Effect of antimicrobial addition from lime extract on edible film as food packaging

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Abstract. Edible film from cassava starch was successfully synthesized. It was equipped with antimicrobials created from glycerol and lime extract. In this study, edible film will be utilized as food packaging. It was easily produced through simple methods. Cassava starch was mixed with glycerol and lime extract in various concentrations. The effect of dosage concentration of lime extract was studied. The thickness of film, moisture content, swelling degree, solubility, water vapor transmission and biodegradability were also studied. Edible film obtained at 0.25 mm of thickness, the swelling degree did not reach 2%. The biodegradability for seven days was only at 60%. This edible film can be viable option as food packaging

Keywords: Antimicrobial; Cassava Starch; Edible film; Lime extract.

1. Introduction
Plastics are still main packaging for various product. This had been environmental issues for recent years[1]. The accumulated plastics in landfills pollutes the environment threaten life. With the increasing of public awareness towards environment and food safety, converting from traditional plastic for food packaging to edible polymers become important[2]. Edible polymers also offer mechanical protection that can potentially be used as water vapor and gas barriers. An edible film is defined as a film that can keep moisture and gas from contaminating food products, defend them from deterioration, and improve food quality. They are also expected to contain active substance such as probiotics, antioxidants and enzymes[3].

Cassava starch is a good material for edible film due to its inexpensive, biocompatible and biodegradability. In particular for food packaging, cassava starch is transparent, odorless and has good oxygen barrier properties[4]. However, pure cassava starch has low mechanical properties. It needs addition of plasticizers to improve its flexibility. In this study, sorbitol and glycerol were chosen as plasticizers due to its stability and compatibility with hydrophilic food package[5].

The study of edible film as food packaging is extended to the ability of the film to prevent microorganism deteriorate the food inside package. Antimicrobial properties such as phenol, flavonoid and essential oil that is contained in lime extract will become added value if it is added on edible film.[6] The objectives of this study are mainly study the effect of addition lime extract as antimicrobial agent towards the mechanical properties of edible film and its biodegradability.
2. Experimental

2.1. Materials
Commercial cassava starch was used, glycerol from sigma-Aldrich, local lime (*Citrus aurantiifolia*) was mechanically extracted and then filtrated to obtain lime extract, silica gel, acrylic mold, molasses and EM4 (Effective microorganism) was used as biodegradable test.

2.2. Edible Film
7.5 g of cassava starch was suspended with 50 ml water. It was mixed at 60 °C, 500 rpm for 40 minutes. After gelatine was formed, it was cooled until 37 °C. 10% (w/w) Glycerol was entered to the suspension together with lime extract (0%, 5%, 10%, 15%, 20% (w/w)). After the suspension became homogenous, it was poured to acrylic mold. Edible film then was dried at 50°C for 24 hr.

2.3. Analytical Methods

2.3.1. Thickness.
Thickness measurement was done by micrometre. Five random places were measured and the results were averaged.

2.3.2. Moisture content
Sample was measured its weight before dried on oven and desiccator. After dried on oven and desiccator, the weight was measured until consistent. The moisture content was calculated as follows:

\[
\text{Moisture content} = \frac{(B-C)}{(C-A)} \times 100\%
\]

Details:
A = Weight of empty cup (g)
B = Weight of empty cup+sample (g)
C = Weight of empty cup +dried sample (g)

2.3.3. Degree of swelling
The sample was soaked with room temperature water for 24 h. the degree calculation as follows:

\[
\text{Degree of Swelling} = \frac{(C-B)}{C} \times 100\%
\]

Details:
A = Weight of empty cup (g)
B = Weight of empty cup (g) + sample before soaked (g)
C = Weight of empty cup (g) + sample after soaked (g)

2.3.4. Biodegradability.
Biodegradability test was carried out by mixing the sample with EM4 for 7 days. The weight of the sample was measured before and after mixing.

3. Result and Discussion
Figure 1. Edible film transparency with concentration of antimicrobial agent (a) 0% (b) 5% (c) 10% (d) 15% (e) 20%.

3.1. Physical Characteristics of edible film

Edible film from cassava starch was successfully created. It was equipped with lime extract as antimicrobial agent. The first characteristic that was observed was the transparency of the edible film. Transparency is known as one of factors that important for consumer acceptance since it had direct impact towards edible film appearances.[7,8] Figure 1 shows the transparency of edible film equipped by antimicrobial agent for different antimicrobial agent concentration. From the figure, there is not much different in transparency, it indicates that the concentration of antimicrobial agent did not have significant impact in the transparency of the film. The next characteristic is thickness. Thickness is one important parameter for edible film, because it represents the strength of the edible film. Figure 2 shows the effect of antimicrobial agent to the thickness of film. The highest thickness obtained was 0.15 mm.

Figure 2. Thickness of edible film.

The moisture content of edible film determined quality of the film. If the moisture content of the film is too high, it will be easy for the product that used film as a package become demerited. The cassava starch as raw material of film is hydrophilic, this is good for the film because it will ensure water to be absorbed. The addition of lime extract had effect of moisture content as shown in figure 3. The higher lime concentration had tendency to higher moisture content in the edible film. This can be resolved by extending drying process[9].

Figure 3. Moisture content of edible film.

The degree swelling is level up of moisture content characteristics. In this test, edible film was intentionally soaked with water for 24 h. If the edible swell, it will reveal that the quality of the film still
poor. Figure 4 shows degree of swelling in the effect of addition of antimicrobial agent. It indicated that the edible film had good quality since the degree of swelling is very low.[4]

![Figure 4. Degree of swelling of edible film](image)

The final important characteristics was solubility of edible film. The edible film should not be easily soluble in the water since it had role to protect the product inside it. Figure 5 shows the solubility of edible film in the water. From the figure, the edible film has low solubility in the water which is good sign for its quality [10].

![Figure 5. Solubility of edible film in water.](image)

3.2. Biodegradability
In this study, biodegradability represents weight loss of edible film during degradation by certain bacteria. Biodegradability not only measuring the strength of edible film but also its degradability in the soil. In this study, EM4 was utilized since it contains many soil bacteria. Figure 7 shows the biodegradability of the film after equipped by lime extract as antibacterial agent. From the figure, edible film can still be degraded by soil bacteria. However, at 15% addition, it was indicated that there was not weight loss, it might due to the existence of antioxidant generated from lime extract[4].
4. Conclusion
Edible film from cassava starch was successfully synthesized. It had physical characteristic at 0.25 mm of thickness, the swelling degree did not reach 2%, it also showed good biodegradability and decent transparency. Edible film from cassava starch equipped with lime extract as antimicrobial agent was viable option as food packaging since there was not significant effect toward physical and chemical quality after the edible film was equipped with antimicrobial agent.

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