The effect of starch-garlic powder ratio on degradation rate of Gadung starch bioplastic

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Abstract. Bioplastic is one of the solutions for environmental problems caused by plastics waste. Utilization of toxic gadung starch in the manufacturing of bioplastic would be as an alternative, due to gadung bulb has high starch content, and it is still not used optimally. This research aimed to learn about the using of gadung starch-mixed with garlic powder of making biodegradable plastic packaging. Also, to observe the duration of degradation, as a level of biodegradability of plastic film produced. The method used making this bioplastic was casting method. The variables used in this study were the ratios of starch and powdered garlic, were 10:0; 8:2; 6:4, and the concentration of garlic powder were 2%; 4%; 6%; and 8 %. The degradation test was done by soil burial test. The results of the soil burial test shown that the film was more rapidly degraded at ratio of 6: 4 compared to the ratio of 8: 2 and 10: 0. The results shown that bioplastic at the starch-garlic powder ratio of 10: 0 was decomposed in 21 days, at the the ratio of 8:2 was 15 days, while at the ratio of 6:4, the plastic film was degraded in the 11 days.

1. Introduction

Synthetic plastic waste nowadays still has been being one of the contributor of environmental pollution in Indonesia, even the world. Synthetic plastics are undegraded thus they would pollute the environment in hundreds even thousands years. Synthetic plastic is made by petroleum, which it is a non-renewable resource [1]. These conditions lead to the using of synthetic plastic packaging would not be used in a long time. One of the solution to this problem is, replacing the raw material of the conventional plastic into a material which easily degraded in nature, called bioplastic. In the recent years for the development of bioplastics from renewable resources to maintain sustainable development of economic and ecological attractive technology [2].

As the plant tuber, gadung has starch in a huge quantities. But some researches reported that the toxic compounds in gadung would cause serious health complications. Among types of bulbs, gadung is one of the unutilized due to alkaloids toxic called dioscorin [3]. Therefore, in this study, the use of gadung starch in the bioplastic manufacturing would be an added value of gadung starch.

A lot of types of bioplastic have different base of material, ranging from starch, cellulose and polyester. The manufacturing of bioplastic made from starch is the favorite choice due to easy and simple to do. Starch is used as a cheap biopolymer that is totally biodegradable, ultimately up to

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carbon dioxide and water [4]. The previous researches which related to this research topic were conducted, based Ganyong Starch [5], rice starch [6] Research conducted by [7] which studied the effect of starch weight and volume of plasticizer on potato starch bioplastic film.

In this research, gadung starch was used due to has a fairly large content of starch compared to the starch from other types of plants bulbs. In addition, gadung bulbs are still rarely consumed by people caused by their toxicity, so this research would increase a value for gadung starch.

This research aimed to learn about the using of gadung starch-mixed with garlic powder, in the process of making biodegradable plastic packaging. Also, to observe the duration of degradation (time needed), as a level of biodegradability of plastic film produced.

2. Materials and Methods
2.1 Procedure
The main material used in this study were gadung starch and garlic powder. Other material used were liquid glycerol, glacial acetic acid, and aquadest. The apparatus used in this study were 300 ml and 100 ml baker glass, 100 ml and 10 ml measuring cup, blender, dropper, spatula, funnel, magnetic stirrer, hot plate (Cimarex), thermometer, glass mold and biodegradation testing container.

2.2 Methods
The gadung bulbs were peeled, then washed to remove toxins and sap from the tubers until clean. The washed bulb was blended to get the slurry. Then the slurry was filtered using a filter cloth and the powder of starch was filtered and the water was removed. The drying of starch was done using sunlight for 1-2 days. Starch was obtained in the form of fine powder.

The process of making plastic film from starch and garlic powder was made with two steps. First step, starch solution was made by mixing starch and aquadest, with 10% (w/v) starch. Garlic solution was made by mixing glacial acetic acid and garlic powder, respectively were 2%, 4%, 6%, and 8%. Both solutions were mixed and stirred using a magnetic stirrer until reach the temperature of 75°C. Then glycerol was added as much as 70% (w/w) of the starch weight used. After the homogeneous was reached, the mixture was poured into a baker glass, then dried for 24 hours at room temperature.

Biodegradation test was done by using soil burial test method. 2 x 2 cm of sample was buried in the soil and the physical changes of plastic was observed every day until the plastic was degraded perfectly. The duration of the decomposition was recorded.

3. Results and Discussion
The soil burial test process or commonly called biodegradable test is needed to study the level of biodegradability of plastic film produced. Bioplastic biodegradation analysis was done through visual film observation. The results shown that the resulting bioplastic films were clearly biodegradable. These results in accordance with biodegradable plastic standards that should decomposed less than 180 days (ASTM D 6400 and EN 13432).

| Ratio of 10:0 |
|--------------|
| Day 1        | Day 3        | Day 5        | Day 7        | Day 9        | Day 11       |
| ![Image](image1.png) | ![Image](image2.png) | ![Image](image3.png) | ![Image](image4.png) | ![Image](image5.png) | ![Image](image6.png) |
| Day 13       | Day 15       | Day 17       | Day 19       | Day 21       |              |
Figure 1. The duration of degradation of bioplastic film at gadung starch-garlic powder ratio of 10: 0.

Figure 1 shown that the bioplastic at the starch-garlic powder ratio of 10: 0 was decomposed in 21 days. The pictures below show the durations of bioplastic degradation at 8: 2 and 6: 4 ratios.
The effect of garlic powder shown that the increasing of the rate of degradation, which shown that on ratio of 6: 4, the plastic film was degraded in the 11 days. The addition of onion powder on the film would increase the number of OH-group. Increasing the number of OH-group, would cause more hydrophilicity and would easier to bind water molecules contained in the soil, which would cause increasing of free volume of the film so the contact surface area between plastic molecules and degradation enzymes would be increased.

The results of the soil burial test in Figure 2.a and 2.b show that at the ratio of starch-garlic powder film at 6: 4 ratio had faster degradation rather than the ratio of 8: 2 and 10: 0. The duration of degradation at the concentration ratio of 6: 4 i.e. 2%, 4%, 6%, and 8% respectively were 15 days, 13 days, 11 days, and also 11 days. While the duration of degradation at the ratio of 8: 2, with the same concentrations, respectively were 17 days, 17 days, 15 days and 15 days.

4. Conclusions

Bioplastics film at garlic powder ratio of 10: 0 was degraded perfectly at day 21. The duration of bioplastic degradation at starch-garlic powder ratio of 8:2 and garlic concentration of 2%, 4%, 6%, and 8% respectively were 17 days, 17 days, 15 days, and 15 days, while of bioplastic at starch-garlic powder ratio of 6:4 and garlic concentration of 2%, 4%, 6%, and 8% respectively were 15 days, 13 days, 11 days, and 11 days. All of duration of degradation resulted were indicate that gadung bioplastic was certainly safe for the environment.

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