



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**THE DEVELOPMENT OF BIOPLASTIC PRODUCT FROM
BANANA FIBER FOR FOOD PACKAGING**

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering Technology (Product Design) with Honours

by

MUHAMAD FAHRUL RAZZI BIN OSNAN NAJIB

B071410428

950501-08-6199

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.....
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ABSTRAK

Biodegradable plastik atau produk berasaskan plastik adalah sejenis plastik yang berasal dari sumber semula jadi yang boleh diperbaharui, seperti minyak sayuran atau kanji. Berbanding dengan plastik yang sedia ada, plastik terbuat dari petroleum atau berasaskan minyak. Kini, sisa plastik telah menjadi masalah dan fenomena kepada alam sekitar. Hal ini berlaku apabila jumlah buangan plastik yang tinggi yang dihasilkan, bukan biodegradabiliti dan pengurangan sumber alam semulajadi yang mana kitaran hayatnya pendek. Tujuan bioplastik atau biodegradasi adalah untuk membangunkan produk mesra alam atau ecogreen terutamanya dalam industri pembungkusan makanan. Pembungkusan makanan dari bioplastik dapat membantu dalam menyelesaikan masalah alam sekitar di mana ia mempunyai tempoh masa yang cepat untuk dilupaskan di dalam tanah dan mudah dihasilkan. Dalam kajian ini, bioplastik dihasilkan dengan mencampurkan serat pisang sebagai bahan semula jadi dengan bahan lain untuk matriks dan plasticizer. Terdapat beberapa proses yang terlibat dalam pengeluaran bioplastik termasuk pencampuran, pemanasan dan proses pengacuan. Ujian mekanikal dan biodegradable dijalankan dalam kajian bioplastik ini. Modulus keanjalan ditentukan oleh ujian tegangan yang digunakan untuk menjalankan keupayaan beban dan ubah bentuk sebelum patah. Ujian biodegradable dijalankan untuk menentukan sampel bioplastik boleh dilupus melalui proses semulajadi dalam tempoh yang singkat.

ABSTRACT

Biodegradable plastic or plastic-based organic matter is a form of plastics derived from natural sources of renewable biomass, such as vegetable oil or starch. Compared to current plastics, they made from the petroleum or oil-based. Nowadays, the plastic wastes have been a phenomenon and problem to environmental. This happens according to the high amount of waste generated, non-biodegradability and the fastest depletion of natural resources regarding its short life cycle. The purpose of the bioplastic or biodegradable is to develop an environment friendly or ecogreen product especially in food packaging industry. Food packaging from bioplastic is able to help in resolving environmental problems where it has a rapid period of time to degrade in soil and easy to produce. In this study, bioplastic bioplastic is produced by mixing banana fiber as a natural material with other materials for the matrix and plasticizer. There are several processes involved in bioplastic production include mixing, heating and molding process. Mechanical and biodegradable tests are carried out in this bioplastic study. The modulus of elasticity determined by tensile test which is used to carry out the load ability and the deformation before fracture. Biodegradable test is carry out for determine the bioplastic sample can be degraded by natural processes in a short period of time.

DEDICATION

This final year project I dedicate to my beloved mother, also made my family on the encouragement and enthusiasm given to me. Without whose caring support it would not have been possible.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

C-14	-	Radioactive isotope of carbon
ASTM	-	American Society for Testing and Materials
ISO	-	International Organization for Standardization
KCAL	-	Kilocalorie
CO ₂	-	Carbon dioxide
OPS	-	Oriented phenylethylene
PET	-	Polyethylene terephthalate
PLA	-	Poly (lactic acid)
GPC	-	Gel permeation chromatography
DSC	-	Differential scanning calorimetry
TGA	-	Thermal gravimetric analysis
MA	-	Maleic anhydride
DMA	-	Dynamic mechanical analysis
MPA	-	Mega Pascal
GPA	-	Giga Pascal
mm	-	Millimetre
°C	-	Degree Celsius
PP	-	Polypropylene
VARI	-	Vacuum Assisted Resin Infusion
PH	-	A scale of acidity and alkali
SD	-	Standard Deviations

CHAPTER 1

INTRODUCTION

1.1 Background of project

Nowadays, plastic substance uses by human increase from day to day. Plastics are referred as a category of constituents called polymers. The mixture of huge molecules, formed by various of molecules that known as monomer. Polymerisation is process for creating plastics that are formed of low-molecular-weight monomer predecessor, organic materials, that are principally produced from petroleum. The capability to be formed to practically any type to make good and realistic product in way of life. Other than that, the plastic is made to be more rigid and hard or flexible and soft due to their light-weight, reasonable price, and features that may attract attention. it is able to make the plastics replace different types of materials such as computer equipment, automotive parts, children's toys, food packaging and more. On the opposite hand, the plastic wastes have been a concern phenomenon environmental. Problems arise when items that are no longer used became a waste of material, and will not be degraded in the soil quickly. This causes pollution of the environment that is increasingly under control.

Otherwise, there is a developing progression to use bioplastic composite. The biofiber in plant is use as a filler and reinforces in plastic composite. The flexibility of the bio-based fiber during processing, certain strengths of fiber, and low cost makes biofiber a significant subject for engineers and researchers developing bioplastics in the industry. Therefore, the cost, energy, materials used and the virgin material can be reduced. this will guarantee prosperity for the next generation.

1.2 Problem Statement

The voluminous use of plastic from petroleum has produced a major problem to the environment and also affected wildlife whether on land or at sea. In other words, plastics contribute pollution to the environment because plastics are everywhere and overuse. Furthermore, plastic is a material that takes a long time to make the process of degradation naturally. This causes the plastic to be the plastic waste. The method of plastic destruction done by the day is irrelevant where plastic is to be burned and planted when it becomes waste. It will cause pollution. The high cost of existing machinery and method avoid banana farmers transform their stalks into more helpful substances. Plus, this might improve their economic addition.

1.3 Objective

- 1) To design bioplastic product from banana fiber
- 2) To perform the biodegradable test on the bioplastic product
- 3) To determine mechanical properties of bioplastic material

1.4 Scope

1) Bioplastic

Development of bioplastics from natural materials and the reduction of chemicals in production are the main purpose in this project.

2) Banana Fiber

This study focuses on fiber resources which in the banana pseudostem. These samples were collected around Sungkai, Perak. The samples used for the study of their chemical properties, physical properties, morphology characterisation and method respectively. The properties of banana fiber, each chemical and physical properties are necessary variables to show the quality of samples to substitute banana fibre resources in food packaging.

3) Food Packaging

Plastic packaging covers several aspects such as portability, safe to use and does not contaminate food, quality and can afford reasonable costs to consumers. As a way of achieving these, here is to understand some of the ways and composition of the materials used, and some other factors such as biology, physic, and chemistry of the material.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The literature reviews related studies done by previous researcher on the bioplastic. By using natural sources, the user of commodity plastic product is changed to biodegradable plastic product. The natural sources can transform to composite material and the reinforcement from fiber natural. The literature reviews mainly focused on the various types of process plastic transforms and the equipment related. Engineering properties and related experimental are focused on tensile strength properties will be studied and discussed.

2.2 Food packaging

The main purpose of food packaging, food engineers wants to produce a quality product, safe and easy to manage and provide well-being to the community. Plus, to produce an improved and lowest costs potential for consumer. it is necessary for food engineer to know the how food deteriorates factors are caused by the biological, chemical and physical reactions. This factors proved once it appropriate with the application of food preservation principles and the quality of food in long period of shelf life. the best food packaging avoid giving effect to the environment and the preserved nature of food is maintained.

2.2.1 Packaging Function

Generally, packaging is divided to four basic functions: -

1. *Containment.*

The capability of food packaging for maintaining the integrity of handling concerned that is processing, filling sealing, transport, marketing and providing of food.

2. *Protection.*

One of the main idea for protection influence by food but it consists of the interference of natural pollution that generally from microorganism, insects and rodents. Plus, the oxidation of lipids, flavour and vitamins. Besides, the moistness change that affects microorganism growing, oxidation rates, and food quality. Moreover, the odour waste and gain of food beside physical harm. Last not least, protection also include preparation of interfere patent structures on the packaging. Food engineer sustains food protection and superiority succeeded by freezing, dehydrating, heat process, and various preservation of foods in providing protection for packaging.

3. *Communication.*

The science of food packaging provides in involving the legal necessities and marketing objectives. The food packaging label is important to produce the information of food details as well as net contents, nutrient contents, and also the country of origin. The package graphic designed to point out the product quality and for selling the product. The bar code meant to permit the marketing especially for tracking inventory speedy check-out.

4. *Convenience.*

Contribute convenience for consumer to show the function of food packaging that such as easy to conduct, easy opening and dispensing, reclosability, and food preparation in the package and also the variety of size package. (John M. Krochta, 2007). The figure 2.1 shows the function of packaging.

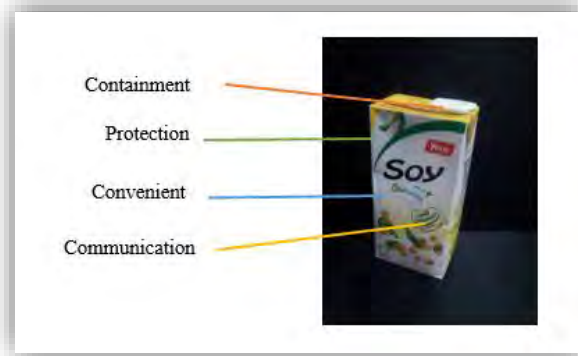


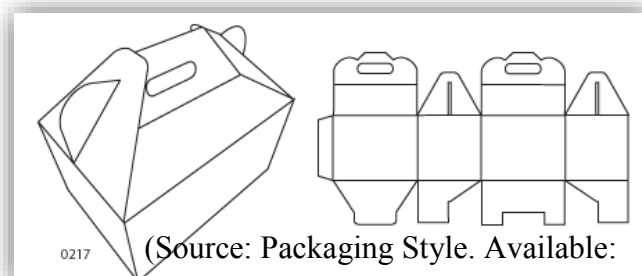
Figure 2.1: Function of packaging.

2.2.2 Packaging Terminology

There are several terms in the packaging that can be viewed before producing it.

1. Package form.

The packaging form is very important to represent the degree of package rigidity. The packaging form divided into many pattern. Firstly, Rigid packaging which means the form of the package do not change and also cannot be deformed. Secondly, semi rigid packaging which will be deformed to some degree of rigidity while not damage and may be returned to original form. Lastly, flexible packaging. it will change follow the filling. once the filling distributed out of package, it loses the form. Figure 2.2 shows the packaging form/style.



(Source: Packaging Style. Available: <http://www.charapak.co.uk/packaging/packaging-styles.php>)

Figure 2.2: The packaging form/style.

2. Package level.

Package level explains the proximity of the food and the packaging usage. The primary packaging is in direct contact with production of food and provides main protection for the environment. It also stated as a selling packaging or user divisions for the important function provided in retail sale and home-based consumption. The next level is secondary package is worked to increase the protection from physical damage. It also functioned as one of the selling packaging which occupied with primary packaging level or by unitizing two or more primary package. Sometimes, the secondary package known as distribution or shipping container for primary package. The last one is tertiary packaging and quaternary packaging usually used in supply, logistics and shipping. This is because they secure the product in loading and transport for supplying to the consumer. (John M. Krochta, 2007). Figure 2.3 shows the level of packaging.



Figure 2.3: Packaging level.

3. Preformed vs. in-line formed packaging.

Things that involve charging food in packaging are produced in different times. Packages that have been created will be isolated in other places before being delivered to the food processing facility. In the production line, ready-made packaging will be filled with food. (John M. Krochta, 2007).

4. Integral vs. nonintegral packaging.

It depends on the important of the definition of packages product either it integral or nonintegral packaging. Some of food will contaminate after removed from their packages because of their contents and chemical reaction so that their packaging is integral. (John M. Krochta, 2007).

2.3 Bioplastic

The value of proposition of reduced carbon influenced by the quantity of renewable carbon in biodegradable plastic product with the rates of timescales of natural biological carbon cycle. The usage of raw biomass material contributes for country economic growth with have rich resources of biomass and probably to commercialize especially in agriculture sector. Plus, bioplastic should be an organic and contains most or partially the quantity of biogenic carbon to classified as a bio-based substance. The determination of content of bio-based depends on the radioactive C-14 signature related to biocarbon and is also measured because the weight percentage from the biocarbon. The bio-based product promises a way to compost in the soil for a short time, a short lifetime, a disposable product and a practical compartment of the packaging. (Ramani Narayan, 2011) Besides, some of bio-composites are biodegradable and some of biodegradable composite are bio-based. they will have determined through the ASTM and ISO standard or there will some problem in health and environmental issues.

2.3.1 Biomass/Renewable Carbon Drivers

In fact, the increased use of natural materials and renewable biomass sources where the estimated prime production of biomass is equivalent to 6.9×10^{17} kcal / year. This means that 7% of the total is the result of human consumption of 4.7×10^{16} kcal / year. The photosynthesis of production process by the environment is estimated at 155 billion ton/year or over 30 tons per capita. Meanwhile, the forests on top of the earth accounted for 42% as