Chemical Properties of Thermoplastic Starch from Tacca Leonpetaloides

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***Abstract*— Environmental problem regarding plastic waste has always posed a threat to our environment. Conventional plastic are unable to be decompose biologically as it chemical structure are consist of polymer bond which are very stable and strong. Thus, the ideas of Thermoplastic starch are being suggested to be research in solving the environmental issue. The suggested starch being used in this research is Tacca Leonpetaloides. Tacca Leonpetaloides can be obtained commonly in the South East Asia region. Thus, the research are more focusing on the usage of Tacca starch into producing Thermoplastic Starch which are different from the conventional plastic used in term of chemical properties. Thus, these researches are focusing on the thermal decomposition. The component of the Thermoplastic Starch used is made from the combination of Polypropylene with Tacca Starch powder and produce it in film condition. From the study , the amount of starch used in the TPS film affect the performance of the thermal decomposition as the amount of starch increase , the thermal decomposition are much more easier to be decomposed whereas the polypropylene are much more hard to be decomposed respectively. The water absorption capabilities of Thermoplastic are the highest at starch 20% to polypropylene of the thermoplastic ratio with 0.263% of weight increase after being immerse in water for 72 hour.**

I. INTRODUCTION

Conventional plastic has been posed an environmental problem nowadays due to it unable to be decomposed biologically. Unlike conventional plastic, thermoplastic starch able to be integrated and decomposed faster when compared with each other. Conventional plastic take too long time to be decomposed and some it take around hundreds of year to be decomposed naturally which posed environmental problem to the environment. Thus, the other alternative to solve this problem is to propose a thermoplastic starch which can be biologically decomposed. In this research , we are focusing in produce thermoplastic starch which are made from 2 material which is polypropylene with the Tacca Leonpetaloides starch as it source are abundant in the South East Asia region. Within the area of the Southeast Asia, Africa, Northern Australia, New Guinea are the place where Tacca Leontopetaloides can be obtained natively. It is a species of flower which come from the yam family of Taccaceae. Tacca Leontopetaloides are commonly known as Polynesian Arrowroot (Vu, Le, Vo, Nguyen, & Nguyen, 2017). This plant is edible and usually eats in raw or roasted condition. The other way that this plant can be eaten is to extract the starch within it because this plant is rich with starch nutrient. Not only limited to be used as food but this plant also is popular in the usage of traditional medicine use for the native people. The roots of the plant which is being squeezed will then be used to rinse the injured to the eyes. Thus, this research is suggesting inducing the starch from the Tacca Leontopetaloides to be used in the synthesis of thermoplastic Starch. The usage of TPS needs to be commercializing as it is different from the conventional plastics. Plastics are commonly produced from the petrochemical-based. Plastics are being used in our daily life for packaging, manufacturing, itemization, tools and etc. However, plastics are not biodegradable and this has cause serious problem to the environment. The reason that plastics are not easily decompose is because plastics are belong to the high polymer chemical family which consist of long chain of carbon atoms which plastic very stable and not easily break down into a simpler component. Thus, most of the plastic take around 50, 100 and some even take more than 500 years to be decomposed(Rick Leblanc, 2018). Plastic also affect the marine life quality(Nafchi, Moradpour, Saeidi, & Alias, 2013). Thermoplastic Starch is one of alternative to help in providing biodegradable plastic to minimize the amount of damage done to the environment. The purpose of this research is to research on the thermal decomposition of the thermoplastic starch at certain temperature and it water absorption capability when being exposed in water for 72 hours.

II. METHODOLOGY

A. Thermoplastic Film Sample Preparation

Thermoplastic Film Sample was prepared by dissolving the Tacca Leontopetaloides starch in distilled water in order to create the starch solution. The starch solution must be heated under the constant stirring for 30 minutes. The solution also must be constantly heated until between the temperature of 85 to 90. The plasticized plastic later will be pour onto the polyacrylic plate and will be left to be dried using the ventilated oven under the temperature of 45^{o}C until the constant weight is achieved which mark the Thermoplastic Film is fully plasticize and lose the moisture content within it. After that, the plasticize dried film will be peeled from the polyacrylic plate and will be milled using a two-roll mill machine. The steps will be repeated with the weight ratio of starch and polypropylene 8:2.

B. TGA

The function of Thermogravimetric analysis is to analyze the thermal properties of the sample. The sample will be decompose

at certain temperature depend on their thermal properties resistance. The sample will be weight before the heating process start from the room temperature of 25ºC into the 500ºC with the rate of 5ºC/min in an ambient air environment. The decomposition of the thermoplastic starch will be recorded according to their weight loss.

C. Water Absorption Analysis

The water absorption test will be conducted by immersing Thermoplastic Starch film with water under 72 hour long. The sample needs to be weighed before being immerse with water. After 72 hour has pass, the sample will need to be dried to ensure moisture outer layer of the sample will be extracted. The sample will then be weighed again and the data will be analyses.

III. RESULTS AND DISCUSSION

A. Thermal Decomposition

Thermal decomposition Analysis can be determined from both DCS and TGA equipment respectively. From TGA analysis, TP1 and TP2 show similar pattern of rate of decomposition since both of are thermoplastic starch. Both of the sample show degradation at the temperature of 70ºC to 90ºC due to moisture loss content within the sample(Ismail, Mansor, Majeed, & Man, 2016). Next the weights of the sample start to decrease once it reach the temperature of between 220ºC and 360ºC due to the decomposition of starch within the sample(Mano, Koniarova, Reis, Azure, & Gualtar, n.d.).The weight of the sample once again will be decrease once the temperature increase between 380ºC to 500ºC due to the decomposition of polypropylene. From the data , we can see that the thermal decomposition of TP1 and TP2 start to decompose at the highest rate at the temperature of 220ºC since they had the starch content within it and compare to the TP3 which start to degrade thermally at the temperature of 390ºC due to strong chemical bond between the polymer which require high heat energy to break it. The starch in sample TP1 and TP2 are completely degraded thermally at the temperature of 360ºC. In term of thermal resistance, we can see TP3 have high thermal resistance compared to TP1 and TP2. When compare the thermal resistance between the thermoplastic starch , TP1 and TP2 degradation are higher at 83.21% weight loss and 82.80% weight lose respectively. Thus, thermal degradation of TP1 is lower than TP2.

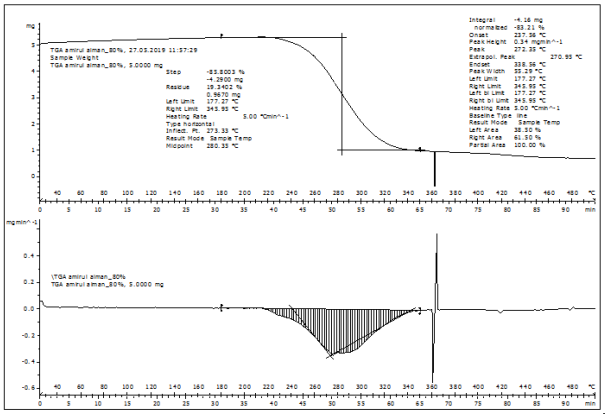

Figure 1.1 Thermogravimetric Analysis of 80% Polypropylene TP1

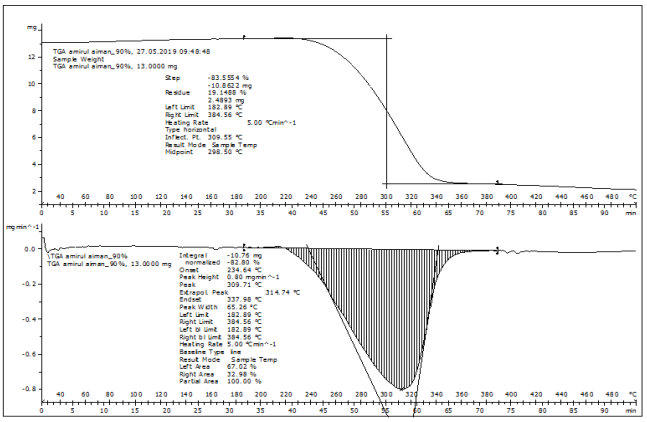

Figure 1.2: Thermogravimetric Analysis of 90% Polypropylene TP2

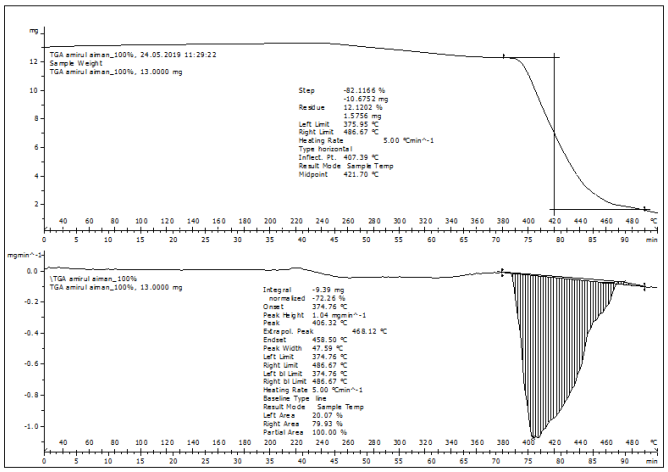

Figure 1.3 Thermogravimetric Analysis of 100% Polypropylene TP3

B. Water Absorption Analysis

Water absorption analysis shows the capability of the thermoplastic to absorb water within in the period of 72 hour after being immersed in water. From the result, we can see the trend of the data show that no water absorption for the TP1 as it is pure polymer, while show increase in water absorption as the amount of starch percentage increase. From the analysis, we can deduce that since starch has hydrophilic, it able to absorb water after being immerse in water unlike polymer which are highly stable and non-hydrophilic. The disadvantages of hydrophilic properties from starch are the hydrophilic properties which show a high forte toward the water affinity. (Montero, Rico, Rodríguez-Llamazares, Barral, & Bouza, 2017) The higher the amount of starch , the better the interaction between the hydroxyl group to be engage with the water(Amin, Sauid, Musa, & Ku Hamid, 2017). Polymer does not engage well with the water as it has a stable chemical composition. The amount of polymer used does affect the capability of film to absorb water(Pervaiz, Oakley, & Sain, 2014). As we can see in TP3, the increase in percentage after being immerse in water is zero unlike the TP1 and TP2. TP1 has a higher increase in weight percentage compared to TP2. One of the reason is due to the percentage amount polymer within the Thermoplastic Starch decrease and the amount of starch within it(Ismail, Mansor, & Man, 2017).

Table 1.1 Data on Water Absorption Analysis

Type of	Weight Before	Weight after	Increase in

Film	being immerse in water,Mo	being immerse in water,Mx	percentage after being immerse in water,X
TP1 (80%)	380.5 mg	381.5 mg	0.263
TP2 (90%)	380.5 mg	381.1 mg	0.158
TP3 (100%)	228.8 mg	228.8 mg	0.000

$$X = \frac{Mx - Mo \times 100\%}{Mo}$$

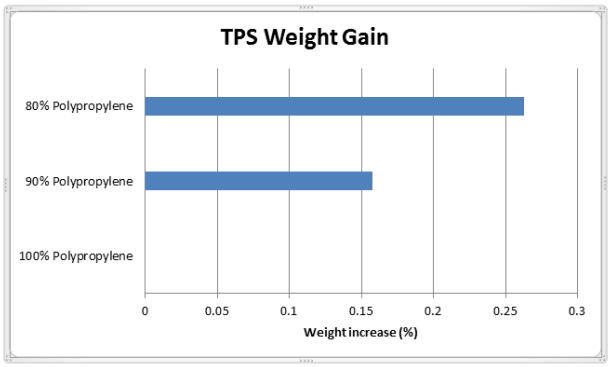

Figure 1.3: Amount of weight gain % after being immerse in water for 72 hour

IV. Conclusion

Thermal degradation analysis of thermoplastic starch from Tacca Leonpetaloides can be further being investigated. It seems the thermal behavior of thermoplastic starch is being affected by the amount percentage of starch within a thermoplastic starch. In term of water absorption analysis, thermoplastic with higher amount of starch are more capable in absorb more water due to it hydrophilic properties of starch. The thermal resistance of the Thermoplastic Starch from Tacca starch thermal degradation are start in high temperature around 220°C to 360°C and stable to be used in daily life. In term of thermal resistance between the thermoplastic , we can see the higher the amount of starch in the thermoplastic the lower it thermal resistance capability. From this research also , we can see that starch from Tacca Leonpetaloides are suitable plasticizer and can be used for the production of Thermoplastic Starch in the future due to it abundance resource and capabilities. The suitability of the polypropylene to be synthesized with the Tacca starch can be done and be proposed for future research reference.

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