# EFFECT OF BANANA SKIN ON BIODEGRADABLE NR LATEX

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# ABSTRACT

## EFFECT OF BANANA SKIN ON BIODEGRADABLE NATURAL RUBBER LATEX

The study presents the effect of banana skin on the biodegradable natural rubber latex which is widely used in the production of glove and has shown one bad effect which is allergy toward the user. This study will be carried out with introducing banana skin into natural rubber latex. The latex films are prepared with 0%, 5%, 10%, 15% and 20% banana skin filler. Effect on banana skin loading on natural rubber latex properties was investigated. Natural rubber latex film was buried in soil for 2 weeks and their biodegradability effect is monitored. The degradation is determined by observation which is the physical appearance before and after the process and also characterization by weight increment. Then, the effects of aging test on the latex films are also tested. After aging test, the microscopic behaviour was investigated and characterized by scanning electron microscopy (SEM). Besides, the tensile strength of the latex films after aging test is also tested. The expected result is to see that banana skin protein will aid in the biodegradation process which will help the NRL to be composed at shorter time compare to the control sample.

## *ABSTRAK*

## KESAN KULIT PISANG TERHADAP TERBIODEGRADASI LATEKS GETAH ASLI

Kajian ini adalah untuk mengkaji kesan kulit pisang terhadap tindakan terbiodegradasi lateks getah asli. Lateks getah asli digunakan dengan meluas dalam penghasilan sarung tangan di mana ianya telah menunjukkan kesan sampingan iaitu alahan terhadap pengguna. Kajian ini akan dijalankan dengan mencampurkan kulit pisang ke dalam lateks getah asli. Filem lateks disediakan dengan 0%, 5%, 10%, 15% dan 20% kulit pisang. Kesan campuran kulit pisang terhadap lateks getah asli adalah diperhatikan. Filem lateks getah asli ditanam di dalam tanah selama 2 minggu dan tindakan terbiodegradasi adalah dipantau dari masa ke semasa. Tindakan terbiodegradasi ini ditentukan dengan memerhatikan keadaan fizikal filem lateks sebelum dan selepas proses dan juga dengan mengukur peningkatan berat filem lateks. Kemudian, ujian penuaan turut dilakukan ke atas filem lateks. Selepas ujian penuaan, analisis mikroskopi pula dikaji dan dicirikan menggunakan imbasan miksroskop elektron. Di samping itu, kekuatan tensil selepas ujian penuaan turut dikaji. Kulit pisang dijangkakan dapat membantu dalam tindakan terbiodegradasi oleh lateks getah asli dengan memendekkan masa proses terbiodegradasi berbanding sampel kawalan.

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| | |
|---|---|
| % | Percent |
| °C | Degree Celsius |

## ABBREVIATIONS

| | |
|---|---|
| NRL | Natural Rubber Latex |
| NR | Natural Rubber |
| SEM | Scanning Electron Microscopy |
| $CO_2$ | Carbon dioxide |
| $CH_4$ | Methane |
| MBT | Mercaptobenzothiazoles |
| HPLC | High Performance Liquid Chromatography |
| mg | Milligram |
| g | Gram |
| GC-TCD | Gas Chromatography-Thermal Conductivity Detector |
| L | Litre |
| IC | Inorganic Carbon |
| ASTM | American Society for Testing and Materials |
| KOH | Potassium Hydroxide |
| TSC | Total Solid Content |
| ZDEC | Zinc Diethyl Carbamate |
| ZnO | Zinc Oxide |
| mL | Millilitre |
| mm | Millimetre |

# CHAPTER 1

# INTRODUCTION

## 1.0 PROBLEM STATEMENT

Natural rubber latex (NR latex) has found to cause allergy to the consumers that use natural rubber based products. As for example, rubber glove is widely use in medical, chemical laboratory and in food processing. It can cause two types of allergy which are allergy toward natural protein in the natural rubber or allergy to the chemicals that is used to convert the natural rubber to the useful products. There are two types of allergy which are Type I and type IV allergy. Type IV which is also called delayed allergy only shows its effect 6 hours or more after usage while Type I allergy is the allergy towards the natural protein which will show its effect directly after usage. If the allergy is not taken into consideration, natural rubber is used as it has good physical properties, dexterity and most importantly it has low cost. Once who is known to has allergy of natural rubber should avoid the use of any products containing natural rubber because there is no treatment for the allergy but there is only medication for the early symptoms. This is why the idea to produce natural rubber which will cause no allergy toward its natural protein is created in which it is reacted with banana skin which in turn will have better biodegradability. Figure 1.1 shows the example of glove which is made from natural rubber latex while Figure 1.2 shows latex allergy on hands of one patient.

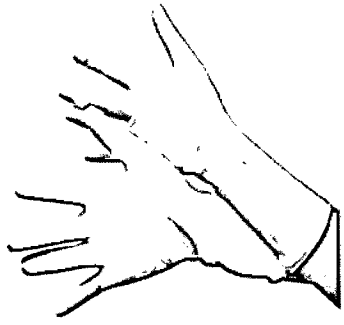

**Figure 1.1** : Natural rubber glove

Source : Zhangjiagang Tri-creation Co., Ltd

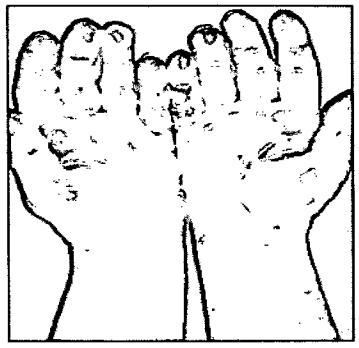

**Figure 1.2** : Latex allergy

Source : Susan M. Pollart et

## 1.1 NATURAL RUBBER LATEX (NRL)

Natural rubber or also called India rubber or caoutchouc is a milky colloid which is obtained from rubber tapping of Havea brasiliensis tree. This type of tree is widely plant in south East Asia. Figure 1.3 below shows how rubber tapping is carried out to obtain rubber.

**Figure 1.3** : Rubber tapping

Source : The rubber tappers of Sarawak

Among of many other types of rubber, NR is used as in many products because of its elasticity, resilience and toughness. NR is a polymer, thermoplastic and an elastomer (hydrocarbon polymer) with repeating units that contain double bonds. These points of unsaturation cause the NR to become very sensitive to ozone cracking. Meanwhile, the latex which is also a natural polymer contain isoprene which is mostly cis-1,4-polyisoprene, proteins, fatty acids, resins and also inorganic materials which are salts. Table 1.1 shows the composition of NRL.

**Table 1.1** : Composition of Natural Rubber Latex

| Constituent | Composition (%) |
|---|---|
| Rubber particles (cis-1,4-polyisoprene) | 30-40 |
| Protein | 2-3 |
| Water | 55-65 |
| Sterol glycosides | 0.1-0.5 |
| Resins | 1.5-3.5 |
| Ash | 0.5-1.0 |
| Sugars | 1.0-2.0 |

Source : K.F. Heinisch, Dictionary of Rubber, 1974

The crude rubber need to be vulcanized before it can be transformed to useful products. Vulcanization is a process of adding in sulphur into the polymer to make them more durable by making crosslink between individual polymer chains. Natural rubber that is not vulcanized can deform easily when they are heated up and brittle when they are cold but the vulcanized natural rubber has the great mechanical properties. Figure 1.4 shows the general reaction for accelerated sulphur vulcanization. In this research, the accelerator used is zinc diethyl carbamate (ZDEC).

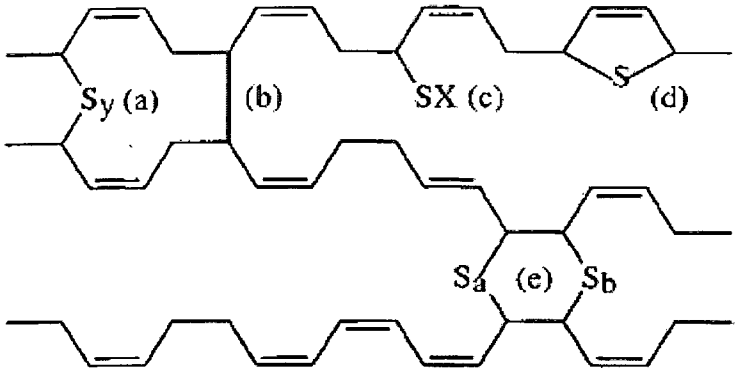


**Figure 1.4** : General reaction process for accelerated sulphur vulcanization

Source : Prasenjeet et. al., (2003)

## 1.2 BANANA SKIN (MUSA AAA)

Generally, banana skin is a peel from banana fruit. Clinical report has shown similarities between natural rubber latex and banana in which both of them produce protein that is the major cause of the allergy. Banana is the general name from a plant called genus Musa. Banana plant is also a tropical plant which is harvested the whole year. Banana is found to contain many organic compounds such as carbohydrate and protein is very helpful for biodegradation process. The composition of banana is shown in Table 1.2:

**Table 1.2** : Composition of banana

| Composition of banana for each 100 gram | |
|---|---|
| Water | 74.2 gram |
| Energy | 92 kcal |
| Fat | 0.48 gram |
| Protein | 1.03 gram |
| Carbohydrates | 23.43 gram |
| Fiber | 2.4 gram |
| Potassium | 396 mg |
| Phosphorus | 20 mg |
| Iron | 0.31 mg |
| Sodium | 1 mg |
| Magnesium | 29 mg |
| Calcium | 6 mg |
| Zinc | 0.16 mg |
| Selenium | 1.1 mg |
| Vitamin C | 9.1 mg |
| Vitamin A | 81 IU |
| Vitamin B1 (Thiamin) | 0.045 mg |
| Vitamin B2 (Riboflavin) | 0.10 mg |
| Vitamin E | 0.27 mg |
| Niacina | 0.54 mg |

Source : UDSA Nutrient Data Base

Based on the table before, banana contains large number of water. This is very helpful in biodegradation process since one of the requirements for biodegradation is large amount of water.

## 1.3 BIODEGRADABLE PROCESS

Biodegradation is the process of natural breakdown of organic material by microorganism with the presence of light, oxygen and moisture and it will yield methane, carbon dioxidè and water. Biodegradation process can occur with the presence of oxygen which is aerobic reaction or without the presence of oxygen which is anaerobic reaction. To measure the effectiveness of the biodegradation process, we have to choose something measurable as our responding variable such as amount of oxygen that the process consumes or carbon dioxide that they produce. However, in this research, the parameter used is the mass in which the mass will increase due to the formation of water during biodegradation process.

## 1.4 OBJECTIVES

1. To study the effect of banana skin on biodegradation process.

2. To study the effect of aging test on morphology of latex films and tensile strength upon addition of banana skin filler.

## 1.5 SCOPE OF STUDY

In this study, banana skin will be used to determine the effect of its composition toward the biodegradability of natural rubber latex. Besides, latex films with banana skin filler will also be tested in aging test because during transportation of latex films which are during shipment to the location, the latex films will undergo reduction in their tensile strength.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 BACKGROUND OF NATURAL RUBBER LATEX

Natural rubber is obtained by tapping the milk (sap) of *Hevea brasiliensis*. Natural rubber is an elastomer (elastic hydrocarbon polymer) which is originally derived from latex. The purified form of natural rubber is the chemical polyisoprene, which can also be produced synthetically. Polyisoprene can be seen at Figure 2.1 while Figure 2.2 shows the extraction of latex from a tree.

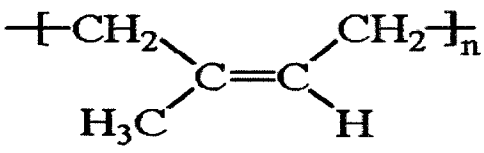

**Figure 2.1** : Polyisoprene

Source : The University of SouthernMississippi

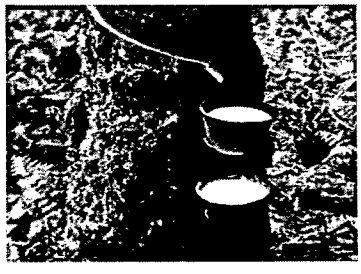

**Figure 2.2** : Extraction of latex from a tree

Source : Royal botanic gardens, Kew

Natural rubber latex is produced by two methods which are Dunlop and Talalay. For each method, once the resulting latex rubber foam is removed from the mold, it is then washed several times to rid it of excess soap residue. Table 2.1 shows the methods for production of natural rubber latex and their description.

**Table 2.1** : Methods for production of natural rubber latex and its description

| Method | Description |
|---|---|
| Dunlop | The Dunlop method is the oldest and predominant processing method used worldwide. In this method, the latex milk is first whipped and poured into a mold. It is then covered and heated at low temperatures until it vulcanizes. During the heating process, the naturally-occurring sediments in the latex settle at the bottom, resulting in a foam that is denser on the bottom than on the top. Dunlop latex is denser and springier than Talalay latex. |
| Talalay | The Talalay process is relatively new. In this method, after the latex milk is poured into a mold and covered excess air is vacuumed out. The mold is then flash-frozen to stabilize the foam. The Talalay process produced a more consistent cell structure and softer, more fragile latex. Because of the extra steps involved, Talalay is more expensive than Dunlop. Talalay foam pieces larger than 40" wide will have glue seams where two or more pieces are glued together. |

Source : kidbean.com

## 2.2 ALLERGY OF NATURAL RUBBER LATEX

According to WebMD, 2011 the exact cause of latex allergy is unknown however to some people, repeated exposure to natural latex can induce certain symptoms of allergy. Besides, people who are also at risk of experiencing natural rubber latex allergy are as follows and Table 2.2 shows the routes of latex exposure.

- People who has defect in their bone marrow cells
- People who has deformed bladder or urinary tract
- People with history of multiple surgeries
- People who is using a urinary catheter which has a rubber tip
- People with allergy, asthma or eczema
- People who has food allergies to bananas, avocados, kiwis or chestnuts

**Table 2.2** : Routes of latex exposure

| Route | Incident |
|---|---|
| Skin | When latex glove is worn |
| Mucous membranes | Mouth, vagina, and rectum |
| Inhalation | Latex glove has powder that can be inhaled |
| Blood | Some medical device that contain rubber |

Source : WebMD

There are three types of natural rubber latex reaction. Table 2.3 shows all three types of natural rubber latex reaction and their description.

**Table 2.3** : Latex reaction

| Latex reaction | Explaination |
|---|---|
| Irritant contact dermatitis | The least threatening type of latex reaction, classified as a non-allergenic skin reaction. It usually occurs as a result of repeated exposure to chemicals in latex gloves and results in dryness, itching, burning, scaling, and lesions of the skin. |
| Allergic contact dermatitis | A delayed reaction to additives used in latex processing, which results in the same type of reactions as irritant contact dermatitis (dryness, itching, burning, scaling, and lesions of the skin), but the reaction is more severe, spreads to more parts of the body and lasts longer. |
| Immediate allergic reaction (latex hypersensitivity) | The most serious reaction to latex. It can show up as rhinitis with hay fever-like symptoms, conjunctivitis (pink eye), cramps, hives, and severe itching. It is rare, but symptoms may progress to include rapid heartbeat, tremors, chest pain, difficulty breathing, low blood pressure, anaphylactic shock, or potentially, death |

Source : WebMD

Latex allergy is classified under non food protein allergy. This is when latex can trigger an IgE-mediated cutaneous, respiratory, and systemic reaction. IgE is a type of antibody that results from an extreme inflammatory response. So, it shows that latex allergy is type I hypersensitivity or immediate allergy. In detail, this allergy is due to excessive activation of certain white blood cells which is the IgE. Table 2.4 shows two types of allergy and their description.

**Table 2.4** : Type of allergy

| Type of allergy | Description |
|---|---|
| Type IV | Some people react to the chemicals used in the manufacturing process, mostly accelerators. The chemicals most likely to cause a reaction are thiurams, dithiocarbamates and mercaptobenzothiazoles (MBT). |
| Type I | • Type I natural rubber latex allergy is an immediate allergic reaction to NRL proteins and is potentially life threatening.<br>• Deaths have occasionally been reported due to latex allergy. |

Source : Health and Safety Executive (2011)

## 2.3 CROSS REACTIVITY BETWEEN NATURAL RUBBER LATEX AND BANANA

According to Porrozi R. *et al.*,(2004) immunogen cross-reactivity is the reaction between an antibody and antigen that is different from the cross reactivity Meanwhile, immunogen is any substance that evokes an immune response or that stimulates immunity (Farlex, 2011). The person who has latex allergy usually shows the same allergy towards certain fruit such as avocado, kiwi, banana, sweet pepper and tomato. According to Monika Raulf-Heimsoth *et al.* (1997), where they conducted immunological cross-reactivity between latex and food by skin prick testing. According to their result, 27 out of 100 are positive for the food skin tests while 17 patients manifested a clinical allergy to at least one food. Table 2.5 shows the percentage of occurring allergy based on different kind of food.

**Table 2.5** : Food and percentage of occurring allergy

| Food | Percentage (%) |
|---|---|
| Avocado | 53 |
| Potato | 40 |
| Banana | 38 |
| Tomato | 28 |
| Chestnut | 28 |
| Kiwi | 17 |

Source : Raulf-Heimsoth et al. 1997

Meanwhile, skin prick test is a test that measure specific IgE attached to cells in the skim important in allergy. When allergy is suspected, skin prick testing is usually recommended because it is simple, quick (providing results within 15-20 minutes) and inexpensive (Allergy UK). Figure 2.3 shows how skin prick testing is done.

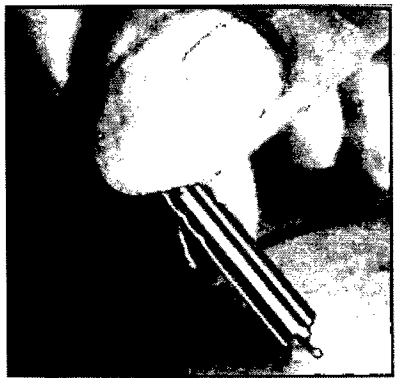

**Figure 2.3** : Skin prick testing

Source : Allergy UK

## 2.4 COMPOSITION OF BANANA SKIN

Bananas are enriched with a lot of vitamins, minerals, sugar and other nutrients. According to Nita Mukherjee (2009), where she compares between an apple and a banana, banana contains four times more protein, two times more carbohydrate, three times more phosphorus, five times more vitamin A and iron, and two times more vitamins and minerals than an apple. Besides, she also state that banana also contain vitamin B (thiamine, riboflavin, niacin, and B6), folic acid, sodium, potassium, calcium, rich of potassium, fibre and digestible sugars. From a research by Edwards and Bobby Gene (1999), the composition of banana is found to be helpful for medicinal purposes which are relief pain, swelling, itching, bruising, wrinkles and sunburn. Table 2.6 shows the composition of banana for their study.

**Table 2.6** : Composition of banana

| Compound | Compostion (amount by weight of composition) |
|---|---|
| 3,3,5-trimethylcyclohexyl | ~1.7% |
| Elemicin | ~0.4% |
| Isopropyl mysistate | ~4.7% |
| 1,4-methylpentadecanoate | ~3% |
| Isopropyl pamitate | ~2.4% |
| Methyl-9,12-octadecadienoate | ~2.6% |
| Methyl-9,12,16-octadecatrienoate | ~2.1% |
| Linoleic acid | ~6.2% |
| Ethyl linoleate | ~7.4% |
| Tryoctylamine | ~5.7% |

Source : Edwards and Bobby Gene, 1999

In fact, if we use banana skin in NR latex, it will not just help in biodegradability but it will leave our hands soft, cure psoriasis, skin allergies and irritation. These are because it is rich with antioxidants (Gomestic, 2011). According to Shinichi Someya *et al.* (2002), antioxidant that is found in banana is gallocatechin which is isolated using HPLC from banana peel and it shows really active antioxidant activity. In addition, they also found that banana peel contain more gallocatechin (158 mg/100 g dry weight) than