DEVELOP CORN AND TAPIOCA STARCH BASED AS BIO PLASTIC MATERIALS FOR PACKAGING MATERIALS.

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DECLARATION

I declare that this project report entitled "Develop Corn and Tapioca Starch Based as Bio Plastic Materials For Packaging Materials" is the result of my own study except as cited in the reference.

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Date : ....

SUPERVISOR'S DECLARATION

I hereby declare that I have read this project report and in my opinion this report is acceptable in term of scope and quality of the award of the degree of Bachelor of Mechanical Engineering.

Signature :...................................

Name of Supervisor :...................................

Date :...................................

DEDICATION

I would like to dedicate this to my beloved parents. Next to my, Supervisor, Professor Madya TS Dr. Mohd Zulkefli Bin Selamat. Laboratory technician Mr. Rizal, my friends and all people that had guided me throughout completion of this project. To the person that encourages me to pursue mechanical engineering field. To the person who give me an inspiration for not giving up studying mechanical engineering

ABSTRACT

Previous studies show that synthetic plastic has more disadvantages than bioplastic such as high cost and higher environmental risk. Recent studies tend to concern towards the environmental issues. The use of starch based TPS films act as an alternative synthetic plastic competitor. The aim of this project is to study the suitable composition of corn and tapioca starch as bio plastic materials and the properties of corn and tapioca starch based TPS as bio plastic materials. Corn and Tapioca starch is usually mix with glycerol and the composition that being selected is 70TPS/30GLY. Another than that, the fabrication process that used in this project is by using casting method, but the result of this method is not satisfying to do mechanical test so the effort that can made in this project going smoothly and efficiently is by fabricate bioplastic film in corn and tapioca starch-based TPS using hot press method to ensure the objectives of this project will be achieved. Three testing that have been done are Tensile Test by referring (ASTM D 3039), Hardness Test (ASTMD 2240 D) and Density Test. From all these three tests, found that the composition of 50% corn 50% tapioca starch has the highest tensile value which is 0.15(Mpa). The hardness test value of this composition is slightly lower than pure tapioca with the value 39 compared to 100% tapioca which is 48. While the density value of composition 50% corn and 50% tapioca is the highest of the overall sample composition which the value is 1.42. These findings present this hybrid TPS 50% corn and 50% tapioca starch composition as a best TPS properties for the development of biodegradable packaging materials.

ABSTRAK

Kajian terdahulu menunjukkan bahawa plastik sintetik mempunyai lebih banyak keburukan berbanding bioplastik seperti kos yang tinggi dan risiko alam sekitar yang lebih tinggi. Kajian terkini cenderung mengambil berat terhadap isu alam sekitar. Penggunaan filem TPS berasaskan kanji bertindak sebagai pesaing plastik sintetik alternatif. Matlamat projek ini adalah untuk mengkaji komposisi jagung dan kanji ubi kayu yang sesuai sebagai bahan bio plastik dan sifat-sifat TPS berasaskan kanji jagung dan ubi kayu sebagai bahan bio plastik. Kanji jagung dan Tapioka biasanya dicampur dengan gliserol dan komposisi yang dipilih ialah 70TPS/30GLY. Selain itu, proses fabrikasi yang digunakan dalam projek ini adalah dengan menggunakan kaedah tuangan, tetapi hasil kaedah ini tidak memuaskan untuk melakukan ujian mekanikal maka usaha yang boleh dilakukan dalam projek ini berjalan dengan lancar dan cekap adalah dengan membuat filem bioplastik dalam TPS berasaskan kanji jagung dan ubi kayu menggunakan kaedah hot press bagi memastikan objektif projek ini tercapai. Daripada ketiga-tiga ujian ini, didapati komposisi 50% jagung 50% kanji ubi kayu mempunyai nilai tegangan yang paling tinggi iaitu 0.15 (Mpa). Nilai ujian kekerasan komposisi ini adalah lebih rendah sedikit daripada ubi kayu tulen dengan nilai 39 berbanding ubi kayu 100% iaitu 48. Manakala nilai ketumpatan komposisi 50% jagung dan 50% ubi kayu adalah yang tertinggi daripada keseluruhan komposisi sampel yang nilainya iaitu 1.42. Penemuan ini mengemukakan TPS hibrid 50% jagung dan 50% komposisi kanji ubi kayu ini sebagai TPS terbaik untuk pembangunan bahan pembungkusan biodegradasi.

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LIST OF ABBREVIATIONS

MMC	Metal Matric Composite
SW Corp	Solid Garbage Management and Public Cleansing Corporation
CMC	Ceramic Matric Composite
PMC	Polymer Matric Composite
PLA	Polylactic Acid
PVA	Polyvinyl Alcohol
TPS	Thermo Plastic Starch
ASTM	American Society for Testing and Material
NFRP	Natural Fibre Reinforced Polymer
PVC	Polyvinyl Chloride
PE	Polyethylene
PS	Polystyrene
PP	Polypropylene
ESEM	Environmental Scanning Electronic Microscopy
SEM	Scanning Electron Microscope

LIST OF SYMBOLS

cm	=	Centimeters
$°C$	=	Celsius
%	=	Percentage
rpm	=	Rate per Minute
min	=	Minute

CHAPTER 1

INTRODUCTION

1.1 Background

Recently, numerous studies on the development of biodegradable film packaging especially made from biopolymers have been done. Generally, there is a huge interest in biodegradable film packaging due to the excessive use of conventional petroleum based as food packaging material which is non-biodegradable and contributed to land disposal problems. The new study on global analysis of plastics made from petroleum reported that out of 6.3 billion metric tons of plastics have become a wastage and on top of that, only 9% has been recycled (Geyer et al., 2017). Based to the Solid Garbage Management and Public Cleansing Corporation (SWCorp), Malaysia generated roughly 1.17 kg of solid waste per inhabitant per day in 2014, making this a serious issue in our country. Plastic garbage, which accounted for 13.2% of total garbage in 2012, is one of the solid wastes that is now being addressed. Plastic garbage, behind food and organic trash (44.5 percent), diapers (12.1 percent), and paper, was the fourth most common type of garbage in Malaysia, according to the National Solid Waste Management Department (2012). (8.5 percent). However, according to the most recent statistics from 2019, the mix of waste is changing, with plastic accounting for almost 20% of all waste. Due to population and tourism expansion, the amount of garbage generated is predicted to increase (Jayashree, 2012).

The current research focuses on bioplastics made from corn and tapioca starch for packaging. Plastics such as polyethylene, polyvinyl chloride, and polystyrene are now made from petrochemicals. More fossil fuels are used to make plastics, resulting in increased greenhouse gas emissions that deplete the ozone layer (Morales-Méndez & Silva-Rodrguez, 2018). Because these polymers remain persistent in the atmosphere. From previously said, plastic is one of the most commonly generated wastes on a global scale. If this hazardous plastic garbage is poorly disposed of and causes contamination in the environment, it will be damaging to living things. When plastics are discarded in landfills, they combine with water and generate dangerous compounds, causing harm to the environment and human health. Due to the characteristics of plastic, which include high molecular weight and closely bound molecules, total degradation of a single plastic waste takes around 100 years. In 2017, Nehra Kiran published a book titled "Nehra Kiran" (Nehra Kiran 2017)

More material with specified properties, such as high tensile strength, lightweight, safe, and less expensive material, is in demand in today's age of modernization (Matthew and Rawling 2003). As a result, natural resources are becoming insufficient to meet rising demands on material capacities. As a result, experts in this field are constantly looking for ways to improve traditional materials. Composites are not a new concept; they have been around for a long time, and composites were employed in ancient Egypt, according to historical records.

Reinforcement-matrix bonding is vital in composites because the load applied on the matrix must be transferred to the reinforcement (Matthew and Rawling, 2003). Reinforcing materials such as Glass, Carbon, and Aramid are available in a variety of strengths and densities. Metal Matric Composite (MMC) (aluminum, magnesium, copper, and lead), Ceramic Matric Composite CMC (silicon carbide, silicon nitride, aluminum oxide), and Polymer Matric Composite (PMC) (silicon carbide, silicon nitride, aluminum oxide) are examples of ductile or tough matrix materials (thermoset and thermoplastic).

The materials commonly used in biodegradable composites, which are the focus of this project, are a mix of two or more natural resource components made up of

Fibers/Reinforced and Matrix/Binder. The researcher or engineer will benefit from this combination because it will provide a desired quality.

This study will focus on Polymer Matric Composites in greater depth (PMC). Polymer Matric Composite (PMC) is a biodegradable composite that can be classified as partially or entirely biodegradable in the future (Ghanbarzadeh, et al., 2013). When exposed to microorganisms in aerobic and anaerobic processes, such as polysaccharide and polypropylene, biodegradable polymers lose their chemical and physical properties and fully breakdown. A polymer that is partially biodegradable is one that has both biodegradable and non-biodegradable components.

Many natural materials, such as bones, wood, and grasses, are formed of composites, according to Matthew and Rawling (2003). Natural fiber-based composites are becoming increasingly popular because to their long-term sustainability, low cost, low density, and greater specific characteristics (Matthew and Rawling, 2003). The ability to deliver natural based fiber on a continual basis is driving the move. Plant fibers, animal fibers, and mineral fibers are the three forms of natural-based composites that are currently being investigated (Mathivanan et al. 2015). Although natural based fiber has acceptable physical and mechanical properties, the type of natural resources employed affects the physical and mechanical qualities.

Agricultural plantations abound in Malaysia. There have been numerous researches conducted on various elements of plant-based fiber. This is demonstrated by the numerous journals that have been published on green composites or bio composites. One of the natural resources that can be used as a composite is the plant. Plants are becoming increasingly popular in the production of new materials. One of the reasons for this is that it has a high tensile strength. Furthermore, not only may the fiber be of natural origin, but the matrix can be made from a variety of natural resources, including starch, sago starch, soy starch, potato, corn, and wheat (Pickering et al. 2016).

The goal of this study is to create a new biodegradable film formulation based on starch and tapioca starch that can be used as a bioplastic material for packaging and to evaluate its qualities. Corn, often known as maize (Zea mays), is one of the most widely consumed cereal grains on the planet. It is the seed of a grass plant that's native to Central America but available in a wide range of variants around the world. PLA (polyactic acid) is commonly manufactured from corn starch, cassava, or sugarcane sugars. It is edible, biodegradable, and carbon neutral. Corn kernels are immersed in sulfur dioxide and hot water to convert them to plastic, where their components break down into carbohydrates, protein, and fiber. The maize oil is extracted from the starch after the kernels have been pulverized. Like the carbon chains in plastic made from fossil fuels, starch is made up of long chains of carbon molecules. Some citric acids are added to create a long-chain polymer (a big molecule made up of smaller units that repeat) that is used to make plastic. PLA can resemble polyethylene (used in plastic films, packaging, and bottles), polystyrene (Styrofoam, and plastic cutlery), or polypropylene (used in plastic cutlery) in appearance and behavior (packaging, auto parts, textiles). Nature Works, based in Minnesota, is one of the most well-known manufacturers of PLA under the Ingeo brand (Renee Cho,2017). Due to the low water resistance of starch-based edible films, they can have an impact on the physical and mechanical properties of the edible film. Other biopolymers, such as hydrophobic and antibacterial compounds, require having starch added to them (Susilawati et.al,2019).

This project will contribute to the waste to wealth objective by focusing on natural fiber-based composites that are appropriate for the title chosen for this project, which is to produce corn and tapioca starch-based bioplastic materials.

1.2 Problem Statement

Every day, there is a greater demand for plastic. This condition adds to the major difficulty of dealing with non-biodegradable plastic garbage, which is not easily biodegradable and has been put in landfills for a long period. As a result, non-biodegradable plastic garbage will pollute the ecosystem, resulting in economic and environmental harm (Drzyzga & Prieto, 2019). A lot of research has been study to replace non-biodegradable garbage with biodegradable garbage. Biodegradable plastic is frequently viewed as a possible waste management solution to the trash accumulation caused by traditional plastic (Mostafa et al., 2018). This is since biodegradable plastics can be degraded by microorganisms after being discarded in the environment, releasing carbon dioxide and water as a byproduct of the decomposition (Nik Abdullah et.al, 2014).

As our awareness of the environmental situation grows, so does our understanding of how important it is to preserve the environment. The area of material science has progressed rapidly in this green effort throughout the years. To stay up with the ever-changing technological environment, many innovative technologies have been developed. The trend away from synthetic plastic composites and toward natural based fiber composites is one evident technological achievement (Santosha, et al. 2017).

According to Santosha et al. (2017), natural fibers have been demonstrated to be a viable alternative to synthetic fibers in recent years. Synthetic polymers are well-known and in high demand for a variety of reasons, including their mechanical and physical qualities. There is always a disadvantage to a synthetic-based composite, no matter how wonderful it is. Composites made of synthetic materials are harmful to the environment and pollute the soil (Norshahida et al. 2012). This issue will be addressed with environmentally friendly materials. As the world becomes more conscious of sustainability, our reliance on petroleum-based materials is dwindling.

Plastics made from petroleum have been widely used all over the world. The disposal of waste plastics has become a big issue as the number of uses has expanded. As a result, the creation of novel polymers that can be destroyed by microbes in soil and ocean has received a lot of interest recently (Park, Chough, Yun, & 4 Yoon, 2005). In the realm of biomaterials, starch has been used as a plentiful and inexpensive raw material. Packing films, on the other hand, are made completely of starch and lack the strength and stiffness needed to survive the forces that many packaging materials are subjected to (Parvin, Rahman, & Islam, 2010).

Thermoplastic starch appears to be an ideal approach for obtaining commercial packaging materials made entirely of pure starch while avoiding the use of synthetic polymers in the formulation. Thermal and mechanical processing, on the other hand, should rupture semi-crystalline starch granules in order to obtain thermoplastic starch. Because the melting point of pure starch is significantly greater than its decomposition temperature, plasticizers such as glycerol are required. Temperature and shear stresses cause the normal crystalline structure of starch granules to be disrupted, and polysaccharides form a continuous polymer phase (Mitrus & Moscicki, 2013).

Biopolymers are the material that has been studied the most. They typically have poor mechanical qualities in terms of processability and end-use functioning due to thermoforming's fragility, which limits their application potential. Plasticizers are used to provide biopolymers the workability they need to overcome this challenge (Vieira et. al. 2011). Blending is another way to improve starch's mechanical properties, and current research has focused on pure starch-based products as well as starch/degradable polymer blend products including starch/cellulose and starch/PVA (Park et. al. 2005).

1.3 Objective

The objectives of this project are as follows:

1.Determine the suitable composition of corn and tapioca starch's as bio plastic materials.

2.Determine the properties of corn and tapioca starch's based as bio plastic materials.

1.4 Scope of Study

The scopes of the project are as follows:

Preparation of Bioplastics Film in tapioca and corn starch- based TPS, glycerol is used as plasticizer, due to its better mechanical properties and good water solubility, ranging from 18 to 25% through it can increase up to 36%. It was shown that glycerol concentration would not affect the glass transition temperatures. TPS film was prepared according to the following procedure: The starch, glycerol were added to 100 mL distilled water in various ratios. The mixture was stirred at a rate of 180 rpm for 10 min. then the mixture was heated on a plate at 100 °C, and manual stirred was done for 70 min, continuously. It was then poured onto a silk/cloth strain on frame and spread uniformly. It took 3-4 days for the mixture to dry out and cast film was removed. The properties corn and tapioca starch based as bio plastic materials composite, the tests such as tensile, density, hardness test, moisture content tests and microstructure analysis will be performed.

CHAPTER 2

LITERATURE REVIEW

2.1 Composites

According to Matthew and Rawling (2003), composites are made up of two elements, one of which is called the reinforcing phase and the other is called the matrix phase. At low densities, reinforcing materials are generally strong, but the matrix is usually a ductile or hard material (Matthew and Rawling, 2003). If the composite is designed and made correctly, it can combine reinforcement strength with matrix resilience to produce a unique combination of desirable qualities not found in any other material. There are a few different sorts of composites that can be classified (Matthew and Rawling, 2003). The composite's matrix material might be made of ceramic, metal, or polymeric material. Fabrication techniques differ depending on the physical and chemical qualities of the matrix and reinforcing fibres (Matthew and Rawling, 2003).

Fiber-reinforced polymer (FRP) is a biodegradable composite material made up of a polymer matrix reinforced with fibre. Nature fibre can be used in a variety of ways. Many sectors are interested in using natural fibre composites in the development of their products. Bamboo, coconut, rice husk, wood, and pineapple leaf are just a few of the natural fibre composite materials employed. A biodegradable composite material, often known as a bio composite, is a composite material with a grid and common fibre support. The behaviour of biomaterial in diverse circumstances is linked to biocompatibility. The ability of a substance to behave in a precise place with a suitable host response.