Preparation of Ganyong \((\text{Canna discolour})\) Starch Bioplastic with the Addition Of Sirih \((\text{Piper betle})\) Leaf Extract

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**Abstract.** Bioplastic production of canna starch with the addition of sirih leaf extract has been done. This study aims to determine the relationship between the additions of sirih leaf extract to the physical properties of canna starch bioplastic. Bioplastic characteristics were studied by measuring thickness, tensile strength, elongation, modulus young and wvtr. This research was conducted in three stages, the extraction of sirih leaf, preparations of canna tuber bioplastic and canna tuber bioplastic with the addition of sirih leaf extract. The results showed that the bioplastics had a thickness of 0.083 mm, a tensile strength of 3.11 mpa, 27.62\(^\circ\) elongation, modulus young 0.1126 mpa and wvtr 7.24 grams / m\(^2\) hour. The addition of sirih leaf extract has a strong effect on changes in tensile strength, elongation, modulus young and wvtr

1. **Introduction**

Demand for good quality of vegetables is now being considered as the importance of health and nutritional value in food consumed. Consumers demand high-quality fresh fruit, durable, and have a long storage time. One effort that can be done to improve the quality and storability are by using bioplastic. Bioplastics are used as some surface coatings for food components that has a function to inhibit the migration of moisture, oxygen, carbon dioxide, aroma and lipids. Bioplastics can be made from polysaccharides and can act as a permeable membrane. Bioplastics will be selective on the exchange of O\(_2\) and CO\(_2\) gases. Bioplastics can reduce the respiration rate of these fruits and vegetables [1]. Starch contain an amylose which can formed a thin layer with strong bonds to create a good bioplastic [2].

Starch which can be obtained from canna tubers also can be used as an ingredient for making bioplastics. Canna is a type of tuber that contains starch. Starch content in Canna is higher than cassava [3]. The composition of amylose and amylopectin of canna starch can be potentially used to make a bioplastic material. Santosso [4] explained that canna starch has 21.14-24.44% of amylose and 75.56-78.86% of amylopectin. Robertson [5] explained that bioplastics can also be used as a food components carriers, such as vitamins, minerals, antioxidants, antimicrobials, preservatives, ingredients to improve the taste and color of packaged products. One example of a substance that can be added is betel leaf extract. Wijayakusuma [6] explains that the content of eugenol in betel plants is more than 42%. Eugenol is a compound that can inhibit growth and even kill mold. The content of eugenol in betel leaves has antifungal properties.

This research will try to make an active packaging material using canna starch and betel leaf extract as a bioplastic manufacturing material. Betel leaf has antimicrobial properties which are expected to prevent microbial growth. The addition of betel leaf extract certainly affects the physical properties of
the bioplastics produced. This study aims to determine the relationship of the addition of betel leaf extract to the physical properties of the bioplastics produced

2. Experimental Methods

2.1. Betel Leaf Extraction
The method used to extract the green betel leaves is called maceration. Green betel leaves are washed clean first, then dried in an oven at 45°C for 12 hours. The dried leaves are then blended with a blender until they become a powder. The 60 grams of Betel leaf powder weighed and then soaked in 600 ml of 96% ethanol solvent for 2x24 hours. Filtering is then carried out to separate the filtrate from the pulp. The solvent is then evaporated using a rotary evaporator. The resulting extract was then used for further testing [7].

2.2. Preparations of Bioplastics
Bioplastic is made by mixing 6 grams of canna starch and 3 mL glycerol. The distilled water is then added until the mixture amounts to 100 ml. The heating is then carried out on the mixture and stirred for 30 minutes at 75 °C [8]. The suspension is then cooled to 37 °C and filtered. The pouring of a mixture of 30 ml is carried onto a 13x18 mica plate. The suspension is then dried in an oven at 50 °C for 3 hours, then allowed to stand at room temperature for 48 hours. The same method is used for making bioplastics with betel leaf extract. Betel leaf extract added with variation 1; 1.5; and 2% (b / b). Each bioplastic sample was then prepared for further testing.

2.3. Water Vapor Transmission Rate Test
Bioplastics were placed in the mouth of a circular cup with an inner diameter of 7 cm, an outer diameter of 8 cm and a depth of 2 cm. 10 grams of silica gel are put into a cup before being covered with bioplastics. The edges of the cup and bioplastics are covered with wax or insulation. The cup is then put into a jar containing 40% (w / v) NaCl solution.

Water vapor diffused through plastic will be absorbed by silica gel and will add weight to the silica gel. Water equilibrium transmission rate conditions are reached within 7-8 hours (steady state conditions), and weighing is done periodically every 1 hour (starting from the 0th hour to the 7th hour). The change in weight shows the diffusion speed of water vapor passing through the plastic.

3. Result and Discussion
3.1. Betel Leaf Extraction
Betel leaf extraction was carried out by maceration method. The results of the extraction of green betel leaf in the form of thick extract with a blackish green color and has a strong aroma. The resulting extract weight was 7.94 grams for every 60 grams of betel leaf powder. Betel leaf extract was then analyzed using FT-IR spectrophotometer. Identification is carried out at 4000-400 cm\(^{-1}\) wave numbers.

The FT-IR spectrum of the betel leaf extract analysis results is shown in Figure 1. The typical absorption that appears in the FTIR spectrum in figure 1 appears at wave number 3425.58 cm\(^{-1}\)which shows the characteristic absorption for the O-H group. Absorption at wave number 1635.64 cm\(^{-1}\) indicates the presence of C = C while wavenumbers 1273.02 cm\(^{-1}\)and 1381.03 cm\(^{-1}\) respectively showed the presence of ether groups (-C-O-C-), methyl (-CH3). An absorption at wave numbers of 1450.47 cm\(^{-1}\)and 910 cm\(^{-1}\) showed the presence of methylene groups (-CH2), as well as vinyl groups (-CH = CH2). These groups can be said to be a typical group of eugenol compounds found in betel leaf extract [9].
3.2. Preparations of Bioplastics
Preparations of bioplastics has done by the solvent casting method. The mixture is poured onto the mica plate and heated to dryness. The resulting bioplastics are then tested for their mechanical properties. The test results of the physical properties of bioplastics are shown in table 1.

| Thickness (mm) | Tensile Strength (MPa) | Elongation at Break (%) | Modulus Young (MPa) | WVTR |
|----------------|------------------------|-------------------------|---------------------|-------|
| 0.083          | 3.11                   | 27.62                   | 0.1126              | 7.24  |

The bioplastic testing with the addition of betel leaf extract were carried out to measure thickness, tensile strength, elongation, young modulus and WVTR. Samples were also analyzed for functional groups using FTIR spectrophotometers.

3.3. Thickness Measurement
Bioplastic thickness is a physical property that is affected by the concentration of dissolved solids and the size of the printing plate. The thickness of the film will affect the rate of transmission of water vapor, gas and volatile compounds [10]. Figure 2 shows the correlation of thickness measurement to Addition of Betel Leaf to Bioplastics Figure 2 shows that the addition of betel leaf extract tends to cause a slight decrease in bioplastic thickness. This is caused by betel leaf extract which tends to increase the tensile strength of the bioplastics produced. Statistical tests explained that the addition of betel leaf extract was not too significant in reducing the thickness of the bioplastics produced.
The Correlation between tensile strength to the addition of betel leaf extract to the bioplastic is shown in Figure 3. Figure 3 shows that the tensile strength value increases with the increasing concentration of betel leaf extract. The value of tensile strength tends to be greater according to research by Damat (2008) in Yulianti [11] states that the greater tensile strength can produce bioplastics that are not easily broken. This is because the formation of hydrogen bonds between chains produces a stronger bioplastic that requires greater force per unit area to stretch it.

Statistical tests showed a strong correlation between the addition of betel leaf extract with an increase in tensile strength. The addition of betel leaf extract is positively correlated to the tensile strength of bioplastics produced.

The relationship of the addition of betel leaf extract to bioplastic elongation is shown in Figure 4. The greater the betel leaf extract added, the lower the bioplastic elongation. This is presumably because the extract added contains solute components that enter the bioplastic matrix network so that it will weaken the bond between polymers which causes the film matrix to form more fragile.
Statistical tests showed a strong relationship between the addition of betel leaf extract with a decrease in elongation. The addition of betel leaf extract negatively correlated to the resulting bioplastic elongation.

3.6. Modulus Young

The relationship of the addition of betel leaf extract to young bioplastic modulus is shown in Figure 5. The greater the betel leaf extract added, it will increase the modulus of young bioplastic. This is presumably because the extract added contains solute components that enter the bioplastic matrix network so that it will weaken the bond between polymers which causes the film matrix to form more fragile [12].

Statistical tests showed a strong relationship between the addition of betel leaf extract with an increase in Modulus Young. The addition of betel leaf extract positively correlated to the young bioplastic modulus produced.
3.7. Water Vapour Transmission Rate (WVTR)

WVTR value is measured to determine the permeability value of a material to water. Water vapor permeability is a measure of a material because it can be passed (penetrated / impregnated) by water vapor. The resulting WVTR diagram is shown in Figure 6. The test results in Figure 6 show that the greater the concentration of betel leaf extract added, the lower the WVTR value. If the WVTR value produced is lower, then bioplastics will be better at holding water vapor [13].

![Figure 6. Bioplastics Water Vapour Transmission Rate](image)

3.8. FTIR spectrophotometer

The FT-IR spectra of the sample are presented in Figure 7. Comparison of the three spectra was conducted to determine the presence or absence of interaction after the addition of betel leaf extract. The FTIR spectra in figure 7 show the existence of stretching OH absorption at the wave number 3425.58 cm⁻¹. The uptake of OH groups changes in intensity due to the addition of OH groups derived from the phenolic compounds of betel leaf extract. The C-H group is shown by the absorption band at the wave number 2924 cm⁻¹ belonging to the betel leaf extract with a sharp intensity after being mixed with bioplastics. The absorption band has shifted to 2931 cm⁻¹ with reduced intensity. The same thing happened to wave number 1273 cm⁻¹ which shows the C-O group [5].

![Figure 7. Spectra FTIR of Betel Leaf Extract (a), bioplastic without the addition of betel leaf extract (b), and bioplastic with the addition of betel leaf extract (c)](image)
The FTIR spectrum of betel leaf extract has a peak that appears in the bioplastic addition of betel leaf extract. The peak, which appears in the absorption of wave number 2152.56 cm\(^{-1}\), indicates the existence of stretching vibration of the C\(\equiv\)C group. The functional group does not interact with other groups, this can be seen from the intensity that does not change and the absence of new absorption bands that appear.

Based on the interpretation of FTIR spectra of betel leaf extract, bioplastics without the addition of betel leaf extract, and bioplastic with the addition of betel leaf extract can be concluded that there is no significant change in functional groups. Shifting wave numbers and changes in absorption intensity indicate physical interactions, namely hydrogen bonds in bioplastic polymers and overlapping between functional groups [14].

4. Conclusion
Based on the results of the research that has been carried out it can be concluded that: The mechanical properties test results of canna starch bioplastic obtained from this study were 0.083 mm thickness test, 3.11 MPa tensile strength test, 27.62% elongation test and WVTR test results of 7.24 g/m\(^2\).hours.

Addition of betel leaf extract to bioplastics can affect the mechanical properties and WVTR except thickness.

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