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Mechanical properties of edible film from Tanduk Banana *(Musa corniculata* Rumph) peels for food packaging

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Mechanical properties of edible film from Tanduk Banana *(Musa corniculata* Rumph) peels for food packaging

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Abstract. The widespread use of plastic has adverse environmental impacts. Therefore, it is necessary to find environmentally friendly packaging material alternatives, derived from biopolymers. This study aimed to make biodegradable films from Tanduk Banana *(Musa corniculata* Rumph) peels and determine the characteristics of these films. The methods used were extraction of pectin from Tanduk banana peel, making of edible film and characterization of mechanical properties of edible film. The raw materials used were variation of tapioca flour (0g; 0.6g; 1.2g and 1.8g), CMC 3%, Glycerol 0.5 ml, and 6g of banana peel pectin. Various tests were carried out to determine mechanical properties of edible film, include tensile strength, elongation, modulus Young, and thickness. Test results show the optimum value of edible film thickness is 1.025 mm and obtained at the composition of 2.4g of tapioca flour. The optimum value of tensile strength is 8.22 MPa, the elongation percentage is 40.4% and obtained at the composition of 1.2g tapioca flour. The optimum value of modulus young is 0.20347 MPa and obtained at the composition of 1.2g tapioca flour.

1. Introduction

Currently the extent of plastic use in Indonesia as food packaging material in order to meet daily needs is very high, reaching 64,000,000 tons/year. Plastic is flexible, economical, durable, hard to tear, and a good barrier against oxygen, water vapour, and carbon dioxide. Plastic also has several disadvantages derived from petroleum, which is increasingly limited in number. Plastic degradation is very slow in nature. It would take years for plastic to fully degrade, and resulting in buildup of plastic waste which causes environmental pollution. Currently, the development of food packaging technology leads to environmentally friendly, biodegradable, more natural and without preservatives packaging materials [1]. Many studies have been conducted to develop biodegradable packaging that is made with natural ingredients that are safe for consumption, does not contaminate food products, can maintain the freshness and durability of the product and emerge in the form of edible thin films. Edible films have been considered an alternative as food packaging due their capability to extend the shelf life of food by reducing moisturizer, and oxidative reactions rate [2].

One of the natural ingredients used in making edible film is pectin extracted from banana peels. Previous studies have shown the yields of extracted pectins from saba banana peels range from 16.24 to 24.5% [3,4]. The formation of edible films from pectin has advantages, in that the surface smoothness in resulting film but it has low mechanical properties [5]. Adding glycerol or sorbitol as plastisizer can make edible film more flexible, smooth, increasing permeability toward water, gas and soluble substances [6]. In this study, the edible film was made from Tanduk Banana *(Musa corniculata* Rumph)

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peel pectins with the addition of glycerol, CMC plasticizers and tapioca which expected produce a mixture of edible film as food packaging materials with optimum mechanical properties such as tensile strength and elongation percentage. This study aimed to make biodegradable films from Tanduk Banana peels and determine the characteristic of these films.

2. Methodology

This study comprised of three stages in the implementation. The first stage was extraction of pectin from banana peels. The second stage was preparation of edible film. The final stage was characterization of mechanical properties of the edible film.

2.1. Materials

Materials used in this research were Tanduk Banana peels from traditional market in Depok, West Java, Indonesia, HCl (Merck), distillate water, tapioca flour, CMC 3%, Glycerol 0.5 ml, NaOH (Merck), Ca Propionate, K-Sorbat. The instruments used in this research include glass apparatus in the laboratory, blender, hotplate stirrer, oven, and tensile testing machines.

2.2. Extraction of pectin

One kg of banana peels was dried in the oven at 60 ºC for 24 hours until dried and brown. The dried peels were then grinded into powder by using blender and then sieved using a 100 mesh sieve. The powder was dissolved in 200 mL of 0.05 N HCl and was stirred at 80 to 90 ºC with magnetic stirrer for 120 minutes. The solution was filtered and then the resulting filtrate was added with 96% ethanol in a ratio of 1: 1 and stirred to form precipitated pectin. It was purified with ethanol repeatedly and dried in the oven at 50 ^{0}C [6].

2.3. The preparation of edible film

Three types of solutions were prepared in this study. The first solution was prepared by dissolving pectin powder in 150ml of distillate water. The second solution was made from tapioca flour with variation concentrations of 0 g; 0.6 g; 1.2 g; 1.8 g and 2.4 g which was dispersed in 150 ml of distillate water. The solution was then heated and stirred with a magnetic stirrer for 60 seconds. The third solution was formed by mixing CMC with 150 ml of distillate water then the solution was heated and stirred with magnetic stirrer until no bubble observed. Next, all of the prepared solutions were put into a glass beaker and stirred and then heated until homogeneous. Then 0.5 ml of glycerol was added to the mixture solution and it was further stirred and heated to 90 ºC. The solution was poured into a mold and dried in oven at 90 ºC for 12 hours.

2.4. Characterization of edible film

The mechanical properties of edible film including thickness, tensile strength, elongation, and modulus young were analysed.

3. Result and Discussion

Pectin was made from Tanduk Banana peel by using extraction process. The extraction started with the separation of banana peels using Hydrochloric acid (HCl). The acid was being used in pectin extraction to hydrolyze protopectin into water-soluble pectin or to prevent pectin from bonding with other compounds, such as cellulose. The use of hydrochloric acid increased yield of pectin extracted was 11.93%.

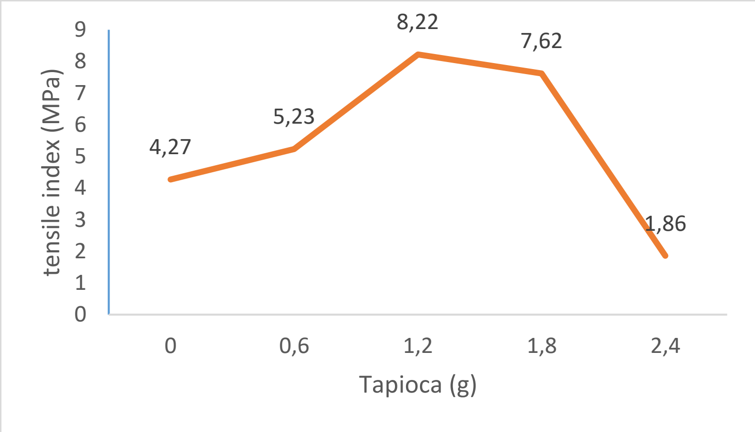

Figure 1. Tensile strength of edible film from pectin banana peels.

Test result showed that edible film made without tapioca flour had tensile index of 4.27 MPa. Edible film with tapioca flour of 0.6 g had tensile index of 5.23 MPa. Edible film with the addition of tapioca flour of 1.2g resulted in a tensile index of 8.22 Mpa. Moreover with the addition of tapioca flour of 1.8g and 2.4g, tensile index were 7.62 MPa and 1.86 Mpa (figure 1). The tensile strength test showed that tensile index of edible film increased with increasing of concentration of tapioca flour until reaching optimum tensile index at tapioca flour of 1.2 gram. It shows that tensile strength values were influenced by the composition of the tapioca flour. However, tapioca flour addition of more than 1.2g decreased the tensile index of edible film. This was due to the reduction of intermolecular interactions of protein chains so that the film matrix was less formed [7]. The formation of edible film involves gelatinization of tapioca granules by heating in excess water. It results in granules swelling and disruption as well as leaching of pectin from the granule. The gelatinization technique and drying method used to obtain edible films affected network charecteristics determining changes in physical properties. Tapioca based edible film are regarded stach systems that have been plasticized with glycerol (level of retrogradation), directly affects the mechanical properties [8].

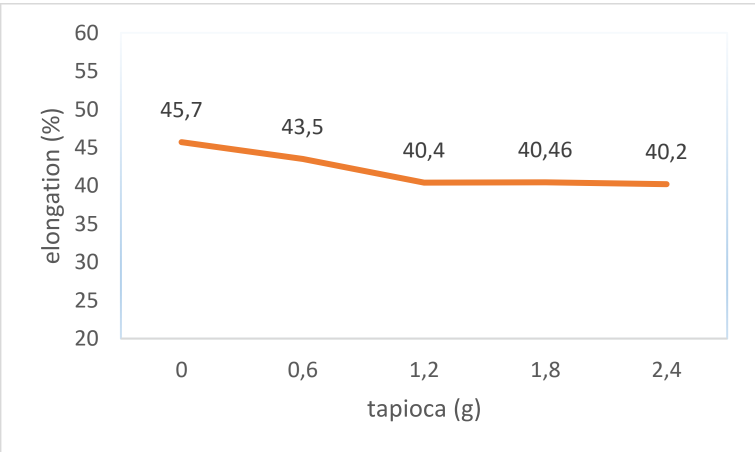

Figure 2. Elongation of edible film from pectin banana peels.

Test results showed that elongation of edible films were obtained range between 40.4 to 45.7% (figure 2). The addition of tapioca flour did not affect the elongation percentage of edible films. Percent elongation of the edible films was influenced by the plasticizer (glycerol, sorbitol, and CMC). The plastisizer are intended to decreased the intermolecular forces along polymer chains, imparting increased film flexibility while decreasing the barrier properties of films [9,10].

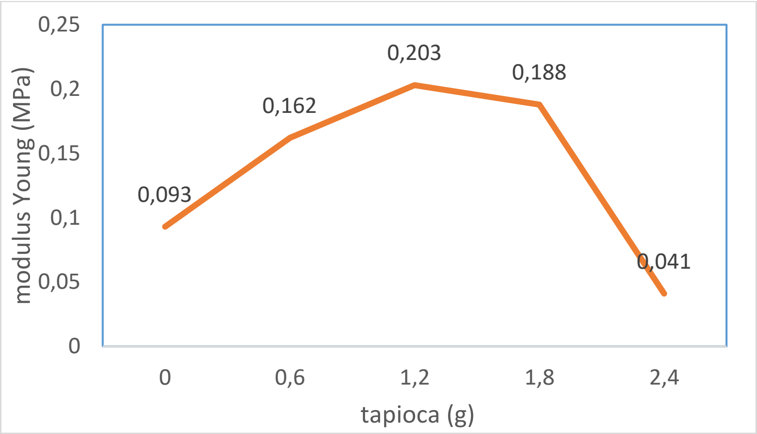

Figure 3. Modulus Young percentage of edible film.

Figure 3 demonstrated that Modulus Young percentage of edible film made without tapioca flour (0g) was 0.093 MPa. Modulus young percentage of edible film made with the addition of 0.6g tapioca flour was 0.162 MPa. Edible film with the addition of 1.2g tapioca flour resulted in modulus young percentage of 0.203 MPa. Edible film with 1.8g tapioca flour had modulus young percentage of 0.188 MPa. Moreover with the addition of 2.4g tapioca flour, modulus young percentage was 0.041 MPa. The results showed that optimum percentage of modulus young of edible film was reached at 0.203 MPa with 1.2g additional tapioca flour. Percentage of modulus Young of edible film increased with the addition of tapioca flour.

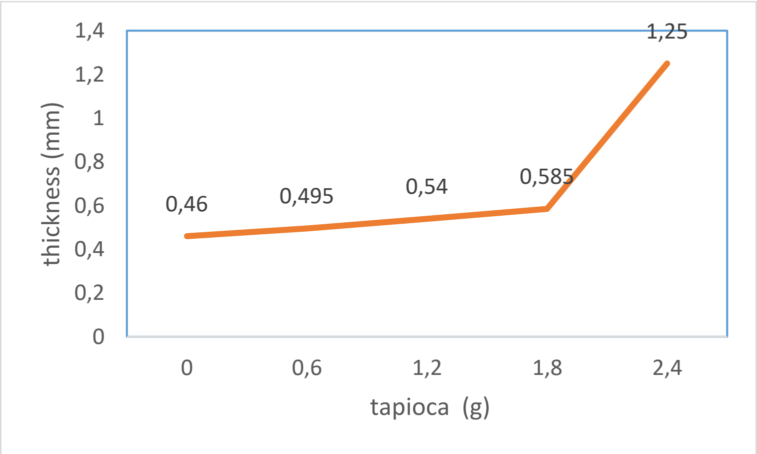

Figure 4. Thickness of edible film from pectin banana peels

Test result showed that thickness value of edible film made without tapioca flour (0 gram) was 0.46 mm. Thickness value of edible film made with the addition of 0.6g tapioca flour was 0.495 mm. Edible film with the addition of 1.2g tapioca flour resulted in thickness value of 0.54 mm. Edible film with the addition of 1.8g tapioca flour had thickness value of 0.585 mm. Moreover with the addition of 2.4g tapioca flour, thickness value was 1.025 mm (figure 4).

The addition of tapioca flour affected the thickness of edible film. The results showed that optimum thickness value of edible film was reached at 1.025 mm with addition of tapioca flour at concentration of 2.4g. The thickness value of edible film increased with increasing of concentration of tapioca flour. Thickness is an important parameter that influences the use of film in forming the product to be packaged. The thickness of film affected by retraction phenomenon that accure in film casting. It was related to composition of dry matter of film and shrinkage during drying period [9]. Thickness also affected the mechanical properties of edible film, such as tensile strength and elongation.

4. Conclusion

This study showed that edible film made from Tanduk Banana peel pectin had following mechanical properties: tensile strength, elongation, modulus young, and thickness. Mechanical properties of edible film such as tensile strength and modulus Young was affected by the addition of tapioca flour in edible film making. The optimum mechanical properties of edible film was obtained with the addition of 1.2g of tapioca flour. The value of edible film elongation and thickness were not affected by tapioca addition.

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