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Musa acuminata L. (Banana) Peel Wastes as Edible Coating Based on Pectin with Addition of *Cinnamomum burmannii* Extract

LAILAN NI`MAH[1,*], INDRI MAKHYARINI[2] and NORMALINA[3]

Department of Chemical Engineering, Faculty of Engineering, Lambung Mangkurat University, Banjarbaru 70714, Indonesia

*Corresponding author: Tel: + 62 812 51562219; E-mail: lailan.nimah@gmail.com

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Pectin functions as an adhesive and maintains tissue stability so that it can be used in making edible coating to improve the quality of food storage. One of the producers of pectin is *Musa acuminata* L. peel (containing 22.4 % pectin). In order not to overgrow with microbes, it is also necessary to have antimicrobial property, which can be obtained from *Cinnamomum burmannii* extract. This study is about raw material preparation, pectin extraction, pectin modification, *Cinnamomum burmannii* extraction and edible coating manufacturing. The parameters *viz*. thickness test, water vapour transmission, tensile strength test, elongation at break, biodegradation, and for trials on storing beef sausage showed that 10 % sorbitol was able to withstand the rate of fungal growth for 7 days; 15 % sorbitol was able to withstand the rate of fungal growth for 5 days; and 20 % sorbitol was able to withstand the rate of fungal growth for 3 days.

Keywords: Peel wastes, *Musa acuminata* L., Edible coating, Pectin, *Cinnamomum burmannii* extract, Sorbitol.

INTRODUCTION

South Kalimantan province of Indonesia is one of the largest producers of banana. The particular variety of banana named Kepok, is a processed banana, which is better in flavour and relatively more resistant to impact and storability [1,2]. Banana is a fruit that is often consumed by humans, either directly after the fruit is riped or processed into other food, but the problem persist as banana peels are thrown away without any further use.

Pectin is a natural substance found in most of the food plants. Pectin is a polymer of D-galacturonic acid linked by α-1,4-glycoside bonds [3]. Apart from being a structural element in tissue growth and the main component of middle lamella in plants, pectin also acts as an adhesive and maintains tissue and cell stability [4]. Pectin consists of good gel-properties so it can be used to make edible packaging. Pectin can be obtained from the peel of fruits such as banana, cocoa, passion fruit and orange peels. Pectin is not only used as an adhesive, but is also used in making new biodegradable materials [5-7].

Pectin is a reversible colloids and soluble in water, which can be precipitated, separated and dried and re-dissolved without losing its gel formation capacity. Pectin is precipitated by alcohol and used not only in identification but also in the manufacturing of the commercial pectin [8].

To improve the physical and functional characteristics of starch films, it is necessary to add biopolymers or other hydrophobic materials having antimicrobial properties [9,10]. Development of active packaging with the addition of antimicrobial can improve the film microstructure, mechanical properties (tensile strength and percent elongation), barrier properties (water vapour permeability and oxygen) and microorganism inhibition [9,11]. Some types of antimicrobial materials that can be added to edible coating/film packaging include essential oils derived from cinnamomum [12]. *Cinnamomum burmannii* is a plant whose bark and branches can be used as a spice materials, essential oils or oleoresin [13,14].

Edible coating is a unique category of packaging material that is different from conventional edible packaging materials. Edible coatings include biodegradable pack-aging films which is a new technology introduced in food processing which has the role of obtaining products with longer shelf life [6,15,16]. Edible coating is widely used for coating frozen meat products, semi-wet foods (intermediate moisture foods), confectionary products, frozen chicken, seafood products, sausages, fruits and medicines, especially for coating capsules [17]. The benefits of edible coatings are that it can optimize the external quality of the product, which protects the product from the influence of microorganisms, prevents the presence of water, oxygen and the transfer of aqueous solutions from food which can make the product become easily staple and moldy [18].

Owing to environmental issues, now a days environmental friendly packaging film (biodegradable) is fastly adopted. The making of edible coating has basic ingredients from nature in the form of pectin. In this study, pectin is used for making edible coatings packaging films obtained from the peel of manurun banana (*Musa acuminata* L.) which is largely grown in southern Kalimantan region of Indonesia. Additionally, *Cinnamomum burmannii* extract was also used using for its antimicrobial properties.

EXPERIMENTAL

Banana peels and *Cinnamomum burmannii* plant were obtained from the local fruit market of South Kalimantan province of Indonesia. While the chemicals and analytical grade chemicals were purchased from Sigma-Aldrich, USA and used as such.

Extraction of *Musa accuminata* L. peel: The extraction process is done by first drying the banana peel for 3 h in an oven, after that banana peel was blended smoothly. Added ordinary water with a ratio of 1:15 followed by the addition of 0.25 N HCl till pH reached 1.5. The mixture was stirred and heated at 70 ºC for 2 h, filtered and allowed to cool at room temperature. Alcohol (96 %) with a ratio of 1:1 was added and left for 16 h. After that the mixture is filtered and a wet pectin is obtained and then washed with 96 % alcohol three times. The pectin is dried at 60 ºC in oven for 8 h.

Modification of banana pectin (*Musa acuminata* L.): The pectin modification process begins by dissolving banana pectin in distilled water. The pH of solution was raised using 3N NaOH to pH 10 and then incubated in an oven at 55 ºC for 1 h. The mixture was allowed to cool to room temperature and again raise the pH of the mixture to 1.5 using 3N HCl and stored overnight. The mixture was precipitated with 96 % alcohol, and allowed to stand in ice for 2 h was pectin residue filtered and then washed finally with acetone. The pectin residue was dried in an oven until it can be blended and sieved 60 mesh.

Extraction of *Cinnamomum burmannii*: Cinnamomum powder (5 g) was placed in a Erlenmeyer flask containing 100 mL distilled water. The solution is heated at 60 ºC for 60 min and then left for 15 min, filtered and preserve the filtrate for further studies.

Production of edible coatings: Accurately weighed 4 % modified pectin, added 0.8 g carboxymethyl cellulose (CMC), and sorbitol in different protions (20, 15 and 10 %). Then added 0.22 g potassium sorbate and 0.14 g of stearic acid into a beaker containing 100 mL distilled water. Then heat the solution up to 80 ºC for 60 min. Cinnamomum extract (1 %) was added and mixed into the edible coating solution with constant stirring using a magnetic stirrer. Temperature of the solution was reduced to 30 ºC for 2 h and then finally coated materials were kept in oven for 24 h at 30 ºC.

RESULTS AND DISCUSSION

Tensile strength: Tensile strength was tested using Torsee's Electronic System Universal testing machine with a speed of 20 mm/min and a load of 100 kgf. Tensile strength test results are shown in Table-1. The best tensile strength was obtained at 10 % sorbitol with a value of 47.1 Mpa. It is believed that increasing the concentration of sorbitol will reduce the tensile strength of edible films, which is in agreement with previous research [19]. The use of plasticizer on edible film will also affect the tensile strength produced. The addition of sorbitol as a plasticizer causes the plasticizer molecules in the solution to lie between the biopolymer bonding chains and can interact by forming hydrogen bonds in the polymeric bonding chains, thereby reducing the interaction between the biopolymer molecules. In addition, as plasticizers will reduce the internal hydrogen bonds in intermolecular bonds because it reduces the stability of the solid dispersion system, consequently the resulting edible coating has weaken the physical properties which will decrease the strength of the edible tensile produced.

Elongation at break: The mechanism of sorbitol as a plasticizer is that sorbitol is a low molecular weight hydrophilic compound which can enter into a polysaccharide intermolecular tissue. Sorbitol can make the distance between molecules wider and produce flexible properties and reduce the level of fragility of the resulting film. Elongation at break test results are shown in Table-1. The results showed that the lowest elongation at break was obtained at 10 % sorbitol by 16.93 %, while the highest vapour transmission rate was 23.22 % at 15 % sorbitol.

It can be observed that the variation of sorbitol concentration on elongation at break shows fluctuating patterns. This is due to plasticizer molecules at certain concentrations of total dissolved solids interacting thereby affecting the increase or decrease in the value of elongation or percent elongation. Addition of more sorbitol will produce edible film which has a higher water content. The higher water content will produce more flexible properties which in turn increase the elongation value of edible film. In addition, increase in the concentration of plasticizer will also produce an increase in the elongation percentage. This is because an increase in the amount of plasticizer decreases intermolecular forces, consequently the level of mobility between molecular chains increases. Plasticizers will add the flexibility of the resulting edible coating, where more plasticizers are added to a certain extent making the edible coating more elastic and flexible [20].

Biodegradation testing: Biodegradation is a chemical process by microorganisms. Biodegradable materials are these materials that can be consumed by microorganisms, while the ability of biodegradation is defined as the ability of material to be composed by biological agents, especially bacteria. Observations were made after every 2 days in the open air. Observations on day 3 showed a reasonably good condition for all sausages, but for sausages wrapped in 20 % edible sorbitol appeared to be sticky with sausages because they consist of good water content which facilitates interaction of water molecules with the surface of sausages.

Using 15 % sorbitol, sausages were hardened and slippery, this is because it has a small amount of steam content of pectin fiber which makes sausages hard, while at 10 % sorbitol is still

TABLE-1
VALUE OF THE DIFFERENT PARAMETERS OF EDIBLE COATING FILMS PREPARED FROM *Musa acuminata* (BANANA) PEEL WASTES CONTAINING 1 % *Cinnamomum burmannii* EXTRACT

Sorbitol (%)	Tensile strength (MPa)	Elongation at break (%)	Thickness (mm)	Water vapour transmission ($g/m^2/24$ h)
10	47.1	16.93	0.1300	175.267
15	26.1	23.22	0.2410	77.5167
20	18.1	18.28	0.2367	115.608

dry and not hardened but dull. On the 7th day, the condition of all sausage protectors was putrefied, this was due to external air factors and the condition of the edible film. At the 20 % sorbitol, the packaging material become damaged in the form of mucus and aqueous, this was in accordance with the high value of the steam transmission rate obtained compared with other variations. Sausages which were not coated with edible film would immediately rot compared to sausages which were coated with edible films. This shows that edible film from banana peel pectin inhibits mold growth in raw sausages stored at room temperature. This is caused by the pectin content in the edible film which can inhibit the rate of fungal growth due to the hydrophobic bonding of the pectin polymer itself which protects the outer surface layer of cow sausage.

Thickness analysis: Based on Table-1, the largest thickness value of 0.241 mm was obtained from edible film having 15 % sorbitol while edible coated film having 10 % sorbitol has the smallest thickness value (0.13 mm). It can be seen that in variations in the concentration of sorbitol, thickness shows fluctuating patterns. This is due to plasticizer molecules at certain concentration of total dissolved solids interacted thereby affecting the increase or decrease the thickness value. Thickness increases with increasing plasticizer concentration. Increasing the concentration of plasticizer will increase the polymer matrix compilers along with the increase in total solids in the film solution, thereby causing the film thickness to increase. Marseno [21] also explained that the greater concentration of plasticizer will increase the thickness and total solids in the edible coating so that the film thickness will increase. In this study, thicknesses ranged from 0.13 to 0.241 mm where the thickness of the edible coating produced meets the standard, namely the maximum value of the thickness of edible film and coating according to the Japanese Industrial Standard is 0.25 mm.

Water vapour transmission analysis (WVP): Water vapour transmission rate is one of the most important properties in edible film. WVP value can be used to measure the permeability value of a material to water vapour and the water vapor permeability is the size of a material that can be passed (penetrated or impregnated) by water vapour. The results of steam water transmission rate are shown in Table-1.

It can be seen that the edible coating with the addition of 15 % sorbitol has the lowest water vapour transmission rate which is 77.5167 $g/m^2/24$ h. While the highest water vapour transmission rate is found in edible coatings with the addition of 10 % sorbitol, which is 175.267 $g/m^2/24$ h. The rate of water vapour transmission increases with increasing sorbitol concentration due to its hydrophilic in nature, and allows water vapours to penetrate the edible films thereby increasing the rate of transmission of water vapour [22].

Conclusion

In this work, *Musa acuminata* L. (banana) peel wastes were used as edible coatings with the addition of *Cinnamomum burmannii* extract. The pectin contents were modified in order to increase its methoxy contents using acetone leaching and also increased the galactonic acid levels to 79.92 % from 67.76 %. Edible films were prepared using modified pectin, sorbitol and 1 % of *Cinnamomum burmannii* extract. It was found that edible coating films with 10 % sorbitol can withstand the rate of fungal growth for 7 days, 15 % sorbitol can withstand the rate of fungal growth for 5 days, while sorbitol 20 % is able to withstand the rate of fungal growth for 3 days only.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this article.

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