UNIVERSITI TEKNIKAL MALAYSIA MELAKA

LEFTOVER RICE STARCH FROM FOOD WASTE TO BIO-BASED PLASTIC

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

by

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering Technology (Process and Technology) with Honours. The member of the supervisory is as follow:

……

(Project Supervisor)

ABSTRAK

Bio-plastik adalah alternatif untuk menggantikan plastik tradisional, yang terdiri daripada bahan petroleum. Bio-plastik juga adalah alternatif yang mampan dan mesra alam berbanding petro-plastik, yang tidak boleh diperbaharui dan tidak mesra alam. Sisa makanan terutamanya beras, yang kaya dengan kanji, telah dianggap sebagai bahan mentah yang berpotensi untuk menghasilkan plastik mesra alam sekitar. Dengan menggunakan kanji nasi untuk membuat plastik dan bersifat mesra alam, ianya dapat membantu menyumbangkan ke arah pengurangkan pencemaran sampah. Terdapat 3 jenis sisa kanji nasi yang telah ujian. Keberkesanan berasaskan bio-plastik kanji nasi dinilai oleh dua jenis ujian iaitu ujian biodegradasi dan ujian tegangan. Hasil telah menunjukkan bahawa sisa nasi putih mempunyai kekuatan yang paling tinggi berbanding dengan sisa nasi goreng dan sisa nasi beriani yang telah dijadikan bio-plastik. Untuk keputusan hasil dari ujian biodegradasi di dalam tanah, yang melibatkan 3 sampel sisa kanji nasi yang berbeza. Penguraian sampel di dalam tanah melibatkan 3 jenis sisa kanji nasi yang berbeza menunjukkan ianya 100% berjaya selepas 8 minggu dan telah mencapai dan dapat diklasifikasikan berjaya mengikut ASTM yang berkaitan. Untuk sampel sisa kanji nasi, bahan tambahan juga didapati memainkan peranan dalam mempengaruhi dan memberi kesan kepada kanji sisa nasi dari segi sifat-sifat mekanikal dan fizikalnya. Sebagai kesimpulan, sisa kanji nasi putih mempunyai potensi sebagai alternatif untuk pembungkusan komersial bio-plastik selepas ianya di sintesis dan setelah diambil kira keputusan dan ciri-ciri mekanikal dan biodegradasinya.

ABSTRACT

Bio-based plastics are a great alternative to replace traditional plastics, which are often composed of petroleum products. Bio-based plastics are also sustainable and eco-friendly alternatives compared to petro-plastics, which are non-renewable and non-biodegradable. Food waste especially rice, which is rich in starch, has been considered as a potential feedstock for producing environmental friendly biodegradable plastic. By using rice starch to make biodegradable plastic to be able to help contribute useful things that may help in lessening garbage pollution. There are 3 different types of leftover rice starch film that had been test. The effectiveness of bio-based starch film is evaluated by two types of testing which is biodegradability testing and tensile testing. The result can indicate that leftover white rice have the higest of strength compare to leftover fried rice and leftover nasi beriani which had been made to bio-plastic. For the result of soil biodegradable test, its involve 3 different types of leftover rice starch. The degradation of 3 different type of samples leftover rice shown 100% successful after 8 weeks and its achives and classifies as sucessfull on the term of biodegradable according the ASTM related. For the rest of the rice samples, additional material was also found to influence and affect the rest of the rice starch in mechanical properties and physical. In conclusion, the remaining white rice has the potential as an alternative to commercial packaging bio-plastic after it in the synthesis and having regard to the results and the mechanical properties and biodegradation.

DEDICATION

Alhamdulillah, all praises to Allah S.W.T for the strengths and His blessing in completing this final year project. I am also thankful to my family, supervisor and friends for the continuous guidance, encouragement, advice, insightful comments, and support to continue develop this project. Finally, I thank all those who have helped me directly or indirectly in the successful completion of my project.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

ASTM	-	American Standard Testing Material
et al.	-	and others
E	-	Modulus Young's
FTK	-	Fakulti Teknologi Kejuruteraan
g	-	Gram
ISO	-	International Organization for Standardization
kg	-	kilogram
kN	-	Kilo Newton
mm	-	Mililiter
min	-	Minute
*m*l	-	Mililiter
m	-	Mass
MPa	-	Megapascal
N	-	Newton
SI Unit	-	International System of Unit
UTS	-	Ultimate Tensile Strength
wt	-	Weight
vs	-	versus
σ	-	Stress
ε	-	Strain
%	-	Percent

Aerobic	-	Aerobic means requiring air, where air usually means oxygen.
Anaerobic	-	Aerobic (Biology) (Of an organism or process) requiring the absence of or not dependent on the presence of oxygen.
Biodegradability	-	The breakdown of an organic chemical compound by micro- organisms in the presence of oxygen to carbon dioxide, water and mineral salts of any other elements present (mineralization) and new biomass or in the absence of oxygen to carbon dioxide, methane, mineral salts and new biomass (from EN13432).
Biodegradable plastic	-	A degradable plastic in which the degradation results from the action of naturally occurring micro-organisms such as bacteria, fungi and algae.
Biodegradation	-	Degradation brought about by the action of naturally occurring microorganisms such as bacteria, fungi and algae.
Composed	-	A managed process that involves the biological decomposition and transformation of biodegradable material to produce carbon dioxide, water, minerals and organic matter (compost or humus).

CHAPTER 1
INTRODUCTION

1.0 Background of Research

Bio-based plastics are a great alternative to traditional plastics, which are often composed of petroleum products. Bio-based plastics are also sustainable and eco-friendly alternatives to petro plastics, which are non-renewable and non-biodegradable. As years pass, we have less and less petroleum available to us, so it is important to find a suitable alternative. In fact, the global production and use of plastic continues to increase within 50 years. Compared plastic production in 2013 and 2012, it rise by four percent and as much as 299 million tons of plastic was produced (World Watch Institute 2015).

The advantages of plastics are light and less bulky than other packaging materials that could be processed into any desired shape or form such as films, sheets and pouches. On the other hand, it saves costs of storage and transportation because of lower volume, easy colouring, no rusting and first-rate water resistance. Although plastic package have great advantages, however they also have some limitations that includes some chemical attack on particular plastics, tendency to creep, less heat resistance, lower gas barrier and lower dimensional stability. Plastics are among the major toxic pollutants, it has the potential to cause or causes significant harm to the environment in the form of air, water and soil pollution. Plastic is a material that is very useful, but it is also made from toxic compounds that can cause disease, and because it seeks to durability, it is not biodegradable. Plastic can remain in the environment for hundreds of years.

Biodegradable, in fact, is one of the alternatives that may help to reduce these harmful impacts on a longer time scale. The problem of global food waste is critical to fine the solution from the standpoint of improving the environment by reducing carbon emissions and landfill usage. In order to trim down this problem, the application of biodegradable material as an alternative choice is increasingly applied. At the same time, food wasted in Malaysia has been found to comprise of 45% of average household waste and about 8,000 tonnes of food waste and kitchen waste are generated on a daily basis (Bernama, 2014).

Food waste especially rice, which is rich in starch, has been considered as a potential feedstock for producing environmental friendly biodegradable plastic. By using rice starch to make biodegradable plastic to be able to help contribute useful things that may help in lessening garbage pollution. This investigatory is a green project that may help in saving our green earth. When believe that it more appropriate to use biodegradable plastic instead of ordinary plastics because it takes billions of years for a plastic to decompose.

Leftover rice starch from food waste to bio-based plastic is based on renewable resources, biodegradable polymers which are meet all criteria of scientifically recognized norms for biodegradability and compost ability. Renewable sources become more viable alternatives and the potential for the plastics industry. When plastics is made from petroleum are burned, they release the carbon dioxide contained in the plastic into the atmosphere, leading to global warming. So by using bio-plastics, it offers significant advantages not only in ecological sense but also in an economically sense. Bio-plastic are a form of plastics derived from plant sources such as of renewable carbon resources include corn, potatoes starch, rice, soy, sugar cane, wheat and vegetable oil. Due to concerns for the global environment and the increasing difficulty in managing solid wastes, bio-based plastic and biodegradable polymeric materials may be among the most suitable alternatives for some applications (Tadahisa Iwata, 2007).

1.1 Problem Statement

In Malaysia food waste comprise of 45% of average household waste. It's about 8,000 tons of food waste and kitchen waste is generated on a daily basis. Re-use leftover rice from food waste into useful product.

1.2 Objectives

The aim of this study are:

(a) To synthesis bio-based plastic from 3 different types of leftover rice.

(b) To evaluate the mechanical and biodegradable properties of synthesis bio-based plastic.

1.3 Purpose of Study

This project focuses on synthesis 3 different types of leftover rice which is leftover white rice, leftover fried rice and leftover nasi beriani. In this study, mechanical and biodegradable properties of bio-based plastic from 3 types of leftover rice will be investigated.

1.4 Scope of Project

(a) Synthesis of bio-based plastic

As bio-bed plastic is formed via the gelatinization method. There are 3 different samples of leftover rice which is leftover white rice, leftover fried rice and leftover nasi beriani. Vinegar, acetic acid, corn starch, lemon grass liquid, water and will be prepare. After that, stirring, heating, and spread evenly onto a rectangle mould and lastly dry at room temperature.

(b) Characterization and degradability measurements

To determine the properties of the bio-plastic starch film synthesised from the various type of leftover rice of food waste, several analyses will be carried out which is tensile test and biodegradable test.

CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

This chapter discussed literatures of food waste to bio-based plastic, their background, material used. Reference and understanding were gain from various sources such as journal, books, paper and internet. The important aspect and focus in this literature review is about food waste, bio-based plastic, starch, rice, rice starch and leftover rice.

2.1 Food Waste

Food waste or food loss is food that is discarded or lost or uneaten. The two are similar, but have key distinctions within their definitions. The causes of food waste or loss are numerous, and occur at the stages of production, processing, retailing and consumption (Galanakis, Charis M, 2015). Food waste is an issue of importance to global food security and good environmental governance, directly linked with environmental for example energy, climate change, water, availability of resources. Then, in economic factor its involve resource efficiency, price volatility, increasing costs, consumption, waste management and commodity markets. In social impact, it will cause to health and equality of life.

2.1.1 Malaysia Food Waste

Malaysians waste an average of 8,000 tonnes or 8 million kg of food on a daily basis, an amount which can feed up to six million people. Solid Waste Management and Public Cleansing Corporation chief executive officer, Datuk Ab Rahim Md Noor said the percentage of food wastage increased by an average of 15% to 20% during festive seasons. The percentage composition of food waste among the solid waste, it is the highest at 45% while the cost of managing solid waste in states had reached RM1.6 billion last year. Accumulation of the 8,000 tonnes of food waste for 18 days could stack as high as the Petronas Twin Towers. In a year, the total food wasted could reach 2.92 billion kg, an amount which could feed 2.2 billion people (Bernama, 2014).

The United Nations Environmental Programme and the World Resources Institute recent report says about one-third of food produced is lost worldwide. Our concern is the food that is not eaten and dumped in garbage bins. Discarded food makes up more than one-third of garbage generated annually. In Malaysia, more than 3,000 tonnes of food are preventable food waste as they were untouched and edible (S. Sundareson, 2016).

2.1.2 Statics Food Waste In Malaysia

Food waste comprise of 45% of average household waste. This Category of municipal waste is crated away by garbage trucks. Approximately ten persent of recyclables contained is being collected by recycling organizations such as paper product, plastic, metals. In an average, each household produce at least one bag of mixed garbage containing kitchen discharge daily. Statistics taken from Ministry of Urban Wellbeing, Housing and Local Government show the data of global warning of food waste in Malaysia (Ministry of Urban Wellbeing, Housing and Local Government, 2012).

Figure 2.1: Percentage (%) of waste dump site in Peninsular Malaysia in the year 2012 <http://www.kpkt.gov.my/kpkt/fileupload/hebahan/lab_sisa_pepejal.pdf>

2.2 Introduction Bio-based Plastic

Bio-plastics are plastics derived from renewable biomass sources, such as vegetable fats and oils, corn starch, or microbiota. Bioplastic is a form of plastic made from renewable plant source rather than non-renewable petrolum. Bio-plastic can be made from agricultural byproducts and also from used plastic bottles and other containers using microorganisms. Common plastics, such as fossil-fuel plastics (also called petrobased polymers), are derived from petroleum or natural gas. Production of such plastics tends to require more fossil fuels and to produce more greenhouse gases than the production of biobased polymers bio-plastics. Some, but not all, bio-plastics are designed to biodegrade. Biodegradable bio-plastics can break down in either anaerobic or aerobic environments, depending on how they are manufactured. Bio-plastics can be composed of starches, cellulose, biopolymers, and a variety of other materials (Hong Chua, 1999).

Biodegradable is the capacity of a material to decompose naturally over time, to be broken down by microorganisms. The biodegradability or rather, the non-biodegradability of conventional petroleum-based plastics is a pressing environment issue. Approximately ten million tons of plastic products are discarded each year. Reusing and cycling plastics have been the first steps in combating the amount of municipal waste that is produced every day. However, mountains of synthetic waste are still generated at a dangerous rate despite efforts to reuse and cycle. A piece of petroleum-based plastic takes approximately 200 years to decompose naturally. As the demand for plastic products continues to rise, so does the pressure of finding a more environmentally- friendly alternative to conventional petroleum-based plastic.

The search for an alternative has led researchers to develop biodegradable plastic blends from organic such as corn, rice or potato starch. However, progress in the development of starch-based degradable plastics is slow and there is doubt as to whether degradable plastics are truly feasible. This is the one of the factor why this project are choose and it could come to terms the feasibility of rise starch as biodegradable plastic.

2.2.1 Bio-based Film

The majority of engineered plastic materials used today are made from synthetic polymers. The use of conventional petroleum-based polymer products creates many potential problems due to their non-renewable nature and ultimate disposal. Cellulose and its derivatives, when used in such applications, offers advantages with respect to sustainability, limited environmental impact and simplified end-of-life disposal issues. Early studies examined the application of chitosan, starch and cellulose derivatives which were shown have film forming properties. There is a considerable interest in biodegradable films made from renewable and natural polymers, such as starch (Roberto J. et al, 1994).