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Utilization of Used Cooking Oil and Cassava Peel as Degradable Bioplastic Film

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Abstract: Plastic product has become a main thing that used in human daily life. Mostly after the plastic are used, it will be a waste. Only small percentage of plastics are recycled and the rest will end up at landfills, rivers and oceans. Normally, plastics can take up to 1000 years to decompose in landfills and some will be burnt. The affect from burning the plastic waste in landfills will cause air pollution. When it burns with food waste, they will produce dioxin and furan. These elements will cause death even in small quantities when human breathe. Another harmful effect of burning plastic waste, is it can damage the ozone layer. Moreover, plastic pollution can affects all living things. At least 100 million marine mammals have died each year because of these plastic pollutions. The main objective of this research is to conduct starch extraction from cassava peels and glycerol extraction from waste cooking oil. It has been achieve during the extraction of 100g cassava peel will yield 3% of starch, while 800ml waste cooking oil yield of 5% only. The best formulation of the bioplastic obtained by controlling the ratio of carrageenan and starch at 2% and 5%. From the physical properties studies which is degradation in water and steam test. Based on the observation of degradation test, when the temperature was at 100ºC the bioplastic degrade within 1.18 minutes and at 20ºC was within 7.33 minutes. For the steam test, only at 100ºC the bioplastic start to degrade within 25 minutes but for other temperature the plastic remains same. As a conclusion cassava starch can be utilized as bioplastic film, because it can dissolve when contact with water and steam. Moreover, glycerine from waste cooking oil can be used as plasticizer.

Keywords: Cassava peels, used cooking oil, bio-plastic

1. Introduction

The Malaysian government create the awareness campaign among the public to minimize the usage of plastic and go to zero plastic used. Malaysian government has encouraged the 1.7 million civil servants to do as it heads towards a zero single-use plastic nation by 2030. In 2011, the domestic trade, Cooperative and Consumerism Ministry has launched a campaign "No Plastic bags on Saturdays". During the decompose process toxic chemical will be released to environment and some cause take place in oxidation. The high demand of plastic used is in food area where the plastic used as packaging and wrapping. Polystyrene plastic is among the most dominant packaging materials in today's society and is not capable of self-decomposition. The material of plastic monomer should pass the food grade and not harmful.

In 2017, around 60% of restaurants and 80% of shopping have implemented the biodegradable plastic bag. Some trades have also opted for cheaper photo-degradable or oxo-biodegradable plastics bag. Photo-degradable plastics disintegrate into smaller pieces when exposed to sunlight, while oxo-biodegradables fragment into smaller pieces and contribute to micro plastics pollution [1]. Malaysia is a global player in the plastic industry with currently about 1,300

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plastic manufacturers. Only 9% of the nine billion tonnes of plastic been recycled. Most ends up in landfills, dumps or in the open environment. Malaysia is a global player in the plastic industry with currently about 1,300 plastic manufacturers. Environmental problems related to plastic waste have become a major problem in Malaysia where it has been ranked as 8th among the top ten countries with mismanaged plastic waste in the world. Plastic pollution is a global problem that needs to be addressed in a sustainable manner.

To reduce the plastic waste and time consume for degradation, this study is to utilize the natural sources from cassava peel and used cooking oil waste by producing bioplastic film. The physical study also be conducted as to identify the characteristic of bioplastic film. Bioplastic film is composting from two main biodegradable materials which is high amount of poly lactic acid (PLA) and glycerine as a natural plasticizer. The PLA and glycerine is produced from waste. The bioplastic film is formulated and produced with minimal used of chemical by considering the principle of green chemistry [2]. In research advantage the special features are 100% self-composting, not harmful to human, environmentally friendly, green product and reduce CO_2 emission. Bioplastic film can be produced as natural resin and thin layer film and not be used as additive material in petroleum based polymer [3].

Most of small or big industry which produce chips from cassava. The cassava will be removed as a waste. To utilize it this research extracted the starch from cassava peels and produce a bioplastic film. In a cutting edge society, oil is regularly utilized for the readiness of nourishment. In this day and age, oil frying strategy is broadly utilized because of the commitment of good taste, alluring shading and better introduction of the nourishment. As this technique turns out to be progressively famous, amassing of waste produced from cooking oil additionally increments. In this way, the utilization of waste vegetable oil rather than refined vegetable oil to create biodiesel is a compelling method to lessen the crude material expense and decrease nourishment deficiencies. Furthermore, utilizing waste vegetable oil could likewise help tackle the issue of waste oil transfer.

2. Materials and Methods

2.1 Sample preparation

The cassava peels were collected from Arrisya Kerepek Ubi Kayu factory which located at Muar. To extract the starch from cassava peels the peels should pass through some pretreatment stage. The peels should be cleaned properly in running tap water with the help of a large basin and the brown colour layer should be removed from the white colour layer. This is because the brown colour layer will produce an unwanted pigment to the starch. Then, chop the peels into small pieces. It is recommended that the preparation and extraction of the starch from the peels should be done in order to emphasize the starch is extracted fresh cassava peels. Firstly, to prepare the oil for glycerol extraction, it should pass some pre-treatment steps which is removal of odour as the beginning. This is compulsory because the oil or the waste cooking oil was collected from a fried chicken stall entitled “Ayam Goreng Pak Chu” which is located at opposite of Pagoh Jaya Speedmart. The oil obtained was used for more than 8 times to fry the chicken. The colour of the oil was dark and it releases an unpleasant smell. The volume obtained was 5 liters.

2.2 Extraction of starch from cassava peels

The cassava peels were dried in oven just to dry out the upper layer moisture. The peels were placed in different beaker and it was filled with water just until the peels completely submerged. Then the mixture was then blended into a homogenized solution. Later the solution was filtered manually to separate the cassava peels cake from solution. Then the filtered cake was blended again to increase the starch yield. The filtered solution was then let sit for few minutes to let the starch to form precipitation. Then the solution was separated from starch by pouring the solution into another beaker. Then the leftover starch was washed several times to purify it. When watery starch was obtained from the cassava peels solution, it was dried in oven at 60 degrees to completely dry the moisture. Then the final yield will be flaky starch and it was grinded into powder.

2.3 Extraction of glycerol from waste cooking oil

To extract glycerin from waste cooking oil, firstly 200ml of methanol was added into a beaker together with 9g of sodium hydroxide (NaOH) or the lye. Then the solution was stirred until all the sodium hydroxide dissolves completely in the methanol. It is a exothermic reaction. In the other hand, 800ml of the filtered waste cooking oil was heated up at 50°C. Then when the temperature reach to 50°C, the methanol sodium hydroxide solution was added to the used cooking oil. Methanol is generally immiscible with the oil, so it will form a layer on top of the oil. To get around that situation strong or vigorous stir will help to solve it. The solution was stirred non-stop for 30 minutes at constant temperature which is at 50°C. That step is called the transesterification step. After 30 minutes the stirring was stopped and the mixture was allowed to settle overnight. After a day the mixture was formed into two layers which is upper layer is biodiesel and second layer is the glycerol. The upper layer which mostly contains biodiesel was separated to another container, after that at the bottom of the beaker there will be left with the messy mix with the gel biodiesel and the glycerol. To remove the gel biodiesel, the glycerin was allowed to settle at the beaker and when the biodiesel float at the top it was easy to scoop away. Then there will be left with the orange crude glycerol mixture. Then it was purified to decolorize it.

2.4 Production of bioplastic film

To produce the bioplastic film, different amount of starch cassava peel is used which is 0.2%, 0.25%, 0.3%, 0.35% and 0.4% by weight of formulation. The amount of glycerin is constants which is 11% by weight in the total formulation. The ingredients were blended until it forms homogenize paste. Then, the mixture was allowed to sit to remove all the bubbles present. The mixture was stirred until all the starch and carrageenan completely diluted in the solution. After that, the mixture was heated up until a thick paste consistency formed and allowed to sit to remove the air bubbles. The moulding process is begin when 80% of air bubbles is removed and poured on a petri dish and placed in dry oven and dried at 60°C for 2 hours.

2.5 Characterization Analysis

A few analyses have been determined to identify which formulation is the acceptable and will undergo the FTIR, tensile test, degradation test and water dissolving test.

3. Results and Discussion

3.1 Tensile test

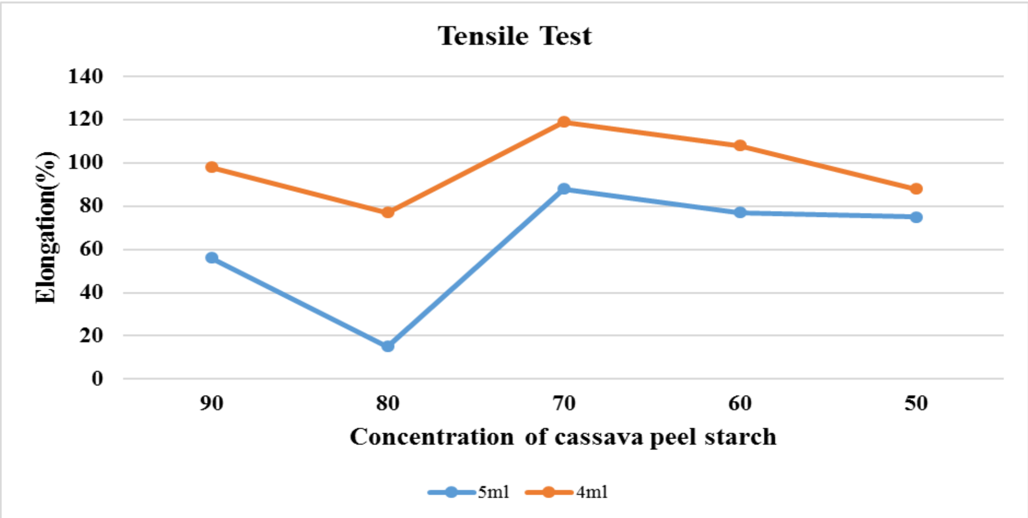

Fig. 1 - Result of elongation

Through the test it was known that when the concentration of cassava peel starch increases or the elongation percentage also decreases, when the concentration of cassava peel starch decreases also will affect the elongation percentage. Cassava peel starch contains natural PLA which act as polymer. Mostly PLA is made up of renewable resources like corn starch or sugar cane. It is natural polymer designed to substitute widely used petroleum based plastics such as Polyethene terephthalate (PTE). This result compares that when the concentration of cassava peel starch increase the tensile strength will decrease. Too much of cassava peel starch as PLA will make the final product hard and easily breakable. From the result above formulation C shows the best elongation percentage (Fig.1).

3.2 Solubility Test

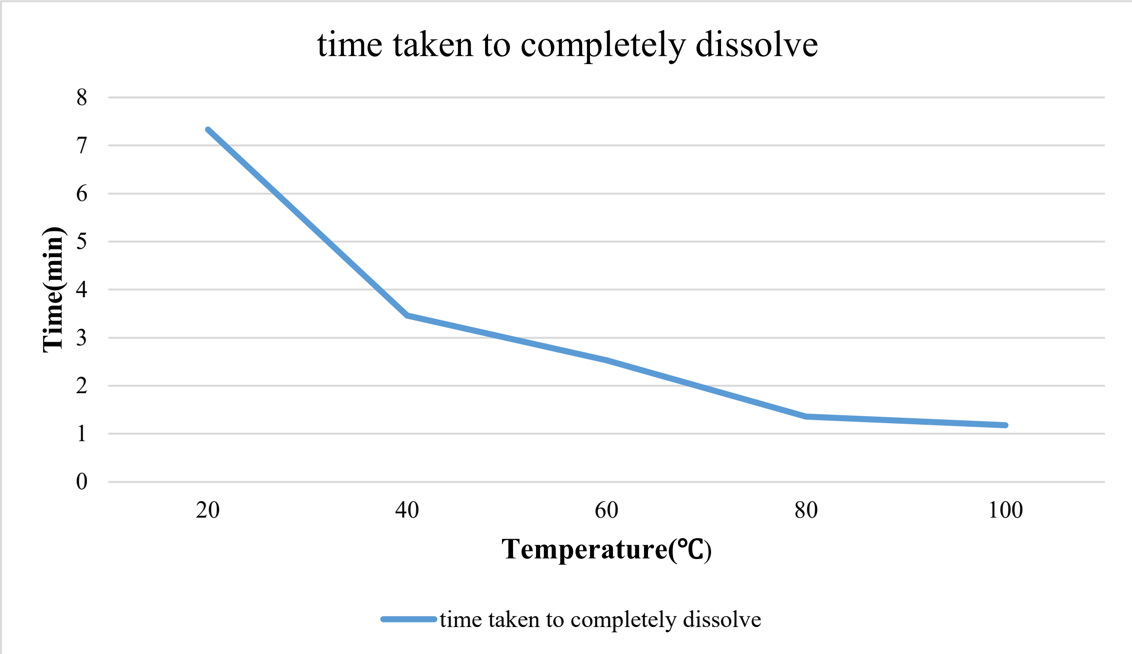

Fig. 2 - Bioplastic film water solubility graph time against temperature

Water solubility for each samples was recorded and observed in the table and graph above. This happens because of the cassava peel starch. Cassava peel starch contains natural PLA in it which will act as polymer bonding to the bio-plastic film. The potential benefit of this PLA is that, starch PLA molecules can be easily triggered or can be breakdown by just adding water to it. This process is well known as hydrolysing. This will make the bioplastic film to solute in the water but other raw material which is the sodium alginate also have the ability to dissolve in water. These raw material provides the bioplastic film the ability to dissolve in water and convenient to the environment. So, based on the result the time taken to the bioplastic to dissolve decreases when the temperature increases (Fig. 2).

3.3 Steam analysis

Table 1 - Effect of steam on the bioplastic film

Sample	Temperature(℃)	Effect of steam on the bioplastic film
A	0	(-)
B	20	(-)
C	40	(-)
D	60	(-)
E	80	(-)
F	100	(/)

**Note: The symbol (-) represents that there is no changes on the bioplastic during the steam test at different temperature. The symbol (/) represents that there is changes on the bioplastic during the steam test.

Based on the observations, after the samples wrapped with bioplastic film it was placed at room temperature to cool completely. And the samples were observed every 5 minutes once to check weather is there got any changes on the bioplastic film or not. The steam from the temperature of 20ºC, 40ºC, 60ºC, and 80 º C didn't not affect the bioplastic film at all. But at 100ºC there was a change occur. At 100ºC the wrapped plastic film tear slightly at the edge of the test tube. From the result, this proved that only high steam affects the bioplastic film, it still can resist until the steam from 80ºC (Table 1).

3.4 Biodegradability test

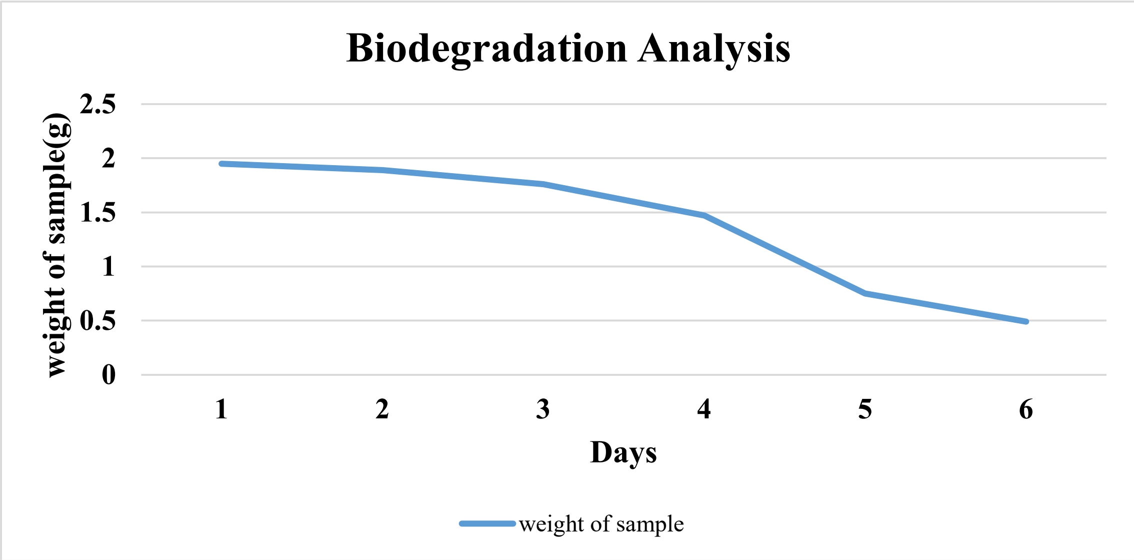

Fig. 3 - Biodegradable analysis

For a polymer to degrade, a main chain with hydrolysable group must be present. Materials that contains amide, urea, or ketone functional group are susceptible to degradation. But in this bioplastic film glycerol and starch plays an important role on biodegradability. Throughout this test, it can be observed that when the days increase the weight of the bioplastic film decreases. The glycerol contains OH group which act as a bond breaker during the degradation process. That is why the plastic started to degrade just in one day after burial. Moreover, for this degradation test the moisture content of the soil has been controlled. This is because if there is moisture present in the soil it will cause the bioplastic to melt in one day. Other than that, another potential benefit of this bioplastic film is it will become a fertilizer after degrade in soil because presence of organic raw materials will convert in fertilizer after they decompose. Moreover, glycerol also can be used as organic fertilizer for growth of plants (Fig. 3).

3.5 FTIR analysis

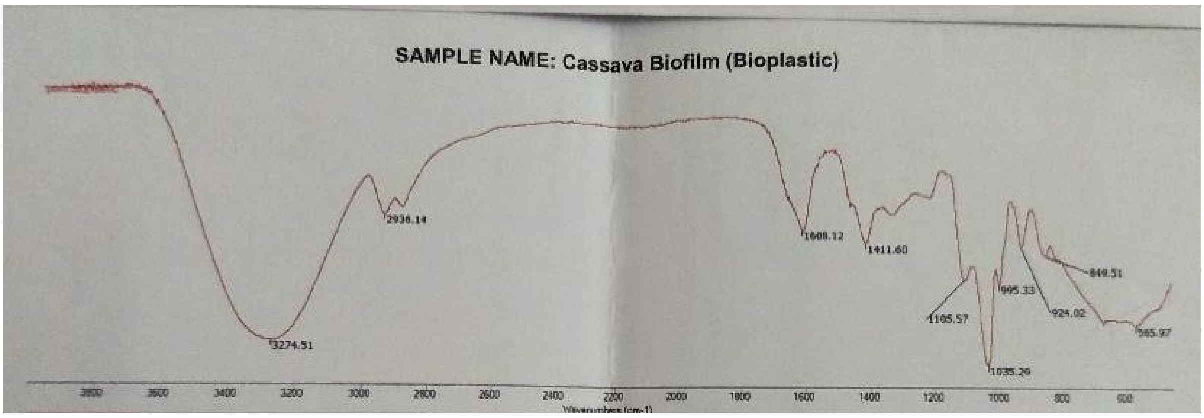

Fig. 4 - FTIR result of Cassava Biofilm and its wavelength of functional group

From the FTIR analysis one of the highest peak obtained was aliphatic tertiary amines and the OH- group. This amine will help the bioplastic film for stretching, because the amine will work as a plasticizer in the bioplastic film. Moreover, tertiary amines are mostly providing toxic properties in normal plastics. Which will provide harmful effect to environment and humans. But the potential benefit of the tertiary amine present in this bioplastic film is, it was derived from natural and edible source which will not harm the environment or humans. This tertiary amine was derived from brown seaweed which is an edible product. Moreover, the polymer that present in the bio-plastic film is the PLA and the functional croup or the monomer is the OH- group and it was successful to identify in the range of 3200 to 3600 throughout the FTIR (Fig. 4).

4. Conclusions

In this work, the bioplastic film has been successfully formulated. The purpose of all the objectives has been successfully achieved. The first objective was to extract starch form cassava peels and extraction of glycerol from waste cooking oil. The extraction of starch was successful because the yielding of the starch was 5g for 100g of peels. The glycerol yielding also was quite high for 800g of waste oil 20g of glycerol was obtained. The glycerol was extracted with the help of methanol and sodium hydroxide to breakdown the glycerol molecule from the fatty acid chain. By combining the starch and glycerol, the bioplastic film was successful to produce. For the analysis the bioplastic film was produced in 5 different concentrations. This was to analyse the elongation test. From this the formulation C shows the best elongation percentage this is because the concentration of starch plays and important role on that. This because the cassava peel starch contains natural PLA which is a strong poly to make the bioplastic film. This pla provides the strength to the plastic for the elongation but it should be in the accurate concentration if too much of pla will harden the bioplastic film and make it to easily broke. Throughout the elongation test the best formulation was chosen for further analysis. Other than that, water solubility analysis gave another confident that this bioplastic film can be easily disposed even though in water. This because the materials used which is the cassava starch natural pla which can be easily breakdown using water. This method is well known as hydrolysing. The addition of glycerol from waste cooking oil to the bioplastic film to make the bioplastic film easily degrade in soil. Glycerol can make the polymer bonding to breakdown throughout the degradation process Then in the steam analysis the only at 100ºC the bioplastic film starts to tear. From this the bioplastic film is suitable for rap food under hot temperature up to 80ºC. In conclusion, this bioplastic film production will give a positive impact to the environment without harming it. Plus this bioplastic film also is easy and convenient to wrap all king of food. This bioplastic film also can be claims as edible because all the materials used are food grade materials. At last, this bioplastic film can replace the cling wrap present in the market and reduce the waste which is sourced from the cling wrap.

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