THE EFFECT OF ADDITIONING SHRIMP SHELL FLOUR (Fenneropenaeus Merguiensis de Man) ON THE BIOPLASTIC CHARACTERISTICS OF PURPLE UWI STARCH (Dioscorea alata)

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ABSTRACT – This research was conducted to determine the effect of adding shrimp shell flour on the bioplastic characteristics of uwi starch and to determine the best addition of shrimp shell flour on the characteristics of the bioplastic produced. This research used a Completely Randomized Design (CRD) with treatment adding shrimp shell flour consisting of 5 levels (0 gr, 0.5 gr, 1 gr, 1.5 gr and 2 gr) each treatment was repeated 4 times so that 20 units were obtained test. Test parameters include tensile strength, elongation, water resistance, thickness, water vapor transmission rate and biodegradation. The data obtained were analyzed statistically using analysis of variance at the 1% and 5% levels. If the difference is significant then the Duncan's New Multiple Range Test (DMRT) will be continued at the 5% level. Biodegrability data is analyzed descriptively by displaying research data presented in the form of images. The results of the research showed that the effect of adding jerbung shrimp shell flour and without adding shrimp shell flour had a significant effect on the values of Thickness, Tensile Strength, Percent Elongation, but had no significant effect on the value of Water Resistance and the value of Water Vapor Transmission Rate (WVTR). The increasing use of shrimp shell flour can accelerate the biodegradability of bioplastics. The addition of shrimp shell flour which produces the best bioplastic is the addition of 2 grams of shrimp shell flour.

Keywords - ***Bioplastics, Shrimp shell flour, Uwi starch***

1. INTRODUCTION

The increase in population will increase the use of natural resources and energy on a large scale which results in the creation of very large amounts of waste which accumulates in the surrounding environment. The increasing use of plastic along with the increase in the human population is not balanced with the handling of the waste produced, so the negative impacts that arise are also very large, including synthetic plastic which has the potential to pollute the environment. The reason is, synthetic plastic is difficult to decompose in nature. Apart from that, if burned, plastic will produce substances that are dangerous to human health, where the smoke produced contains toxic gases such as HCN (Hydrogen Cyanide) and CO (Carbon Monoxide), resulting in air pollution and long-term impacts such as warming. global (Borghei et al., 2010).

The negative impact of using synthetic plastic has encouraged researchers to make plastic that can decompose naturally which is called bioplastic or biodegradable plastic. According to (Waldi, 2007), the use of plastic base materials that can be decomposed naturally by microorganisms continues to be carried out to reduce environmental problems caused by non-organic waste, especially plastic waste.

Bioplastics are plastics that can be used like ordinary plastics which use basic materials available in nature such as starch, vegetable oils and microbiota so that they can be broken down by microorganisms in a short time, therefore bioplastics can be said to be environmentally friendly plastics. So that plastic is not harmful to the ecosystem, making bioplastic requires at least three main parts, namely starch, plasticizer and chitin. Starch is one of the most abundant normal polymers in nature and has easily destroyed properties, good mechanical properties and very affordable costs economically, therefore starch polymers have been widely explored and created to produce plastic that is not harmful to the ecosystem to replace plastic. Synthetic materials are widely used today.

According to (Hapsari, 2014) cassava tubers have a starch content of 75.6 – 84.3%. However, starch, which is mostly hydrophilic, greatly influences the stability and mechanical properties of the resulting biogradable film so that the plastic has low resistance to water and is easily damaged. Therefore, to increase the physical value and function of biodegradable film, materials containing chitin must be added (Nahwi, 2016).

Shrimp waste contains good nutrition, namely 53.47% protein, 6.65% fat, 17.28% water, 7.72% ash and 14.61% chitin. Shrimp waste comes from the heads, shells and tails of shrimp. This part contains chemical compounds, namely protein, fat, calcium, carbonate, ash and chitin (Rasyidi Fachry & Sartika, 2012).

However, because chitin is a material that is stiff and hard, a plasticizer in the form of glycerol is needed so that the biodegradable film sheet becomes more flexible, prevents cracking, increases elasticity, and maintains the film's resistance to gas and water vapor so that it remains intact (Nahwi, 2016).

This research aims to determine the effect of adding shrimp shell flour on tensile strength, elongation, water resistance, thickness, water vapor transmission rate and biodegradation of the resulting bioplastics as well as to determine the best addition of shrimp shell flour on the characteristics of the resulting bioplastics.

2. RESEARCH METHODS

2.1 Materials and Tools

The materials used in this research include uwi starch, shrimp shell flour, acetic acid (CH3COOH), glycerol, distilled water, NaCl, and CaCl.

The tools used in this research include beakers, stirring rods, 100°C thermometers, dropper pipettes, sieves, spatulas, cutters, magnetic stirrers, hotplates, blenders, flexi glass molds measuring 20 x 20 cm, tensile strength tools, incubation tools , digital balance, and screw micrometer.

2.2 Implementation of Research

2.2.1 Experimental design

This research was carried out using a completely randomized design (CRD) with the treatment of adding shrimp shell flour consisting of 5 treatment levels with 4 repetitions so that 20 experimental units were obtained. The treatments used are:

Table 1. Composition of materials for making bioplastics from jerbung shrimp waste flour and purple uwi starch

Treatment	Uwi strach	shrimp shell flour	Gliserol	5% acetic acid solution	Aquades
P0	5 gram	0 gram	2 ml	2 ml	141 ml
P1	4,5 gram	0, 5 gram	2 ml	2 ml	141 ml
P2	4 gram	1 gram	2 ml	2 ml	141 ml
P3	3,5 gram	1,5 gram	2 ml	2 ml	141 ml
P4	3 gram	2 gram	2 ml	2 ml	141 ml

2.2.2 Uwi starch extraction (Ulyarti et al., 2016)

Uwi are cleaned, washed and steamed for five minutes at 100°C before being sliced into 2 to 3 millimeter thicknesses. After that, the uwi slices were washed three times with water and soaked for 30 minutes in a NaCl solution containing 15% salt. The uwi pieces were ground in a blender with the addition of 1:2 water (uwi: water), then the results of the mash were separated using a 200 mesh sieve. The precipitate was left for 6 hours, then the precipitate was washed using water until the correct supernatant was obtained. The starch precipitate was dried in an oven at 50°C for 6 hours. The dried starch was sieved using a 60-section sieve, put into a closed container and stored at room temperature.

2.2.3 Making shrimp shell flour (Pratiwi, 2017)

The shrimp shell used is a type of jerbung shrimp in good condition with the characteristics of not having a bad smell, having a hard texture and still fresh, then the shrimp shell is washed using running water with the aim of getting clean shrimp shells (no dirt). The shrimp shells that have been cleaned are then soaked using a 5% acetic acid solution. The acetic acid soaking time was 1 hour. The soaked shrimp shells are dried in the oven at 110-120°C for approximately one hour. After the drying process is complete, the size reduction process is carried out using a blender until smooth and then sifted with a 100 mesh sieve.

2.2.4 Dilution of acetic acid (CH3COOH) 5%

5% acetic acid is made by pouring 20 ml of 25% acetic acid into a 100 ml measuring cup, then adding 80 ml of distilled water to the measuring cup. Then the solution is homogenized.

2.2.5 Preparation of starch solution.

Make a starch solution by weighing 5, 4.5, 4, 3.5 and 3 grams of uwi starch, then dissolving it in 141 ml of distilled water in a beaker and stirring until it becomes like milk.

2.2.6 Making bioplastic solutions (Pradeep et al., 2022)

The bioplastic solution was made by mixing the starch solution with 0 gr, 0.5 gr, 1 gr, 1.5 gr and 2 gr shrimp shell flour (0 gr was done without adding shrimp shell flour). Then 2 ml of 5% CH_3COOH solution and 2 ml of glycerol were added. After that, the solution was homogenized using a magnetic stirrer at a temperature of ± 100°C until the mixture became semi-solid.

2.2.7 Bioplastic printing (Made Heni Epriyanti et al., 2016)

The film mixture is poured into a glass mold measuring 20 cm x 20 cm. Next, it was dried using an incubator at a temperature of 50°C for 24 hours. After that, the mold is removed from the oven and cooled to room temperature. The film formed is peeled from the mold and then stored in an airtight container. Furthermore, the characteristic tests include tests for tensile strength, percent elongation, thickness, water resistance, wvtr, and biodegrability.

2.3 Analysis of Research Parameters

2.3.1 Tensile strength test (*JIS Z 1707: 2019, n.d.)*

The tensile strength test was carried out by slicing a sample measuring 2 x 10 cm, then attaching it with a clamp measuring 1.5 cm horizontally on both sides. Tensile strength is determined by looking at the maximum load when the bioplastic sheet breaks. This test was carried out 4 times. To calculate it, use the following formula:

$$Ts = \frac{\mathrm{Ft}}{Wt} \text{ x } 15 \qquad \text{pers. 1}$$

Information :
Ts = Tensile force (N/15 mm in widht)
Ft = Maksimum force (N)
Wt = Width of test piece (mm)

2.3.2 Test percent elongation (Elongasi)

The percent elongation test is carried out to calculate the elongation of the bioplastic, when the bioplastic sheet breaks. This test was carried out 4 times. The elongation percentage is calculated using the following equation:

$$\varepsilon \frac{= (\mathrm{L}-\mathrm{L0})}{L0} \text{ x } 100 \qquad \text{pers. 2}$$

Information :
Ɛ = Strain (%)
L = Increase in length (mm)
Lo = Length at first (mm)

2.3.3 Water resistance test (*Natalia et al., 2019*)

The method used for the water resistance test (swelling) is based on the method used by Lazuardi and Cahyaningrum (2013). Bioplastic samples were cut into 2x2 cm pieces and weighed first (W0). After that, the sample is placed into a measuring cup filled with distilled water. The sample is soaked for 20 minutes, after 20 minutes the water on the surface is removed with a tissue, and the sample is weighed once again to determine the final weight (W). The percentage of plastic resistance to water can be calculated using the equation:

$$\text{Water absorption } \% = \frac{(\mathrm{W}-\mathrm{Wo})}{Wo} \text{ x } 100\%$$

Information :
Wo = Dry sample weight (gr)
W = Sample weight after soaking in water (gr)

Plastic water resistance = 100% - percent of water absorbed pers. 3

2.3.4 Thickness Test

The thickness test was carried out by calculating the thickness of the bioplastic using a micrometer screw. Each corner and center of the bioplastic are five locations where bioplastic film measurements are taken. The thickness value is obtained from the average of the estimation results. This test was carried out 4 times.

$$\text{Average thickness} = \frac{\text{point 1+point 2+point 3+point 4+point 5}}{5} \qquad \text{pers. 4}$$

2.3.5 WVTR (Water Vapor Transmission Rate) (*Dewi et al., 2021)*

Film is used to cover a test tube containing 5 grams of calcium chloride. The weight of the tube is then measured. The reaction tube was placed in a desiccator which was saturated using saturated sodium chloride (RH 75%). Conditioned at room temperature for 24 hours. The final weight of the sample was weighed and calculated using the formula:

$$WVTR = (W - W0)/(t \times A) \qquad \text{pers. 5}$$

Information :
W0 = Initial weight (gr)
W = Final weight after 24 hours (gr)
T = Time (24 jam)
A = The area of the film (m2)

2.3.6 Biodegrability test (*Fibriyani, 2017)*

The biodegradability test was carried out to determine the time it takes for a plastic film sample to degrade. The biodegradability test chosen is controlling soil microorganisms as aids in the degradation process or what is called the soil burial test technique (Subowo and Pujiastuti, 2003) in (Fibriyani, 2017). Samples measuring 2 x 2 cm2 were placed and planted in containers filled with soil, the samples were left exposed to open air without being covered with glass. Observations on the samples were carried out once a day until the samples experienced complete degradation.

2.4 Data Analysis

The data obtained were analyzed statistically using analysis of variance at the 1% and 5% levels. If the difference is significant then the Duncan's New Multiple Range Test (DMRT) will be continued at the 5% level. Biodegrability data is analyzed descriptively by displaying research data presented in the form of images.

3. RESULTS AND DISCUSSION

3.1 Product Description

Bioplastics or biodegradable plastics are plastics that can be used like ordinary plastics, but can be broken down by microorganisms which then become water and carbon dioxide gas after they are used up and thrown into the atmosphere. Biodegradable plastic is plastic that is not harmful to the ecosystem because it can be returned to nature (IBAW, 2005). The following picture of bioplastic can be seen in **figure 1**.

P0 **P1** **P2** **P3** **P4**

Figure 1. Bioplastic with the addition of shrimp shell flour

3.2 Discussion of Parameters

Table 2. Characteristics of uwi starch bioplastic with the addition of shrimp shell flour

Treatment	Tensile strength (Mpa)	Percent elongation (%)	Water resistance (%)	Thickness (mm)	WVTR (g/m^2.24 hours)	Biodegrability (day)
P0	4.16±0.82^{a}	12.32±4.84^{c}	58.33±33.58	0.135±0,009^{a}	173.83±280.47	34
P1	4.34±0.92^{a}	8.67±1.17^{b}	59.52±17.60	0.142±0,005^{a}	59.71±12.54	32
P2	4.38±0.36^{a}	5.05±1.01^{a}	65.35±19.28	0.171±0,008^{b}	59.71±22.67	30
P3	6.37±0.83^{b}	4.10±0.77^{a}	68.10±9.87	0.1715±0,008^{b}	62.36±23.88	12
P4	6.41±1.57^{b}	3.79±0.66^{a}	74.60±12.02	0.1815±0,018^{b}	50.42±29.55	10

Information : Numbers followed by the same lowercase letter in the same column indicate that they are not significantly different at the 5% level according to the DMRT test.

3.2.1 Tensile Strength

Based on the data in **table 1**, the average value of tensile strength shows that the addition of 0.5 grams of shrimp shell flour is 4.34 Mpa up to 2 grams of 6.41 Mpa increases as the amount of shrimp shell flour increases. Bioplastic without the addition of shrimp shell flour has the lowest average tensile strength value, namely 4.16 Mpa. The addition of shrimp shell flour can increase the tensile strength of bioplastics. The more shrimp shell flour added, the tensile strength of the bioplastic will increase. Apart from that, if the use of shrimp shell flour is too high it will reduce the stiffness value because the chitin content in shrimp shells has a linear polymer chain structure. Where the ability of the linear chain structure to arrange ordered polymer molecules results in the formation of a crystalline phase. The crystalline phase can provide strength, firmness and hardness so that it can make the plastic layer break more easily (Yuana Elly Agustin, 2016).

The tensile strength results show that all treatments have met the standards according to JIS 2019 (Japanesse Industrial Standard), namely at grade 5, namely <25 Mpa.

In this study, tensile strength values were obtained ranging from 4.16 - 6.41 MPa, this value is lower than research by Irfan Indriyanto (2014) concerning the Effect of Adding Chitosan on the Characteristics of Aloe Vera Pectin Biodegradable Plastic, the highest tensile strength value when adding chitosan is the highest, namely 20 ml is 12.06 Mpa, it can be seen that the greater the chitosan concentration, the greater the tensile strength value. These results show that chitosan can increase the tensile strength value of biodegradable plastic. This is because the greater the concentration of chitosan, the more hydrogen bonds there are in bioplastics, so the chemical bonds are stronger and more difficult to break because it requires a large amount of energy to break these bonds. The elongation value becomes smaller as the chitosan concentration increases, due to the decreasing bond distance between the intermoleculars (Sanjaya and Tyas; (2008) in (Indriyanto et al., 2014).

3.2.2 Percent Elongation

In **table 1** it can be seen that the addition of shrimp shell flour has an effect on the resulting elongation value, the higher the addition of shrimp shell flour, the lower the elongation value, the highest elongation value is for bioplastic without the use of shrimp shell flour with a value of 12.32%, and the lowest value in bioplastics using 2 grams of shrimp shell flour with a value of 3.79%. The average value of percent elongation shows that the addition of 0.5 grams of shrimp shell flour was 8.67% up to 2 grams of 3.79% and decreased as the amount of shrimp shell flour increased. The analysis results show that the elongation value becomes smaller as the amount of shrimp shell flour increases due to the decrease in the intermolecular bond distance (Sanjaya and Tyas, 2008).

The results of the elongation analysis show that the elongation value ranges from 3.79% - 12.32%, where the highest value is found in bioplastic without the addition of shrimp shell flour with a value of 12.32%. The elongation value results show that all treatments meet the standards according to JIS 2019 (Japanesse Industrial Standard) which is at grade 5, namely <20 Mpa.

The magnitude of hydrogen interactions in shrimp shell flour, both between molecules and intra molecules, is influenced by the addition of shrimp shell flour. Apart from that, the chitin content in shrimp shell flour has a linear polymer chain structure, where the linear chain structure will generally form a crystalline phase because it is able to organize the required polymer molecules. The crystalline phase can provide strength, stiffness and hardness to bioplastic films, but also makes them more brittle so they break easily. In accordance with this hypothesis, the exploration results show a tendency for tensile strength values to increase and percent elongation to decrease along with increasing shrimp shell flour. Glycerol, which functions as a plasticizer, will be located between the biopolymer chains so that the distance between shrimp shell flour and starch will increase. This reduces the hydrogen bonds between shrimp shell flour - starch and is replaced by hydrogen interactions between shrimp shell flour - glycerol and glycerol – starch (Yuana Elly Agustin, 2016).

The research results obtained are in line with research by Ririn Dwi Eristina (2018), regarding the Effect of Adding Chitosan on the Mechanical Properties of Cassava Starch Bioplastics with Glycerol and Zinc Oxide (ZNO) Plasticizers as Strengtheners, after adding chitosan, the elongation value decreases as the chitosan concentration increases. at a rate of 2% to 10%. The regression coefficient for the tensile strength graph which is on the trendline is 0.98, indicating that the correlation between variables x and y is quite good. The more chitosan content, the lower the elongation value. This is due to the hard nature of chitosan (Eristina, 2018).

3.3.3 Water Resistance

Table 1 shows that the water resistance value increases with the amount of shrimp shell flour used. The highest water resistance value was found in bioplastics with the addition of 2 grams of shrimp shell flour, namely 74.60%, and the lowest value was found in bioplastics without the addition of shrimp shell flour, namely 58.33%. The average value of water resistance shows that the addition of 0.5 grams of shrimp shell flour is 59.52% up to 2 grams of 74.60% increases as the amount of shrimp shell flour increases. Bioplastic without the addition of shrimp shell flour has the lowest average value of water resistance, namely 58.33%. This shows that plastic without shrimp shell flour is not water resistant because starch and glycerol are hydrophilic so they often bind with water. Glycerol as a plasticizer increases the flexibility of plastic films. However, more empty space increases with the addition of glycerol, which creates holes for water atoms to enter. The more shrimp shell flour used, the higher the water resistance value produced in the bioplastic. This increase in value is caused by shrimp shell flour which is hydrophobic in nature, so the more shrimp shell flour is added, the more water resistant the bioplastic produced will be (Nahir, 2017).

The results of the analysis show that the solubility value ranges from 23.75% -58.33%, the results obtained are in line with research by Lazuardi and Cahyaningrum (2013) on the manufacture and characterization of bioplastics made from chitosan and cassava starch using glycerol plasticizer. It can be seen that the composition of chitosan: starch without the addition of glycerol, the more dominant starch, the plastic resistance will decrease. This can be shown in the composition of chitosan: starch (1:3) of 21.4%. Meanwhile, the plastic with the best water resistance increases with the increasing amount of chitosan, namely plastic with the composition chitosan: starch (3:1) with a low water absorption capacity of 2.8%. The greater the water absorption capacity, the less able the plastic is to protect the product from water, which can cause the product to quickly become damaged or reduce in quality (Lazuardi & Cahyaningrum, 2013).

3.3.4 Bioplastic Thickness

From **table 1**, it is known that the thickness value of bioplastics with various additions of shrimp shell flour increases according to the amount of shrimp shell flour used. The highest thickness value was found when using 2 grams of shrimp shell flour and 3 grams of yam starch, namely 0.1815 mm, and the lowest value was for bioplastic without the use of shrimp shell flour and 5 grams of hawi starch, namely 0.135 mm.

The results obtained are in accordance with standard quality requirements for edible film thickness. According to the Japanase industrial standard (JIS) (2019), the maximum thickness of edible film is 0.25mm.

The thickness value obtained by adding shrimp shell flour increased. This is caused by increasing the concentration of shrimp shell flour in biodegradable plastic, causing an increase in the thickness value of biodegradable plastic (Marlina & Achmad, 2021). The impact on the tensile strength value of bioplastics is greatly influenced by the thickness of the biodegradable plastic film. The main thing that influences the mechanical properties of plastic materials is the relationship between the constituent parts. The thicker the biodegradable plastic film, the greater the strength of the biodegradable plastic in suppressing water absorption, thus extending the useful life span of the product.

The thickness value obtained increases with the addition of shrimp shell flour, namely in the range of 0.135 mm – 0.1815 mm, which is in line with research by Nurdiniah Nahir (2017), regarding the effect of adding chitosan on the characteristics of bioplastics from tamarind seed starch. This bioplastic is made from tamarind seed starch. has a thickness of between 0.12 to 0.32 millimeters. The average value of bioplastic thickness shows that the addition of chitosan concentration of 3%, 4% and 5% increases along with increasing chitosan concentration. This is because the total solids in the solution will increase as the chitosan concentration increases. The mechanical properties of bioplastic film are greatly influenced by its constituent parts, causing the thickness of the bioplastic to increase (Nahir, 2017).

3.3.5 WVTR (Water Vapor Transmission Rate)

In **table 1**, it is known that the average value of water vapor transmission rate shows that the addition of 0.5 grams of shrimp shell flour is 59.71 g/m^2.24 hours up to 2 grams is 50.42 g/m^2.24 hours, which decreases with increasing amount of shrimp shell flour. Bioplastic without the addition of shrimp shell flour has the highest average value of water vapor transmission rate, namely 173.83 g/m^2.24 hours. This is because shrimp shell flour has hydrophobic properties, thus affecting intermolecular forces and embedding between plastic polymers which can reduce plastic moisture. The water vapor transmission rate of bioplastics decreased when shrimp shell flour was added to the plastic matrix. This is because shrimp shell flour is able to change the surface of the bioplastic from a large porous state to a small porous state.

The results of all treatments have met the standard quality requirements for water vapor transmission rate according to the Japanase industrial standard (JIS) (2019), namely grade 5 (>100 g/m^2.24 hours) for bioplastics without the addition of shrimp shell flour and grade 4 (>20 - <100 g/m^2.24 hours) for bioplastics with the addition of 0.5 grams – 2 grams of shrimp shell flour.

The WVTR value ranges from 173.83 – 50.42 g/m^2.24 hours, this result is smaller than research by Supeni and Irawan (2012), concerning the Effect of Using Chitosan on the Barrier Properties of Modified Tapioca Edible Film, the barrier properties of Edible Film which are added with chitosan solution as a filler had the lowest value of 215.48 g/m^2.24 hours and the highest value of 357.24 g/m^2.24 hours. Both these values were found to be significant. The large value of the water vapor transmission rate in edible film with the addition of chitosan filler is because the film is still influenced by the hydrophilic properties of the raw material (tapioca) and filler (chitosan) (Supeni & Irawan, 2012).

3.3.6 Biodegrability

Biodegradation tests are carried out to determine how quickly bioplastics are degraded by microorganisms in an environment. The medium used is soil because in soil there are many types of microorganisms (fungi, bacteria and algae) and in large quantities, so it will support the degradation process that will be carried out. In the table above, bioplastics with the addition of 2 grams of shrimp shell flour degraded completely on day 10, bioplastics with the addition of 1.5 grams of shrimp shell flour decomposed on day 12, bioplastics with the addition of 1 gram of shrimp shell flour decomposed on day 30, and bioplastic with the addition of 0.5 gram of shrimp shell flour completely decomposed on day 32. The decomposition time for the bioplastic samples became faster as the amount of shrimp shell flour was added. Bioplastics without the addition of shrimp shell flour can decompose completely on the 34th day. This happens because bioplastics with the addition of shrimp shell flour do not have the ability to absorb water well so the bioplastic becomes very dry when exposed to the heat of the sun, as a result the bioplastic samples break easily and decompose.

The faster time it takes for bioplastics to decompose completely indicates good degradation results because the mass of bioplastics is decomposed more quickly by microorganisms. From the results above, it can be seen that what influences bioplastic degradation is the amount of shrimp shell flour added, the more shrimp shell flour added, the faster the bioplastic will be degraded.

4. CONCLUSION

Based on the results of the research that has been carried out, it can be concluded that the effect of adding jerbung shrimp shell flour and without adding shrimp shell flour on bioplastics made from uwi starch has a significant effect on the values of Thickness, Tensile Strength, Percent elongation, but has no significant effect on the values of Water Resistance and water vapor transmission rate (WVTR) value. The water resistance values obtained were 58.33%, 59.52%, 65.35%, 68.10%, 74.60%, while the WVTR values obtained were 173.83 g/m2.24hr, 59.71 g/m2.24hr, 59.71 g/m2.24hr, 62.36 g/m2.24hr, 50, g/m2.24hr. The increasing use of shrimp shell flour can accelerate the biodegradability of bioplastics.

The addition of shrimp shell flour which produces the best bioplastic is the addition of 2 grams of shrimp shell flour with a thickness of 0.18 mm, tensile strength of 6.41 MPa, elongation percentage of 3.79%, water resistance of 74.60%, steam transmission rate water 50.42 g/m2.24 hours, and the degradation time is 10 days.

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