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Mechanical Properties of Bioplastics Product from Musa Paradisica Formatypica Concentrate with Plasticizer Variables

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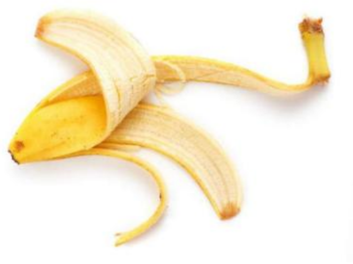
Abstract. In order to obtain bioplastics product form *Musa paradisica formatyca* concentrate, sorbitol and glycerol plasticizer substance is added. The purpose is to make bioplastics produces more flexible and more elastic. This study is conducted to determine the effect of the composition of sorbitol and glycerol plasticizer so that an optimal biodegradable plastics be able to obtain. The other ingredients utilized are acetic acid, chitosan, and aquedest. The method used for this study is mixing 100 ml of the essence of *Musa paradisica formatypica,* 0.7% chitosan (% v / v), 0.5% acetic acid (% v / v), 5 grams of cornstarch with plasticiser (0%, 1%, 2 %, 3%, 4%, 5% sorbitol and 0%, 1%, 2%, 3%, 4%, 5% glycerol) of the volume of essence of banana peel, then heated to 90ºC with a stirring speed of 300 rpm for 30 minutes. The results obtained in the form of thin sheets of bioplastic were tested mechanically in the form of tensile strength and percent elongation. Based on the analysis of tensile strength and elongation percent technique, it was found that bioplastics were close to the standard, i.e., in the sample 3% glycerol (% v / v) with a tensile strength of 46.4201 Mpa and percent elongation of 15.15152% and a sample of 5% sorbitol (% v / v) tensile strength 31.4228 MPa and elongation percentage 15.15152%.

Key Notes : Bioplastic, Musa paradisica formatyca, Plasticizer

1. Introduction

Plastics are widely used for various things, including as food packaging, food, and drink pads, for school, office, automotive and various other sectors, because it has many advantages, including flexible, economical, transparent, strong, not easily broken, laminated form which can be combined with other packaging materials and some are heat and stable [1]. Besides having these various advantages, plastics also have drawbacks, including the main raw material for the manufacture of plastics derived from petroleum which is depleting and non-renewable [2].
One of the methods that can be applied to reduce these environmental problems is developing bioplastics products. Bioplastics are renewable plastics because their constituent compounds originate from plants such as starch, cellulose, and lignin as well as animals such as casein, proteins, and lipids [3]. Based on the raw materials used, biodegradation plastics are divided into two groups, i.e., groups with petrochemical raw materials and groups with raw materials for plant products such as starch and cellulose [4].

Starch-based plastic is safe for the environment. Plastics with raw materials in the form of synthetic polymers take around 50 years to decompose naturally, while biodegradable plastics can decompose 10 to 20 times faster [5]. Starch is the most promising raw material for making plastics in the future because it is always available in large quantities and is cheap. This plastic has high mechanical strength and can function as a gas barrier, especially oxygen, carbon dioxide and fat [6].



Source : *(http://claudiagallery.com)*
Figure 1. *Musa paradisica formatypica* peel

Musa paradisica formatypica peel is a large amount of waste. In general, *Musa paradisica formatyca* peel has not been used in real terms, only disposed of as organic waste or used as animal feed such as goats, cows, and buffaloes [7]. *Musa paradisica formatyca* peel can be used as a raw material for making bioplastics because it contains 0.98% starch. *Musa paradisica formatypica* peel is a residual waste of production from snacks such as (banana chips, sale of bananas, etc.) which are usually only used as animal feed [8]. The composition contained in Skin *Musa paradisica formatypica* can be seen in the following table:

Table 1. Composition Per 100 Skin *Musa paradisica formatypica*

No	Elements	Composition (%)
1	Water levels	11.09
2	Carbohydrate levels	40.74
3	Fat levels	16.47
4	Protein levels	5.99
5	Rough fibre levels	20.96
6	Ash levels	4.82
7	Cellulose levels	17.04
8	Lignin levels	15.36

Source: *[16]*

In bioplastics production, plasticizers need to be added so that the plastics produced is more elastic, flexible and resistant to water [9]. Glycerol and sorbitol are widely used as plasticizers because of their stability and non-toxic. Glycerol and sorbitol are plasticizers to reduce fragility, increase film flexibility and durability, especially if at low temperatures [10]. Therefore, a mixture of sorbitol and glycerol plasticizers is expected to produce bioplastics that have optimal characteristics. In addition to plasticizers, in the manufacture of biodegradable plastics, it is necessary to add substances such as chitosan as a reinforcement and resistance to water bioplastic [11].

Several studies related to biodegradable plastics [12]. [13] with hygroscopicity between 3.55-7.59%; the rate of water vapour transmission is between 0.0017-0.0021 g / hour cm^3; the water solubility is between 2.54-59.01%; acid solubility 4.05-87.86%; stretch power between 2.73-179.61 MPa; breaking length between 1.95-19.81 MPa; tear resistance between 2,50-26,32 Mpa [13] and in the biodegradation test in the soil the film weight decreased between 5.73-85.08%. [8] with a tensile strength of 10.51 kg / cm2 and elongation of 17.33%. Therefore researchers are interested in conducting research using the concentrate of *Musa paradisica formatypica* peel, cornflour, chitosan, acetic acid, and sorbitol and glycerol as plasticizers.

2. Study Methods

This study was conducted using 2 stages, i.e., the manufacture of plastics and the analysis of the results of bioplastics. The tools and materials used in this study include. Concentrate of *Musa paradisica formatypica* peel, sorbitol, glycerol, acetic acid, chitosan, aquedest, measuring cylinder, hotplate, beaker, stirrer, thermometer, glass plate, analytical balance, and tensile testing apparatus.

2.1 Study Procedure

2.1.1 Production of concentrate skin Musa paradisica formatypica

Prepare 8 kg of *Musa paradisica formatypica* peel. Then clean the *Musa paradisica formatypica* peel and cut the *Musa paradisica formatypica* peel into a dice. Smooth the diced *Musa paradisica formatypica* peel using a blender by adding 8 L aquedest to get the the *Musa paradisica formatypica* peel concentrate.

2.1.2 Bioplastics Production

The production of bioplastics film samples from *Musa paradisica formatypica* peel concentrate and cornstarch begins with preparing cornflour, chitosan, acetic acid and plasticizers (glycerol and sorbitol) with variations of 0, 1, 2, 3, 4, 5 ml then heating for 30 minutes with stirring speed of 300 rpm to 90. After thickening, poured into a glass mould and dried in 50 temperature oven for 8 hours. And allowed to stand for 2 days until it can be released from the mould. Plastic is ready for analysis.

Source : *Researcher's Document*
Figure 2. Bioplastics peel concentrate *Musa paradisica formatypica*

2.2 Bioplastics Analysis Procedure for Tensile and Elongation

The Bioplastics analysis procedure for Tensile-Strength (MPa) and Elongation properties are elaborated as follow:

1. Press ON button to operate the tool;
2. Prepare bioplastics with standard determined measurement;
3. Clamp the one side of the bioplastics at the lower part of the jaws and the other side of the bioplastics at the upper part of the scale;
4. Press UP button in order the scale will pull the bioplastics and indicate force which gave to them;

5. Measure the increase of the length of the bioplastics after it broke up to determine the elongation percentage.

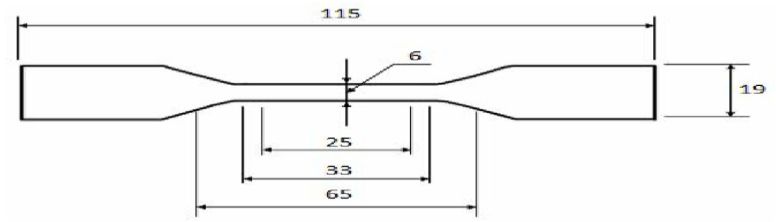


Figure 3. Bioplastics elongation and tensile properties specimen measurement
Source: EN ISO 527:5:1996

2.2.1 Tensile-Strength (MPa)

The tensile test is carried out with the test object drawn from two directions so that the length increases and the diameter shrinks. The amount of load and length increase is recorded during the test. Tensile strength is the maximum load that can be accepted by the material [5].

$$TS = F_{max} / A_0 \quad (1)$$

where :

TS = tensile-strength
F_{max} = maximum force
A_0 = initial surface width

2.2.2 Elongation (%)

Percent lengths can be calculated by comparing the length of the film at break and length of the film before being pulled by the Tensile Strength Elongation Tester. The mathematical percent elongation can be calculated using the Elongation Percentage formula:

$$(\%) = [(L_1 - L_0)/ L_0] \times 100\% \quad (2)$$

where :

L_1= the final length of the test object
L_0= the initial length of the test object

3. Results and Discussions

In this study, before measuring by tensile testing, each bioplastics sample was cut according to EN-ISO 527:5-1996 concerning determine of tensile properties of plastic standards. The following is the result of testing the mechanical properties of bioplastics from the concentrate of *Musa paradisica formatypica* peel.

3.1 Tensile Strength

The following is a graph of the effect of various plasticizers on the tensile strength of bioplastic films based on the concentrate of *Musa paradisica formatypica* peel.

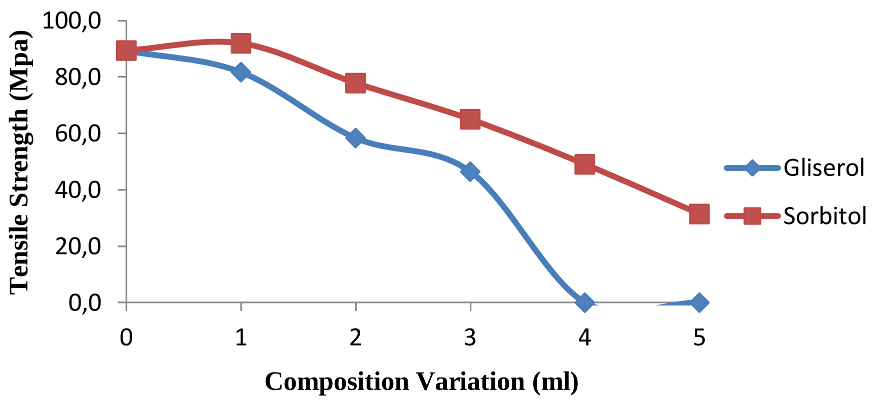


Figure 4. Graph of the effect of various plasticizers on the tensile strength of bioplastic films based on concentrate skin *Musa paradisica formatypica*

Tensile strength is the maximum pull that can be achieved until the film can survive before breaking up. Tensile strength measurement to determine the amount of force achieved to achieve maximum pull in each unit of film area to stretch or elongate [14]. The tensile strength obtained without using a plasticizer is 89,3587 Mpa, with the addition of glycerol plasticizer ranging from 81,6993 Mpa to 46,4201 Mpa. fragile. While the tensile strength values obtained by adding sorbitol ranged from 91.9118 Mpa to 31.4228 Mpa. The tensile strength of bioplastic films is strongly influenced by the content of the added plasticizer. From the graph above can be seen the higher the plasticizer composition used in making bioplastics to the composition of 5 ml, the lower the tensile strength of the bioplastics produced. This is due to the increase in the concentration of the plasticizer will reduce hydrogen bonds in the film to increase flexibility, by increasing the flexibility the tensile strength of the film will be smaller because the resulting film becomes flexible, soft, and flexible so that the tensile strength decreases [14].

3.2 Elongation Percent

The following is a graph of the effect of various plasticizers on the percent elongation of bioplastic films based on the concentrate of *Musa paradisica formatypica* peel.

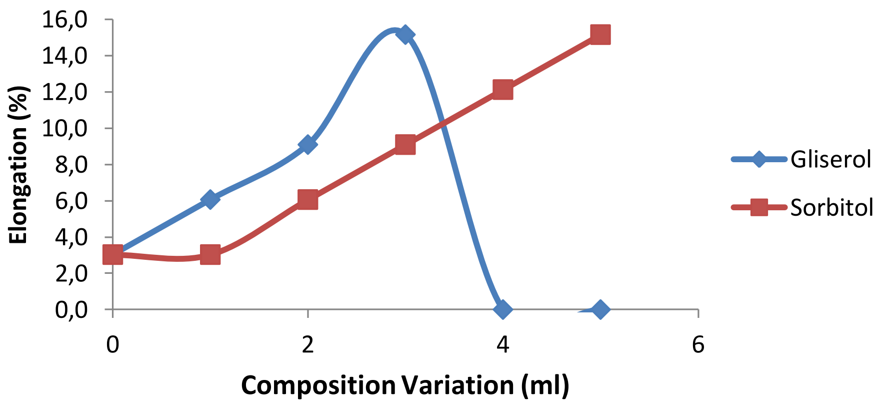


Figure 5. Graph of the effect of variations of plasticizer on percent elongation of bioplastic films based on the concentrate of *Musa paradisica formatypica* peel.

Elongation Percent is a change in the maximum length of the film before being disconnected [15]. The value of elongation in the plastic film produced by the addition of glycerol ranged from 6.0606% to 15.1515% while the plastic produced by the addition of sorbitol ranged from 3.0303% to 15.15152%. From the graph above can be seen the higher the composition of sorbitol plasticizers used in the manufacture of bioplastics to the composition of 5 ml, the higher the percent elongation of bioplastics produced as well as glycerol plasticizers, only in the composition of 4 and 5 ml glycerol cannot be read due to the product produced brittle and destroyed when it will be tested. This is because an increase in the concentration of plasticizers will increase the viscoelastic response and molecular mobility of the plastic polymer chain. Increasing the mobility of polymer chains is shown by increasingly elastic materials so that elongation values tend to increase [15].

4. Conclusions

From the results of the research that has been done, it can be concluded that variations in the concentration of sorbitol and glycerol plasticizers affect the mechanical properties of bioplastics namely tensile strength and percent elongation. All bioplastics from the concentrate of *Musa paradisica formatypica* peel are close to the standard with the highest tensile strength value of 91,9118 MPa in the composition of 1% (v / v) and 89,3587 MPa sorbitol in the composition of 0% plasticizer (% v / v) while the optimum condition value percent of bioplastic elongation from the concentrate of *Musa paradisica formatypica* peel which is close to the standard is 15.15152% in the composition of glycerol plasticizers 3% (v / v) and 15.15152% in the composition of 5% (v / v) sorbitol plasticizers.

From the results of the study, it can be concluded that the higher the plasticizer composition up to 5 ml of sorbitol and 3 ml of glycerol, the lower the tensile strength and the higher percent of elongation. So that the best results where the tensile strength and elongation percent which are close to the standard are found in the sample 3% glycerol (% v / v) with a tensile strength of 46.4201 Mpa and percent elongation of 15.15152% and a strong sample of 5% sorbitol (% v / v) pull 31,4228 MPa and elongation percentage 15.15152%.

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