank you for your blessing, advice, and kindness.

I would want to express my heartfelt gratitude to everyone who assisted me during the course of my research by extending a million thanks to them. I would like to convey my sincere gratitude to my respected supervisor Dr. Ridhwan Bin Jumaidin for his direction, criticism, and willingness to lend a helping hand and provide advice during this project. From the beginning of the semester till now, I have been really grateful for his hospitality, intelligence, and knowledge.

Finally, I would want to express my gratitude to my parents, Shamsudin bin Mohamad and Hanisah binti Nor, for their unwavering support. I am aware that this research would not have been possible without their assistance and encouragement. In advance, I'd want to express my gratitude to all the other anonymous individuals who assisted me in various ways in order to complete my study.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

In recent years, the environmental awareness and concern are spreading rapidly throughout the world. One of the factors that contributed to these changes was the enforcement of environmental law regulations (Prachayawarakorn et al.,2013). The use of non-biodegradable plastic contributes to environmental challenges such as water pollution, air pollution, and landfill problems. All of these difficulties have prompted fresh research into the production of biodegradable materials such as thermoplastic starch (TPS), which is derived from natural resources and is easily degradable.

Marichelvam et al., (2019), stated the plastic is widely employed in various industries, particularly the packaging industry; annual production of petroleum-based plastic reached more than 300 million tonnes until 2015, with just around one percent being bioplastic. Recently, around 50% of bioplastic preparations are made from starch because bioplastic-based starch is easy to manufacture and is frequently used in packaging applications. Due to the qualities of starch, as well suited for use in bioplastic manufacturing when combined with glycerol as a plasticizer (Marichelvam et al., 2019). The development of bioplastic has a favourable influence on the environment by lowering the use of fossil fuels and plastic waste, as well as the emission of carbon dioxide.

The usage of conventional thermoplastics has resulted in environmental issues, which has accelerated the development of biodegradable thermoplastic materials. Biodegradable materials are both safe for consumers and environmentally friendly. As a result, the

commendable attempt to limit the use of non-biodegradable plastic and promote the use of biodegradable plastic.

Neat starch has several disadvantages, including a high solubility in water, brittleness, a low melting temperature, and inferior mechanical qualities when compared to synthetic polymer-based materials. Numerous physical and chemical modifications, including as plasticisation, mixing, derivation, and graft copolymerisation, were researched to improve the characteristics of starch. TPS is produced by infusing starch granules with mechanical and thermal energy and a plasticizer. Plasticisers are critical in the production of thermoplastic starch because they enhance starch behaviour by decreasing internal hydrogen bonding between polymer chains while increasing free volume. This results in increased flexibility and processability, as well as increased mobility of molecular chains. Plasticisers' effectiveness is dependent on the similarity of the polymer employed. Plasticisers are available in a variety of different forms, including glycerol, sorbitol, urea, fructose, sucrose, and glycol. However, the most often used plasticisers are those classified as polyols, including glycerol and sorbitol. Numerous studies have been undertaken recently to investigate the potential of specific ionic liquids (ILs) as new starch plasticisers (Jian et al., 2013) . Additionally, in a recent study, fried sunflower oil was used as a plasticiser in thermoplastic starch composites. The characteristics of starch-based materials are improved, demonstrating that they are the most environmentally friendly option for bio-composites (Diyana et al., 2021).