INVESTIGATION OF PHYSICAL AND ENVIRONMENTAL BEHAVIOUR ON CORN STARCH

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DECLARATION

I declare that this thesis entitled "Investigation of Physical and Environmental Behaviour on Corn Starch " is the result of my own research except as cited in the references. This thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :

Name : Nur'Ain Nazzeha Binti Anuar

Date : 28th January 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 and Technology) with Honours.

Signature	:	
Supervisor Name	:	Ts. Dr. Nazri Huzaimi bin Zakaria
Date	:	28th January 2022

DEDICATION

This project is dedicated to my parents, Mr. Anuar bin Haron and Mrs, Dayang Suphiani binti Abang Alli for never stop supporting me and accomodate all my needs. To my supervisor, Ts. Dr. Nazri Huzaimi bin Zakaria for guided me from the begining until the end of this project and thank you to all that involve in this project for their support and help.

ABSTRACT

The objectives of this study are to prepare and fabricate a matrix sample test from corn starch mix with plasticzer (glycerol). Then to characterize the matrix on biodegradability using soil burial testing and water solubility method. Lastly, to find the physical behaviour by using density, moisture content and water absorption testing. Composites are materials that are created by mixing two or more natural or artificial elements with various physical or chemical qualities to create a substance that is stronger as a group that as separate components. Composite materials are being invented and redesigned with the goal of improving and adapting traditional products while also introducing new products in a sustainable and appropriate way. A composite has a continuous component known as the matrix and a discrete or discontinuous component known as the fillers. Thermoplastics are polymeric materials that can be reformed (melted and hardened) repeatedly while retaining their properties. Some researchers have investigated the development and characterization of starch-based films made from cassava, sago, agar, sugar palm and many more. All these starches are potential biopolymer material for making biodegradable films. Corn is one of the most abundant sources of plant residue, offering a number of advantages such as high starch levels, outstanding uniformity, performance, ease of availability, and biodegradability. This source accounts for more than 60% of total plastic auxiliary yield. Glycerol is a valuable by-product produced in a variety of methods and by a variety of industries. Before beginning the testing, we must prepare the sample first. The sample is made of a mixture of corn starch and a plasticizer which is glycerol. For the mixture, hand mixed manually the corn starch and glycerol first before mixing using blender for two to three minutes. Then put the mixed material into the mold with the size of 140 x 60 mm, before press it in hot press machine under 25 kg/cm2 pressure. Before proceeding to hot press process, pre-heat the mold in the machine first for 15 minutes with temperature 165℃. After that, hot press the mold for 15 minutes with the same temperature then cooling process also for 15 minutes. Next, take out the sample from mold by using 10 tons press machine and the sample is ready to be cut by using cutting machine. The density of a material is an essential attribute to consider throughout the material selection process. A water absorption test is widely performed to determine how much water a material absorbs over a period of time. The equilibrium moisture content of thermoplastic was measured using moisture content. The term "water solubility" refers to a material's ability to resist water. Water solubility, in other hand, indicates how a substance degrades when immersed in water. The weight loss due to moisture and microorganism activity during the soil burial phase can be used to estimate a material's biodegradation characteristic. There are some recommendations provided to extend understanding of corn starch behaviour from this project. Suggest various type of plasticizers such as sorbitol, urea, fructose and other to investigate the behaviour and properties of corn starch. To increase the strength of thermoplastic. by adding multiple forms of plant fibers such as kenaf, banana leaf, pineapple leaf, bamboo, and others.

ABSTRAK

Objektif kajian ini adalah untuk menyediakan dan membuat ujian sampel matriks daripada campuran kanji jagung dengan plasticzer (gliserol). Kemudian untuk mencirikan matriks kebolehbiodegradasian menggunakan kaedah ujian pengebumian tanah dan kaedah keterlarutan air. Akhir sekali, untuk mencari tingkah laku fizikal dengan menggunakan ketumpatan, kandungan lembapan dan ujian penyerapan air. Komposit ialah bahan yang dicipta dengan mencampurkan dua atau lebih unsur semula jadi atau tiruan dengan pelbagai kualiti fizikal atau kimia untuk menghasilkan bahan yang lebih kuat sebagai satu kumpulan daripada komponen yang berasingan. Bahan komposit sedang dicipta dan direka bentuk semula dengan matlamat untuk menambah baik dan menyesuaikan produk tradisional sambil juga memperkenalkan produk baharu dengan cara yang mampan dan sesuai. Termoplastik ialah bahan polimer yang boleh diubahsuai (cair dan mengeras) berulang kali sambil mengekalkan sifatnya. Beberapa penyelidik telah menyiasat perkembangan dan penciriann filem berasaskan kanji yang diperbuat daripada ubi kayu, sagu, agar-agar, aren dan banyak lagi. Semua kanji ini adalah bahan biopolimer yang berpotensi untuk membuat filem terbiodegradasi. Jagung ialah salah satu sumber sisa tumbuhan yang paling banyak, menawarkan beberapa kelebihan seperti paras kanji yang tinggi, keseragaman yang luar biasa, prestasi, kemudahan ketersediaan dan kebolehbiodegradan. Sumber ini menyumbang lebih daripada 60% daripada jumlah hasil tambahan plastik. Gliserol ialah produk sampingan berharga yang dihasilkan dalam pelbagai kaedah dan oleh pelbagai industri. Sebelum memulakan ujian, kita mesti menyediakan sampel terlebih dahulu. Sampel dibuat daripada campuran kanji jagung dan pemplastis iaitu gliserol. Untuk adunan, bancuh secara manual kanji jagung dan gliserol dahulu sebelum digaul menggunakan pengisar selama dua hingga tiga minit. Kemudian masukkan bahan campuran ke dalam acuan bersaiz 140 x 60 mm, sebelum ditekan dalam mesin penekan panas di bawah tekanan 25 kg/cm2. Sebelum meneruskan proses penekan panas, panaskan dahulu acuan di dalam mesin selama 15 minit dengan suhu 165°C. Selepas itu, tekan panas acuan selama 15 minit dengan suhu yang sama kemudian proses penyejukan juga selama 15 minit. Seterusnya, keluarkan sampel daripada acuan dengan menggunakan mesin penekan 10 tan dan sampel sedia untuk dipotong menggunakan mesin pemotong. Ketumpatan bahan adalah sifat penting untuk dipertimbangkan sepanjang proses pemilihan bahan. Ujian penyerapan air dilakukan secara meluas untuk menentukan jumlah air yang diserap oleh bahan dalam satu tempoh masa. Kandungan lembapan keseimbangan termoplastik diukur menggunakan kandungan lembapan. Istilah "keterlarutan air" merujuk kepada keupayaan bahan untuk menahan air. Keterlarutan air, sebaliknya, menunjukkan bagaimana bahan merosot apabila direndam dalam air. Kehilangan berat akibat lembapan dan aktiviti mikroorganisma semasa fasa pengebumian tanah boleh digunakan untuk menganggarkan ciri biodegradasi bahan. Terdapat beberapa cadangan yang diberikan untuk memanjangkan pemahaman tentang tingkah laku kanji jagung daripada projek ini. Cadangkan pelbagai jenis pemplastis seperti sorbitol, urea, fruktosa dan lain-lain untuk menyiasat kelakuan dan sifat kanji jagung. Untuk meningkatkan kekuatan termoplastik. dengan menambah pelbagai bentuk gentian tumbuhan seperti kenaf, daun pisang, daun nanas, buluh, dan lain-lain.

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LIST OF SYMBOLS AND ABBREVIATIONS

^oC	-	Degree celcius
%	-	Percent
ABS	-	Arcrylonitrile-Butadiene_stryrene
AI_20_3	-	Aluminium oxide
B4C	-	Boron Carbie
CMC	-	Ceramic matrix composite
C3H8O3	-	Glycerol
HfB_2	-	Hafnium diboride
Kg	-	Kilogram
mL	-	Mililiters
mm	-	Millimeter
MMC	-	Metal matrix composite
PHA	-	Polyhydroxy-alkanoate
PLA	-	Polyactic acid
PMC	-	Polymer matrix composite
PVC	-	Polyvinyl chloride
PVOH	-	Polyvinyl alcohol
RH	-	Relative humidity
SiC	-	Silicon Carbide
TiB2	-	Titanium diboride
TPS	-	Thermoplastic
Wt%	-	Weight percent
ZrB_2	-	Zirconium diboride

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

Composites are made up of two materials, one of which is called the reinforcing phase and comes in the form of fibers, papers, or particles, and the other is called the matrix phase and it is embedded in the reinforcing phase. Environmental issues have resulted in considerable interest in the development of new composite materials based in biodegradable resources. The thrust on developing innovative and weight less material from locally available, cheaper and renewable sources was of greater interest (Sathishkumar et al., 2013).

Nowadays, our world is facing problems with one of the biggest pollution which is plastic pollution. Plastic waste is a major contributor to environmental pollution because it needs thousand years to disposed. This issue is important becasue it can cause a serious damage to environment through it non-stop production and destruction. Plastic contains toxic chemical which can lead to harm effect towards air, water, earth, animals and humans (Azahari et al., 2011).

As a result, much focus has been given on the development of various biodegradable materials in order to address this serious issue (Azahari et al., 2011). Being biodegradable means that it can be degraded by the enzymatic actions of microorganisms such as bacteria, fungi, algae, and so on. So, in general, biodegradable materials are derived from natural renewable sources and starch, cellulose, lignii, chitin, protein., are the most common examples of natural biodegradable polymers (Ruhul Amin et al., 2020).

Starch is one of the most promising materials due to its availibility, economic, abundant, biodegradable, and renewable (Jumaidin et al., 2016). Starch can be the option as it is the least expensive biopolymer among the natural polymers, and starch is found in abundance in corn, potato, rice, and many other natural sources (Ruhul Amin et al., 2020). Besides starch, glycerol is one of the material that needed in producing of thermoplastic. Glycerol is a chemical that has a multitude of uses in the pharmaceutical, cosmetic, and food industries and it is also an organic compound. Glycerol is derived from natural or petrochemical feedstocks (Tan et al., 2013). However, starch-based biodegradable products reveal some disadvantages attributed mainly to starch's highly hydrophilic character (Ribba et al., 2017).

1.2 Problem Statement

These days, petroleum-based polymers have caused harm to the environment due to their production from a non-biodegradable material. This situation has to lead the world to plastic pollution. Moreover, non-biodegradable plastic also threatens food safety and quality, coastal tourism, ocean health, human health and contributes to climate change. And most visible and distressing impacts of petroleum-based plastics in marine life are suffocation, ingestion, and entanglement of hundreds of marine species (Ridhwan Jumaidin et al., 2020). Hence, a possible way to solve these issues is to produce a thermoplastic using biodegradable material. Thus, the purpose of this study is to produce biodegradable plastics that are eco-friendly and safe for the environment to replace petroleum-based plastics by using corn starch and glycerol.

1.3 Research Objective

The objectives of this study are as follows:

a) To produce the matrix by using biodegradable material which is corn starch.

b) To investigate the physical and environmental behaviour of corn starch in various plasticizer loadings.

1.4 Scope of Research

The scope of this research are as follows:

- To prepare and fabricate a matrix sample test from corn starch mix with plasticzer (glycerol).
- To characterize the matrix on biodegradability using soil burial testing and water solubility method.
- To find the physical behaviour by using density, moisture content and water absorption testing.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The use of composite materials dates back centuries and began with natural fibers. Clay was reinforced with straw to build walls and buildings in ancient Egypt around 3000 years ago. Metals, for example, were later introduced as more durable building materials (Raj et al., 2021). Composites are materials that are created by mixing two or more natural or artificial elements with various physical or chemical qualities to create a substance that is stronger as a group that as separate components. To optimise the result of the end of the product, the component materials (matrix and reinforcement) do not mix entirely or lose their valuable qualities (Raj et al., 2021).

Composite materials, in particular, are being invented and redesigned with the goal of improving and adapting traditional products while also introducing new products in a sustainable and appropriate way. Natural fibers are mostly derived from plants or animals. The first is primarily made of cellulose, whereas the latter is made of protein. Natural fibers are commonly referred to as vegetable fibers in the composited industry. One of the problems with natural fibers is the lack of information and mechanical variances. Furthermore, the lack of industry standards for both producers and users of these materials in term of how to collect, treat, process, and post-process natural fibers adds to the selection process' complexity. These concerns are, in fact, major deterrents to the general use of natural fibers in a variety of applications. To fill this void, this study presents a study of various mechanical properties of natural fibers and their applications (Peças et al., 2018).

In addition to being environmentally friendly, composites made of biodegradable polymetric matrixes reinforced with natural fibers have remarkable mechanical properties (Beltrami et al., 2014). Biodegradability refers to the ability of microorganisms such as bacteria, fungi, algae, and others to decompose by enzymatic activity. In general, biodegradable materials are generated from natural renewable sources, such as starch, cellulose, lignin, chitin, protein, and other natural biodegradable polymers being the most common examples (Ruhul Amin et al., 2020). Figure 2.1 shows the flowchart of Biocomposite.

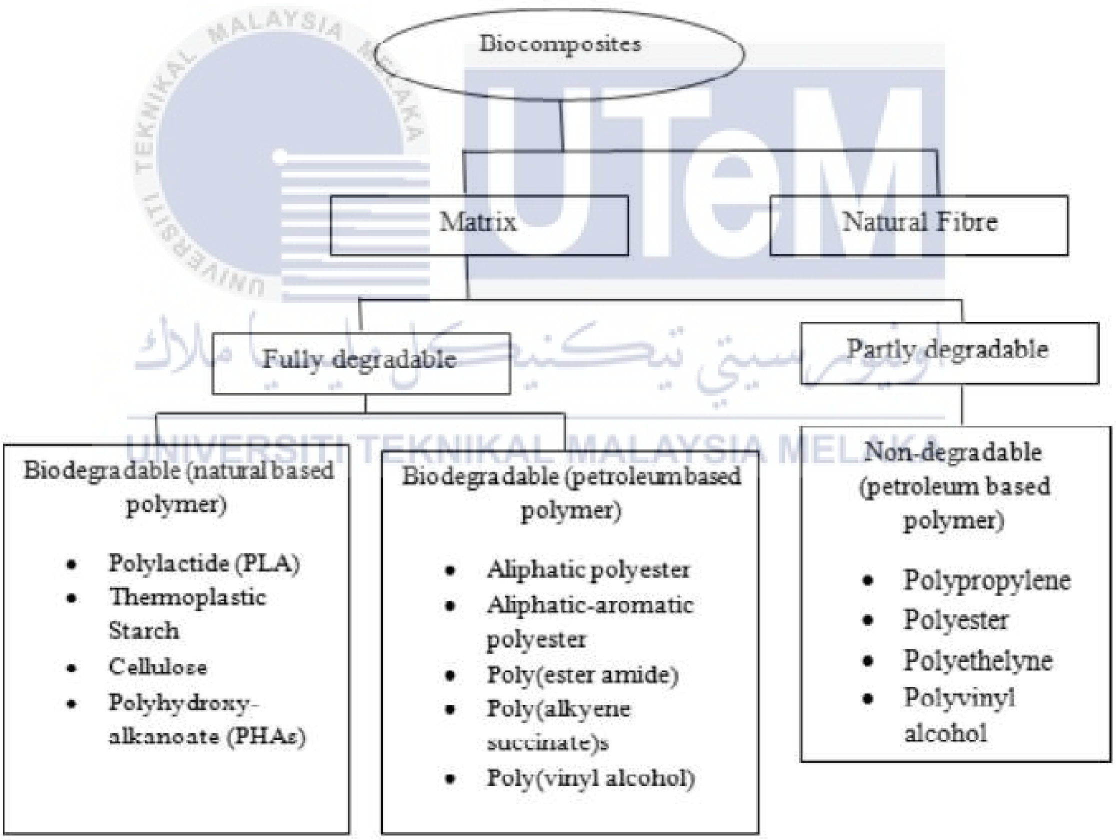

Figure 2.1 Classification of biocomposite (Sahari & Sapuan, 2012)**.**

2.2 Matrix

2.2.1 Introduction of matrix

A composite has a continuous component known as the matrix and a discrete or discontinuous component known as the fillers. The matrix and the fillers combine to form one material in the composite material. The filler is the load bearing component of the composites, while the matrix, which is the reinforcing material, holds the filler together (Ruano et al., 2016). Even though the reinforcement improves the overall characteristics of the matrix, the matrix holds the reinforcement in order to create the desire shape (Sharma et al., 2020).

2.2.2 Type of matrix

There are various types of composites. Ceramic matrix composites (CMC), polymer matrix composites (PMC), and metal matrix composites (MMC) are the type of composite (Ruano et al., 2016). The type of matrix is shown in Figure 2.2.

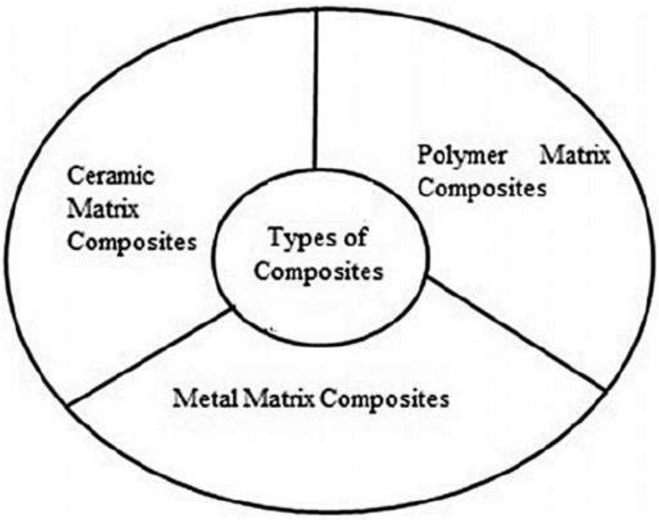

Figure 2.2 Type of matrix (Sharma et al., 2020)

Ceramic Matrix Composites (CMCs) are a mixture of ceramic particulates, fibers, and whiskers with a matrix of another ceramic and can be defined as solid materials with highly strong bonding that is typically ionic but can be covalent in a few cases. Ceramics, metals, glasses, and polymers can be used to reinforce the ceramic matrix. Ceramic-based matrix materials exhibit exceptional corrosion resistance, high melting points, superior compressive strength, and temperature stability. Ceramic matrices are a popular material for high-temperature applications such as pistons, blades, and rotors in gas turbine parts. They can withstand high temperatures and perform well in corrosive environments. The primary goals in the development of CMCs are to improve toughness because monolithic ceramics are brittle while having high stiffness and strength. It is undeniable that reinforcement, in the form of particulates and continuous fibres, has resulted in an increase in toughness, but the increase is even greater for the second, oxide-based or non-oxide-based CMCs, as illustrated by a comparison of modulus of elasticity of a few ceramics in Figure 2.3 below (Sharma et al., 2020).

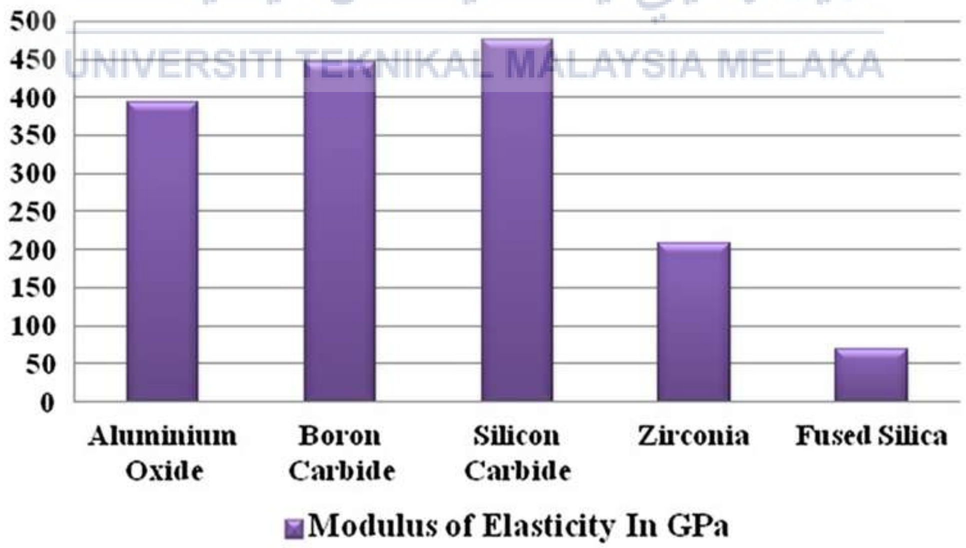

Figure 2.3 Modulus of Elasticity of ceramic materials (Sharma et al., 2020)**.**