Comparison the Using of Polypropylene and Low-Density Polyethylene Plastic Waste as a Matrix in Making Biodegradable Plastics and Starch from Empty Fruit Bunch of Palm Oil as a Filler

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Abstract. The using of plastic waste from various types of plastics such as polypropylene and LDPE is carried out to see the properties of each biodegradable plastic produced, so that it can be used according to their respective needs. The addition of starch from empty fruit bunch of palm oil is expected to produce biodegradable plastic that breaks down naturally so that it can overcome the problem of plastic build up. The composition used in the manufacture of biodegradable plastics is the ratio of plastic waste and starch of empty fruit bunch of palm oil is 60:40. The method of molding biodegradable plastics is the hot press method. Biodegradable plastic from LDPE type plastic waste has a tensile strength price of 6.9410 N/m² and a elongation value of 3.1875%, a melting point temperature of 103°C and a decomposition temperature of 384°C, the gravimetric thermal test obtained a residue of 12.6%, and analysis of morphological properties shows spread the starch from empty fruit bunch palm oil evenly. Biodegradable plastic from polypropylene type plastic waste has a tensile strength value of 9.81 N/m² and elongation of 0.5625%, a melting point at a temperature of 163.68°C and decomposes at a temperature of 445.62°C the gravimetric thermal test obtained a residue of 11.5%. From the resulting characteristics, it can be concluded that biodegradable plastic made from LDPE material has lower strength but higher elasticity, and biodegradable plastic made from Polypropylene has better strength but low elasticity.

1. Introduction
Plastic packaging is a material that is widely used by producers and the public. In fact, every time you buy a product at a traditional market or supermarket, you are always given plastic packaging to wrap it.
The government has started to think about how to reduce the amount of plastic use in Indonesia. One of the government's efforts is to require consumers to pay for each plastic bag used at a high enough price, but this is not enough to deal with plastic waste in the environment. Plastic compounds are compounds that are difficult to degrade naturally so that they will cause accumulation of plastic waste in various places. The right alternative is to make plastic packaging that can be degraded by combining it with biological materials. One type of plastic that is used as a plastic bag packaging is a type of polyethylene. One of the handling of used plastics is by way of recycling, but the quality is not as good as processed fresh plastic. Another way is by modifying it into a new material with the addition of fillers or reinforcement to improve its quality and usability. Biodegradable plastic is one of the materials under certain conditions of time to undergo changes in its chemical structure by influencing its properties through microorganisms (bacteria, fungi, algae) [1]. Several studies have been carried out on the manufacture of biodegradable plastics which continues to grow at this time, starting from the variety of starch used, for example by using durian seed starch [2] which is carried out with a polypropylene matrix, wet method and using xylene solvent. The maximum starch composition used in the reflux device is 2 percent. Hidayani et al. [3] has also made biodegradable plastics from a mixture of polypropylene plastic waste and durian seed starch by modifying polypropylene plastic waste and using a crosslinking agent in the form of 1% maleic anhydride and 1% benzoyl peroxide initiator assistance. The results of biodegradable plastics obtained at optimum conditions contain 4% durian seed starch and can interact chemically based on FT-IR test data but the results of this study are deemed insufficient because of the poor level of plastic homogeneity and lack of physical appearance. Hidayani et al. [4] carried out research developments by replacing durian seed starch which is considered a seasonal fruit with starch sourced from empty oil palm fruit bunches which is available almost all the time and is a problem for the environment because it is a waste from oil palm fruit processing. The source of the plastic used in the manufacture of biodegradable plastics into Low-Density Polyethylene (LDPE) has a low melting point of 110°C, which is expected to be not much different from the melting point of starch. The results of this study indicate the optimum conditions for the addition of starch variations as much as 40%, but the weakness is the physical appearance of the biodegradable plastic produced is black like charred and has a strong odor. Based on the considerable starch composition that can be added as a filler in making biodegradable plastics in the previous year's research, Hidayani et.al. [5] varied the plastic base material used, namely using High-Density Polyethylene (HDPE) plastic waste. The mixing method that was carried out was changed to a dry mixing method with an extruder, where the wet method was considered less environmentally friendly because it produced chemical wastewater which would be disposed of into nature and had a large cost [6]. The results of this study indicate that the optimum condition of the biodegradable plastic produced is at 40% variation of the starch of empty oil bunches with an even physical appearance, but the color of the biodegradable plastic is still brown. Pelita et al. [7] made a biodegradable plastic film by mixing polypropylene plastic waste and oil palm empty bunch starch using an extruder and adding 1% benzoyl peroxide initiator and maleic anhydride crosslinking agent by comparing plastic waste and filler material 60:40. From the aforementioned studies, the researchers conducted a comparison of the characteristics of biodegradable plastics made from 2 types of plastics, namely polypropylene and LDPE so that the use of biodegradable plastics produced can be optimized according to their plastic properties.

2. Methodology

2.1 Equipments and Materials

Equipments and materials used in this study are:

2.1.1 Equipments

The equipments was used: a set of pyrex brand glassware, knife, bowl, rheomix type 141, Mettler Toledo Analytical Balance, Memmert electric oven, Torsee SC-2DE taper pressure press, tensile test unit Type SC-2DE, Tantalum 3N8 Purity 100 mesh, a set of Shimatsu Japan DTADT-30, Q-500 series TGA
2.1.2 Materials
The materials used are: LDPE waste, Polypropylene Plastic Waste, Maleic Anhydrate PA Merck as crosslinking agent, Benzoyl Peroxide PA merck as inisiator, Empty fruit bunches palm oil, and aquadest.

2.2 Experimental Methods

2.2.1 Making Starch from Palm Oil Empty Fruit Bunch with Extraction Methods
The empty oil palm bunches are washed using running water, then the bunches are cleaned using a knife. The inside of the empty oil palm bunches is split open and the contents are taken. After that, it is immersed in water, then the starch that settles after one night is dried using an oven at a temperature of 110°C.

2.2.2 Mixing Plastics and Starch from palm oil empty fruit bunch with rheomix methods
Two different matrix are Polypropylene and LDPE and starch from palm oil empty fruit bunch as filler were prepared in composition 60:40. For making this plastics biodegradable have chemical reaction, we adding 1% anhydrate maleic as crosslinking agent and 1% benzoil peroxide as inisiator. This material was mixed with dried mixing method, and ingredients of this compound is 10 grams. After that, we go to melt blending method, with temperature 135°C for polypropylene and 110°C for LDPE. The rotation speed for this phase at 60 rpm and 5 minutes mixing time.

2.2.3 Molding Stage for Produce Plastic Biodegradable with Press Process
To final step of making plastic biodegradable, biodegradable plastic powders prepared for hot press method with a hydraulic pressure at 150 kg/cm² and thickness 2 mm, temperature at 130°C for polypropylene and 105°C for LDPE for 15 minutes.

2.2.4 Characterization Biodegradable Plastics
Tensile strength testing by ASTDM D-1822 type L with a load of 100 kgf and a rate of 50 mm/min with a specimen thickness of 2 mm.[8]

Thermogravimetric analysis (TGA) studies on the samples were carried out on Q-500 series TGA Analyzer (TA Instruments, USA). The weight of each sample was 5–10 mg and temperature range was 35–750 °C with a heating rate of 20 °C/min.

3. Results and Discussion
Figures 1 and Figure 2 show the biodegradable plastic produced from two different matrix, polypropylene plastic waste and LDPE waste. At this two figures results shown through photos no significant differences from the results of two materials for biodegradable plastics. This may occur because the basic material of the two samples is plastic and the addition of filler to the sample is carried out by a treatment method that adapts to the properties of the plastic respectively.

![Figure 1. Biodegradable Plastic from Polypropylene Plastic Waste](image)

3.1 Characterization of Tensile Properties
Analysis of the tensile properties from result of biodegradable plastic can be seen in Table 1. The value of tensile properties from biodegradable plastic prepared from both different materials which ids Polypropylene plastic waste and LDPE waste showing significant results. This significant results cause
of the composition is the same but the characteristic this two different type of plastics are different. Polypropylene type plastics have a much greater tensile strength than LDPE type plastics, because the basic material of polypropylene plastic with carbon chain properties has high strength, but low flexibility, whereas for LDPE type plastics the tensile strength value is lower but the elasticity value is more higher. This is because the LDPE plastic type carbon chain tends to be straight [8].

### Table 1. Characterization Plastic Biodegradable of Tensile Properties

| No | Sample (Matrix)          | Load (kgF) | Stroke (mm/m) | Tensile Strength (N/m²) | Elongation at break (%) |
|----|--------------------------|------------|---------------|-------------------------|------------------------|
| 1  | LDPE and Starch          | 1.365      | 1.235         | 6.9410                  | 3.1875                 |
| 2  | Polypropylene and Starch | 1.485      | 1.321         | 9.81                    | 0.52                   |

3.2 Characterization of Thermal Properties with Differential Thermal Analysis and Thermal Gravimetry Analysis

The Differential Thermal Analysis and Thermal Gravimetry Analysis were carried out on plastic biodegradable result from two different matrix (LDPE Waste and Polypropylene Plastic Waste), which showing in Table 2.

### Table 2. Thermal Properties Analysys from Plastic Biodegradable

| Characterization     | Biodegradable Plastic (60:40) from LDPE and Starch | Biodegradable Plastic (60:40) from PP and Starch |
|----------------------|---------------------------------------------------|--------------------------------------------------|
| Melting point (°C)   | 103                                               | 163.65                                           |
| Decomposition point  | 384                                               | 448.47                                           |
| % Residues (TGA)     | 12.6                                              | 11.5                                             |

From the results of the thermal properties of the two biodegradable plastics produced, a significant difference will be seen from the two biodegradable plastics. This is based on the basic properties of the 2 types of plastics used as a matrix of biodegradable plastic mixtures. Polypropylene plastics have higher physical strength than LDPE plastics. However, LDPE plastic waste material has a higher elasticity value than polypropylene waste. This can lead us to conclude where the use of these materials will be directed to It can be seen from the results data from two different matrix materials of biodegradable plastics do have significant differences. The plastic biodegradable from LDPE waste where the MP temperature results at 103°C and the DP temperature at 384°C. The decomposed point temperature has increased where the Polypropylene waste where the MP temperature results are 163.65°C and DP temperature at 448.47°C. The temperature is in according with the combination between the initial LDPE waste dan Polypropylene Plastic Waste temperature and palm oil empty fruit bunch starch where the melting point temperature has decreased which shows the reduced, which one the decrease of melting point is due to the addition of starch as a filler, means that the biodegradable plastics are still prominent but has been affected by other materials.

From the data of thermal gravimetry analysis, we can be seen conclusion that the biodegradable plastic are produced with comparison (60:40) by two different materials have similar percentage of residues which are 12.6% and 11.5%, which may occur because effect of starch from the palm oil empty fruit bunch contains the carbon chain which is the last decomposed organic carbon atoms.
4. Conclusion
Biodegradable plastic from LDPE type plastic waste has a value of tensile strength in 6,9410 N/m² and value of elongation in 3,1875%, form DTA test showing MP temperature of 103°C and a DT of 384°C, the TGA test obtained a residue of plastic biodegradable from LDPE waste is 12,6 %, and analysis of morphological properties shows spread the starch from empty fruit bunch palm oil evenly. Biodegradable plastic from polypropylene type plastic waste has a value of tensile strength in 9,81 N/m² and value of elongation in 0,5625%, form DTA test showing MP temperature of 163,68°C and a DT of 445,62°C, the TGA test obtained a residue of plastic biodegradable from Polypropylene Plastic waste is 11,5%.

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