DEVELOPMENT OF BIODEGRADABLE MAT FROM CASSAVA STARCH AND COCONUT FIBER

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A thesis submitted
in fulfillment of the requirements for the degree of
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DECLARATION

I declare that this Choose an item. entitled "Development Of Biodegradable Mat From Cassava Starch And Coconut Fiber" is the result of my own research except as cited in the references. The Choose an item. has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

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Date : 25 Jan 2023

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 with Honours.

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DEDICATION

To Al-Quran, the greatest source of knowledge Bring me sheets of iron" - until, when he had leveled [them] between the two mountain walls, he said, "Blow [with bellows]," until when he had made it [like] fire, he said, "Bring me, that I may pour over its molten copper."

(Al-Kahf: Verse 96)

Alhamdulillah

Praise to Allah for the strength, guidance and knowledge that was given by Allah for me to complete this study

&

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&

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ABSTRACT

The vast majority of plastic items created in the twentieth century are derived from petroleum fuels. Polyester, nylon, and acrylic are only a few of the materials available. Others include PVC, polypropylene, polystyrene, polyethylene, and polypropylene. The usage of petroleum-based plastics has been connected to a number of environmental challenges, including greenhouse gas emissions, persistence in marine and terrestrial environments, pollution, among others. However, bioplastics, a rapidly growing class of polymeric materials that have been promoted as environmentally friendly replacements to standard petroleum-based plastics, are gaining traction. When there is a greater emphasis placed on the creation of new materials with a strong emphasis on environmental sustainability, a new trend in materials development emerges, such as composites, which have become well established for a wide variety of applications. With growing awareness of the importance of renewable bioresources, there is a greater emphasis on the use of readily available materials in the local community and region. The purpose of this research is to develop a biodegradable mat made of cassava starch and coconut fibre that can be composted. The natural fibre is thermoplastically manufactured in order to contribute to the solution of the problems associated with petroleum-derived plastic waste. The resilience of a biodegradable mat composed of cassava starch and coconut fibre will be determined using a straightforward experimental technique. The goal of this research is to create biodegradable thermoplastic cassava starch reinforced with coconut fiber and investigate its morphology, physical properties, and environmental properties. To address the shortcomings of the cassava starch biopolymer, biocomposites were created by incorporating 10,20,30,40, and 50wt percent coconut fiber into a thermoplastic cassava starch matrix. All components were uniformly mixed before being formed using hot compression molding. After that, the functional properties of TPCS/CF biopolymer composites were assessed to determine their suitability as biodegradable materials. The findings of this study have theoretical and practical ramifications, which will be examined at length at the conclusion of this article. It is anticipated that this development would also highlight its limitations. Suggestions and recommendations for further study will also be given to help future scholars have a better grasp of the subject matter.

ABSTRAK

Sebilangan besar barangan plastik yang dicipta pada abad kedua puluh berasal daripada bahan api petroleum. Poliester, nilon dan akrilik hanyalah beberapa bahan yang tersedia. Lain-lain termasuk PVC, polipropilena, polistirena, polietilena dan polipropilena. Penggunaan plastik berasaskan petroleum telah dikaitkan dengan beberapa cabaran alam sekitar, termasuk pelepasan gas rumah hijau, kegigihan dalam persekitaran marin dan daratan, pencemaran, antara lain. Walau bagaimanapun, bioplastik, kelas bahan polimer yang berkembang pesat yang telah dipromosikan sebagai pengganti mesra alam kepada plastik berasaskan petroleum standard, semakin mendapat tarikan. Apabila terdapat penekanan yang lebih besar terhadap penciptaan bahan baharu dengan penekanan yang kuat terhadap kelestarian alam sekitar, trend baharu dalam pembangunan bahan muncul, seperti komposit, yang telah menjadi terkenal untuk pelbagai jenis aplikasi. Dengan kesedaran yang semakin meningkat tentang kepentingan sumber bio boleh diperbaharui, terdapat penekanan yang lebih besar terhadap penggunaan bahan yang mudah didapati dalam komuniti dan wilayah tempatan. Tujuan penyelidikan ini adalah untuk membangunkan tikar biodegradasi yang diperbuat daripada pati ubi kayu dan sabut kelapa yang boleh dikompos. Gentian semula jadi dihasilkan secara termoplastik untuk menyumbang kepada penyelesaian masalah yang berkaitan dengan sisa plastik terbitan petroleum. Ketahanan tikar terbiodegradasi yang terdiri daripada kanji ubi kayu dan sabut kelapa akan ditentukan menggunakan teknik eksperimen yang mudah. Matlamat penyelidikan ini adalah untuk mencipta kanji ubi kayu termoplastik terbiodegradasi diperkukuh dengan sabut kelapa dan menyiasat morfologi, sifat fizikal dan sifat persekitarannya. Untuk menangani kekurangan biopolimer kanji ubi kayu, biokomposit telah dicipta dengan menggabungkan 10,20,30,40, dan 50wt peratus sabut kelapa ke dalam matriks kanji ubi kayu termoplastik. Semua komponen dicampur secara seragam sebelum dibentuk menggunakan acuan mampatan panas. Selepas itu, sifat kefungsian komposit biopolimer TPCS/CF dinilai untuk menentukan kesesuaiannya sebagai bahan terbiodegradasi. Dapatan kajian ini mempunyai kesan teori dan praktikal, yang akan dikaji dengan panjang lebar pada akhir artikel ini. Pembangunan ini juga dijangka menyerlahkan batasannya. Cadangan dan cadangan untuk kajian lanjutan juga akan diberikan untuk membantu sarjana masa depan memahami perkara yang lebih mendalam.

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LIST OF SYMBOLS AND ABBREVIATIONS

μm	-	Micrometre
Ωm	-	Ohm metre
°C	-	Celcius
mm	-	Milimetre
%	-	Percentage
in	-	Inch
g	-	Gram
g/cm3	-	Gram per Cubic Centimetre
kg/m3	-	Kilogram per Cubic Metre
g/cc	-	Gram Cubic Centimetre
dyne/cm^2	-	Dyne per Square Centimeter
Gpa	-	Gigapascal
Mpa	-	Megapascals
Tg	-	Teragram
Wi	-	Initial weight
Wf	-	Final
RPM	-	Revolution per minute
DCS	-	Differential Scanning Calirometry
SEM	-	Scanning Electron Microscopy
TGA	-	Thermogravimetric Analysis
XRD	-	X-ray Diffraction
RVA	-	Rapid Viscoamylograph Analysis
FTIR	-	Fourier Transform Infrared Spectroscopy
TPS	-	Thermoplastic Starch
TPCS	-	Thermoplastic Cassava Starch
PMC	-	Polymer Matrix Composite
CMC	-	Ceramic Matrix Composite
CF	-	Coconut Fiber
PP	-	Polypropylene

PE	-	Polyethlene
PET-F	-	Polyethylene terephthalate
PP-F	-	Polypropylene fiber
PAN-F	-	Polyacrylonitrile
LDPE	-	Low Density Polyethylene
HDPE	-	High Density Polyethylene
UHDPE	-	Ultra High Density Polyethylene
IUPAC	-	International Union of Pure and Applied Chemistry
FAO	-	United Nation Food and Agriculture Organization
CO2	-	Carbon Dioxide
CH4	-	Methane
H2O	-	Water
Na-OH	-	Sodium Hydroxide

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CHAPTER 1

INTRODUCTION

1.1 Background

Worldwide demands for energy has risen as a result of advances in science and technology (Rangappa et al., 2020). Concerns have arisen as a result of this progress, such as material shortages and environmental conservation (Thyavihalli Girijappa et al., 2019). In addition, the rapid depletion of oil resources, greenhouse gases from the widespread use of petroleum-based products, and their non-biodegradability have prompted scientists to investigate novel biodegradable, renewable, and recycled products (Scaffaro et al., 2018). Biodegradable composites are a type of material that can be used to address these issues while also promoting environmental sustainability. End-of-life disposal is not a concern with bio composites because they decompose organically without harming the environment (Sanjay et al., 2018). In compared to typical petroleum-based synthetic composites, the use of bio composites offers distinct advantages such as recyclability, renewability, and biodegradability, as well as low density and lower cost (Gholampour & Ozbakkaloglu, 2020). In addition, they are flexible and provide excellent thermal and acoustic insulation. Furthermore, bio composites are non-toxic, which means they do not cause health issues and are therefore safer to use than synthetic composites. These concerns have prompted new research into the development of biodegradable materials. Plastics have become indispensable due to their diverse applications, yet they are damaging to the environment due to their inability to biodegrade. Plastics accumulate in the environment as landfills or are dumped into the sea as a result of their widespread use, improper disposal, and recycling,

arising in sequestering carbon and also the extinction of ocean life, respectively (Ahmed et al., 2018). The most waste comes from packaging and shopping bags made of plastic, which cannot be recycled well and often ends up in open dumps or landfills (Alam et al., 2018). Plastic production and distribution have steadily increased throughout time. Plastics derived from petroleum are frequently utilized in our daily lives as single-use plastics since they offer a tremendous lot of usefulness due to their adaptability, durability, flexibility, and toughness. Plastic bags are widely used for a variety of reasons, including expense, styling, and only one use (Wagner, 2017). Plastic's extensive use has resulted in an excess of plastic garbage in the environment. According to (Ferreira et al., 2020), research on biodegradable product, this could eventually result in significant global problems for the environment and people, because the disintegration percentage of these substances is extremely slow, approximately 100 years, due to their hydrophobic characteristics and their ability to effectively escape quick microbial 16 activity. Hence, bioplastics derived from renewable resources have the potential to replace synthetic plastics since they are biodegradable.

The transition away from petroleum-based plastic toward biodegradable plastic is critical to addressing this issue in order to protect a healthy ecosystem for future generations while also providing additional plastic disposal choices for those who use plastic. Starch is a biopolymer that is widely used around the world. It is a renewable resource that provides intriguing possibilities and alternatives to petroleum-based polymers. It is fully biodegradable and plentiful in nature this makes it a good choice for a wide range of applications. It may be found in a variety of plants, including maize, cassava, potato, and tuber, to mention a few. According to (Domene-López et al., 2018), starch is stored in plants in the form of cellulose amorphous and crystalline granule-packed forms, with the former being the most abundant. Because there is considerable concern that starch-based bioplastics,

such as thermoplastic starch (TPS), are contaminating the environment, the following information is provided: Fillers and fiber are becoming more prevalent in packaging materials, with some formulations using bio fillers or fiber to strengthen the bio-based plastic used in specific applications.

1.2 Problem Statement

Since the 1970s, non-biodegradable materials have grown in popularity, and this has had a negative impact on both people and the environment. These materials, which are made of petroleum-based plastic polymers, are harmful to the environment since they do not decompose in landfills and pollute groundwater as a result of their presence. Besides threatening food safety and quality, non-biodegradable plastic also poses a risk to tourism activities and sea wellness, and wellbeing of humans, as well as contributing in response to global. The most visible and distressing effects of plastics derived from petroleum on suffocation is a risk to the environment life, consumption and entanglement of countless marine species. Non-biodegradable materials require hundreds of years to degrade. Additionally, a downside of adopting synthetic polymers is that they contain harmful chemicals and generate poisonous fumes during the burning phase. Essentially, most polymers are made from petroleum, which requires more fossil fuels, resulting in emissions. (Marichelvam et al., 2019)

Bioplastics obtained from biomass, such as polymers, have the benefit of being degraded by microorganisms (fungi and bacteria) in bioactive ecosystems, such as landfill space, through enzymatic or non-enzymatic processes (chemical hydrolysis). Among their end products are carbon dioxide (CO2), methane (CH4), water (H2O), biofuels, and other organic products important for maintaining the greenhouse balance (Zhong et al., 2020). Furthermore, this type of composite material is fully biodegradable, with low toxicity,

(Bhatia, 2016), cheap cost, abundant natural resources, and ease of processing (Q. Wang et al., 2019). Starch is a very popular biopolymer found in nature and used in the production of bio polymer composite (Herniou-Julien et al., 2019).

When bio composites are used, end-of-life waste is not even an issue, according to (Thyavihalli Girijappa et al., 2019), because they decompose organically without damaging the ecology. In compared to typical synthetic composites derived from petroleum, the use of biomaterials composites has distinct advantages such as reusability, environmental friendliness, and good biocompatibility, in addition to stability and low expense (Gholampour & Ozbakkaloglu, 2020). Furthermore, they are flexible and provide excellent acoustic and thermal insulation. Moreover, bio composite materials are non-toxic, which means they present no health risks and are thus safe and secure to use than synthetic composites (Hemath et al., 2020). Due to these benefits, they have numerous applications in sectors such as automobiles, aviation, building, defensive performance, biomaterials, packaged foods, and sports equipment, and other. (Hemath et al., 2020)

Coir is a popular natural fiber, according to (Goyat et al., 2021). It is derived from coconut coir through a number of chemical and mechanical processes. White coconut fiber is derived from unripe coconut husk and has a low strength. Brown fiber, on the other hand, has comparable high levels of mechanical qualities and is generated from fully grown coconut coir. Because coconut coir is a waste product, it is not destructive to both humans and animals. Coir isn't a new fiber its applications may be traced back to ancient times. Coir is used in the fabrication of rope, mattresses, yarns, and fabrics. These day, coir is often used as reassurance in various polymeric materials used in the automotive and aerospace industries. (Ibrahim et al., 2014)