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Fabrication of Edible Film from Papaya Extract (*Carica Papaya L.*) with a Mixture of Tapioca Flour, Wheat Flour, and Glycerine

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Abstract. Fabrication of edible film from papaya extract (Carica papaya L.) with tapioca , wheat and glycerin mixture has been successfully conducted. The edible film was made by mixing papaya extract, tapioca, wheat, and glycerin until homogeneous and poured on the plastic plate then dried in an oven for 2 days at 40ºC with the comparison of tapioca: wheat (7.5 g: 2.5 g) and (5 g: 5 g). Edible films produced were then tested for their characteristics and nutrient levels. The results show that the edible film with the comparison of tapioca: wheat (7.5 g: 2.5 g) show a good result with the characteristics which include thickness tensile strength, elastic and SEM that is 0.193 mm; 0, 1442 Kgf/mm-^{2}; 48.82% and making a film with the structure that has tight pores, compatible, and smooth. The levels of nutrients were water, ash, protein, fat, carbohydrates, and beta carotene from the edible film were 16.23 %; 2,921 %; 5.44 %; 1.76 %; 73.65 %, and 116.052 ppm, respectively. The organoleptic test results show good results that the panelist liked the edible film.

Keywords: Edible Film, Papaya, Tapioca, Wheat, Glycerin

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1 Introduction

Foodstuffs are generally very sensitive and easily degraded due to environmental, chemical, biochemical, and microbiological factors. The decrease in the quality can be accelerated in the presence of oxygen, water, light, and temperature. One way to prevent or slow down this phenomenon is with proper packaging. Food packaging is the process of packaging food with appropriate packaging materials. Packaging can be made of one or more materials that have appropriate uses and characteristics to maintain and protect food in the hands of consumers, so its quality and safety can be maintained (Hui, 2006).

Packaging has developed very rapidly, ranging from traditional and natural packaging to modern attractive synthetic packaging. However, with technological advances, plastic makes

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humans trapped in the technology that they created by themselves. Plastic, which was originally a symbol of a new packaging civilization, now has a toxic impact that is very detrimental to human life, so packaging from natural materials has begun to be widely developed (Suminto, 2006).

On the other hand, consumer demand for highly nutritious food, which is more durable or longer stored and meets environmental demands is increasing. Krochta (1994) stated that edible plastic packaging, hereinafter referred to as edible film, has potential characteristics to meet the needs of these consumers.

The edible film is a type of material for coating and wrapping various foods to extend the shelf life of products, which may be eaten together with food (Embuscado, 2009). Meanwhile, according to Bourtoom (2007), the edible film is defined as an edible thin layer placed on or between food components, which can provide an alternative packaging material that does not have an impact on environmental pollution because it uses renewable materials and the price is cheap. The development of edible films in food, in addition to providing better product quality and extending shelf life, is also an environmentally friendly packaging material.

Edible films can combine with food additives and other substances to enhance the color, aroma, and texture of products, control microbial growth, and increase the attractiveness of food. Benzoic acid, sodium benzoate, sorbic acid, potassium sorbate, and propionic acid are some of the antimicrobials added to edible films to inhibit microbial growth. Citric acid, ascorbic acid, and other esters are some of the antioxidants were added to the edible films to increase stability and maintain nutritional composition and food color by preventing rancidity oxidation, degradation, and discoloration (Wahyu, 2008).

Papaya fruit contains many vitamins, such as vitamin A which is found in 100 g of ripe papaya and contains between 1.094 to 18.250 SI. Meanwhile, beta-cryptoxanthin, zeaxanthin, and lutein act as antioxidants in preventing cancer and other degenerative diseases. In addition, there is vitamin C (62 to 78 mg/100 g) and folate (38 micrograms/100 g) (Suryani, 2010).

Wheat flour contains gluten, which is what distinguishes wheat flour from other flour. Gluten is a compound in wheat flour that is chewy and elastic. Where in bread making, gluten is what expands well and can determine the elasticity of the noodles, and has a role in making egg martabak so it is not easily torn. Generally, the gluten content determines the protein content of wheat flour, the higher the gluten content, so the higher the protein content of the wheat flour. Gluten content in wheat flour, which determines the quality of making a portion of food, is very dependent on the type of wheat (http://www.bogasari.com/about-kami/seputar-tepung-terigu.aspx).

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Tapioca flour has the advantage because it contains linamarin so it can prevent the growth of cancer cells. Tapioca flour is often processed into glucose syrup and dextrin which is needed by various industries, including the confectionery industry, fruit canning, ice cream processing, beverages, and the fermentation industry (http://www.scribd.com/doc/ Tapioca Flour).

Research on edible films with various fillers has been carried out. Among them by utilizing starch from various sources. One of the studies that have been carried out is "Fabrication an edible film from sago starch using fillers of sago stem powder and glycerol as plasticizer" by Hasibuan (2009) and "Fabrication of edible film from a mixture of starch, papaya fruit extract (*Carica papaya L.*) and glycerin as packaging material” by Ulpa (2011).

Based on the description above, the authors would like to make edible films from papaya extract (*Carica papaya L.*) with a mixture of tapioca flour, wheat flour, and glycerin.

2 Materials and Methods

2.1 Equipments

In this study, the equipments used were an oven, Kjeldahl flask, distillation apparatus, soxhlet apparatus, stirrer, desiccator, UV-Visible spectrophotometer, torsion apparatus, paper lead, analytical balance, furnace, and crucible cup.

2.2 Materials

The materials used were glycerin, selenium, H_2SO_4, H_3BO_3, NaOH, HCl, N-hexane, Tashiro Indicator, aquadest, papaya, tapioca flour, and wheat flour.

2.3 Sample Preparation

Papaya is peeled and then seeds were removed. Then the papaya that has been cleaned was cut into small pieces, squeezed with gauze, and then filtered. The papaya fruit extract filtrate was produced.

2.4 Fabrication of Edible Film

2.4.1 Comparison of Tapioca Flour and Wheat Flour (7.5 g:2.5 g)

A total of 100 mL of papaya fruit extract was put into a beaker glass. Then, added 7.5 g of tapioca flour and 2.5 g of wheat flour. Stirred until homogeneous with a magnetic stirrer. Then, heated at 70ºC on a hotplate and 1 mL of glycerin was added. Next, the mixture was stirred again until homogeneous and thickened. Then, poured into a plastic plate while flattened. Dried in the oven ± for 2 days at 40ºC.

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2.4.2 Comparison of Tapioca Flour and Wheat Flour (5 g:5 g)

A total of 100 mL of papaya fruit extract was put into a beaker glass. Then, added 5 g of tapioca flour and 5 g of wheat flour. Stirred until homogeneous with a magnetic stirrer. Then, heated at 70ºC on a hotplate and 1 mL of glycerin was added. Next, the mixture was stirred again until homogeneous and thickened. Then, poured into a plastic plate while flattened. Dried in the oven ± for 2 days at 40ºC.

2.5 Edible Film Thickness Measurement

The thickness measurement of the edible film was measured using a caliper at three different places and then the average thickness of the edible film was calculated.

2.6 SEM (Scanning Electron Microscopy) Analysis

The sample to be tested was cut in sizes of ± 0.3 cm x 0.3 cm x 0.2 cm. Then a specimen holder with a diameter of 1 cm and a thickness of 0.5 cm was prepared which had been cleaned with acetone and smeared with dotite. Then the sample was attached to the specimen holder and dried on a hot plate for 10 to 15 minutes. The dried samples were then put into a fine-coat apparatus and tested using SEM spectroscopy.

2.7 Tensile Strength Test

Tensile strength is one of the most important basic properties of polymer materials and is often used to characterize a polymeric material. The tensile strength of a material is defined as the maximum load (F_{max}) used to break the specimen divided by the initial cross-sectional area (A_0).

Tensile Strength Test Calculation:

$$\text{Tensile strength} = \frac{Fmaks}{Ao} = \frac{Load}{Ao} \qquad (1)$$

$$\text{Elongation } (\varepsilon) = \frac{\text{stroke}}{I_0} \text{x } 100\% \qquad (2)$$

Description:

ε *Load* = voltage

Stroke = strain

Ao = Specimen area

lo = specimen length

2.8 Determination of Moisture Content

The edible film was put into a porcelain cup that has a known weight. Then dried in the oven at 100 to 105ºC for 6 hours. The cup was cooled into a desiccator. After cooling, the dried cup was

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weighed. This was repeated continuously until a constant weight was obtained. Then the water content was calculated.

Calculation formula:

$$\text{Content} = \frac{\text{Wi}}{\text{Wo}} \times 100\% \qquad (3)$$

Description:

Wi = Weight of loss vapor

Wo = Weight of wet sample

2.9 Determination of Ash Content

As much as 2 g of the edible film was weighed and put into a porcelain dish of known weight. It was heated at a maximum temperature of 600ºC for 3 hours. Then, cooled in a desiccator and was weighed until a constant weight was obtained.

Calculation Formula :

$$\text{Ash content} = \frac{M2 - M1}{Mo} \times 100\% \qquad (4)$$

Where,
Mo : Sample Weight (g)
M1 : Empty Crusible Weight (g)
M2 : Crusible Weight + Ash (g)

2.10 Determination of Protein Content

The edible film was weighed and put into a 100 mL Kjeldahl flask and added 2 g of selenium and 25 mL of concentrated H_2SO_4. Then, It was heated on an electric heater or a burner until it boils and the solution becomes clear greenish. Allowed to cool, then put into a 250 mL volumetric flask and diluted with distilled water to the marked line. As much as 50 mL of the solution was taken with a pipette and put into a distillation apparatus, and added 50 mL of 40% NaOH (aq). Then, distilled for 10 minutes. The distillate was accommodated in an Erlenmeyer glass containing 25 mL of 4% borate solution that had been mixed with the Tashiro indicator and then titrated with 01N of HCl solution.

$$\%\ \text{protein} = \frac{\text{V x N HCl x 0,014 x f.k x f.p}}{\text{W}} \times 100\% \qquad (5)$$

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Where, V: volume of titrant used

f.k : protein conversion factor

f.p : dilution factor

W: sample weight

2.11 Determination of Fat Content

As much as 10 g of the edible film was weighed and put into a beaker glass and added 30 mL of 25% HCl and 20 mL of distilled water and some boiling stones. Then boiled until black and then filtered with Whatman filter paper No.41 in hot condition. Next, washed with distilled water until it does not react with acid. Then the filter paper was inserted into the paper thimble. Then put into a Soxhlet apparatus and extracted with n-hexane for approximately 5 hours. Distilled with n-hexane and dried the fat extract in an oven at 100 to 105ºC. Then, cooled and weighed to a constant weight.

Calculation formula :

$$\text{Fat content} = \frac{\text{Wfat}}{\text{Wsample}} x100\% \quad (6)$$

Description :

Wfat = Weight of fat

Wsample = Weight of sample

2.12 Determination of Carbohydrate Content (by difference)

The total percentage of moisture, ash, fat, and protein content was calculated. Carbohydrates are known by calculating the difference between 100% and the sum of these percentages.

Carbohydrate content = 100% -

% (protein + fat + water + ash)

(Winarno, 1992).

2.13 Determination of Beta Carotene Content

A total of 0.1 g of edible film from papaya fruit extract was dissolved with distilled water in a 25 mL of volumetric flask. Diluted to the marked line then homogenized. Next, inserted into a cuvette and then the absorbance was measured at 446 nm. The absorbance was recorded. Then, calculated the value of beta-carotene using the formula:

$$\beta\text{-carotene} = \frac{\text{Abs x 383 x Vt}}{\text{Wsampel (g) x 100}} \quad (7)$$

Where the value of 383 was the determination of the beta carotene search formula.

2.14 Determination of Organoleptic Value

This test includes color, smell, taste, and texture which were determined by a preference test by 15 panelists, where the panelists were non-smokers, and before tasting, it was required to drink water first. This test was determined by the hedonic scale as follows:

Tabel 1. Organoleptic test hedonic scale

Hedonic Scale	Numerical Scale
Like very much	5
Really like	4
Like	3
Dislike Moderately	2
Dislike very much	1

3 RESULT AND DISCUSSION

3.1 Results

The results of edible films obtained in this study can be seen in the table below:

Tabel 2. Analysis of the nutritional content of the edible film obtained

No	Parameter	Results Comparison 7.5 g:2.5 g	Results Comparison 5 g:5 g
1	Water content	16.23%	20.48%
2	Ash content	2.921%	2.408%
3	Protein Content	5.44%	5.35%
4	Fat Content	1.76%	2.31%
5	Carbohydrate Content	73.65%	69.42%
6	Beta Carotene Content	116.052 ppm	176.721 ppm

Tabel 3. Analysis of the characteristics of edible films obtained:

No	Parameter	Results Comparison 7.5 g:2.5 g	Results Comparison 5 g:5 g
1	Tensile Strength	0.1442 KgF/mm^2	0.1181 KgF/mm^2
2	Elongation	43.09%	39.25%
3	Thickness	0.193 mm	0.216 mm

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3.2 Discussion

3.2.1 Moisture Content

The water content of edible film from papaya fruit extract with a mixture of tapioca flour, wheat flour, and glycerin with a ratio of tapioca flour: wheat flour (7.5 g: 2.5 g) produced was 16.23% and the water content of edible film from fruit extract papaya with a mixture of tapioca flour, wheat flour and glycerin with a ratio of tapioca flour: wheat flour (5 g: 5 g) produced was 20.48%.

The higher the water content of the edible film produced will result in a decrease in the quality of the edible film due to the ease with which the material undergoes decay by microorganisms. The water content of the edible film should be below the Aw of bacteria (0.6), Aw of yeast (0.87 to 0.91), and Aw of fungi (0.8 to 0.87). It was intended that the edible film which will be used as food packaging was not overgrown with fungus and free from bacteria and yeast that can grow on media containing high water content and has the appropriate Aw. Based on the data on water content, it can be seen that the edible film with a ratio of tapioca flour: to wheat eggplant (7.5 g: 2.5 g) has lower water content. This means that edible films with this ratio are better to use because they are expected to rot longer than those with high water content. The level of water content in this edible film depends also on the maturity level of the papaya fruit extract used and the humidity of the environment when the edible film is stored before the water content test is carried out.

3.2.2 Ash Content

The ash content of edible film from papaya fruit extract with a mixture of tapioca flour, wheat flour, and glycerin with a ratio of tapioca flour: wheat flour (7.5 g: 2.5 g) produced is 2.92% and the ash content of the edible film with a ratio of flour tapioca: wheat flour (5 g: 5 g) produced was 2.41%. According to Sudarmadji, ash was an inorganic substance left over from the combustion of organic material. The ash content in a food ingredient shows the minerals contained in the food. The ash content and composition in it depend on the material and the method of ashing. In addition, the influence of temperature, pH, cleanliness, and purity of material also affects the ash content of a food ingredient.

The edible film with a ratio of tapioca flour: wheat flour (7.5 g: 2.5 g) has a higher ash content than the edible film with a ratio of tapioca flour: wheat flour (5 g: 5 g) due to the addition of tapioca flour which more, where in tapioca flour there are various inorganic substances such as

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calcium, iron, phosphorus, potassium, zinc, copper, and so on. So it can be concluded that these inorganic substances affect the ash content of the edible film produced.

3.2.3 Protein Content

The protein content of edible film from papaya fruit extract with a mixture of tapioca flour, wheat flour, and glycerin with a ratio of tapioca flour: wheat flour (7.5 g: 2.5 g) was 5.44% and the protein content of the edible film with a ratio of tapioca flour: wheat flour (5 g: 5 g) of 5.35%. The protein content of the edible film with the ratio of tapioca flour: to wheat flour (5 g: 5 g) was lower due to the higher water content. With increasing water content, the speed of protein hydrolysis reactions by enzymes that may come from bacteria on *edible films* is also faster. Therefore, some proteins will undergo a hydrolysis process. The hydrolysis process will result in the formation of free amino acids. These amino acids then undergo a deamination process and produce keto acids and ammonia. This ammonia was likely to be oxidized to nitrite by nitrifying bacteria as a food source. As a result, the protein content in the analysis using the Kjeldahl method decreased.

The high protein content of the edible film produced comes from wheat flour which is added to the manufacture of edible films, where the protein from wheat flour is 8.9 g/100 g. This edible film is suitable for consumption because of its high protein content. The protein content of edible films in addition to increasing the nutritional content of edible films as food packaging materials also increases the ability of edible films to protect packaged food ingredients. By regulating the migration of oxygen and carbon dioxide molecules through the pores of the edible film, it can prolong the decay process of packaged foodstuffs.

3.2.4 Fat Content

The fat content of the edible film from papaya fruit extract with a mixture of tapioca flour, wheat flour, and glycerin with a ratio of tapioca flour: wheat flour (7.5 g: 2.5 g) was 1.76% and the fat content of the edible film with a ratio of tapioca flour: wheat flour (5 g: 5 g) was 2.31%. This fat content was from tapioca flour and wheat flour where tapioca flour has a fat content of 0.02 g/100 g and wheat flour of 1.3 g/100 g. Therefore, the fat content of edible films with a ratio of tapioca flour: wheat flour (5 g: 5 g) was higher because the fat contribution from wheat flour is higher than that of edible films made with a higher ratio of tapioca flour. Fat content is one of the important nutrients because it is a source of energy. According to Winarno, one gram of fat can produce 9 kcal, while carbohydrates and protein only produce 4 kcal.

3.2.5 Carbohydrate Content

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Carbohydrate content of edible film from papaya fruit extract with a mixture of tapioca flour, wheat flour, and glycerin with a ratio of tapioca flour: wheat flour (7.5 g: 2.5 g) is 73.65% and the carbohydrate content of the edible film with a ratio of tapioca flour: wheat flour (5 g: 5 g) was 69.42%. Carbohydrate content in the edible film with a ratio of tapioca flour: wheat flour (7.5 g: 2.5 g) was higher due to the addition of more tapioca flour, where carbohydrates from tapioca flour itself were 88.69 g/100 g. while the carbohydrates in wheat flour were only 72.3 g/100 g. However, the addition of tapioca flour and wheat flour, papaya fruit extract also contributed quite high carbohydrates was 12.2 g/100 g.

Carbohydrate content in edible films in addition to increasing the nutritional content of edible films as food packaging materials, together with protein can increase the ability of edible films to regulate the migration of oxygen and carbon dioxide molecules through the pores of the edible film, to prolong the decay process of packaged foodstuffs.

3.2.6 Beta Carotene Analysis

Beta carotene analysis was carried out by spectrophotometric method. Where beta carotene was measured at a wavelength of 446 nm. The test results of beta carotene edible film from papaya fruit extract with a mixture of tapioca flour, wheat flour, and glycerin with a ratio of tapioca flour: wheat flour (7.5 g: 2.5 g) produced was 116.052 ppm and for edible films with a ratio of tapioca flour: wheat flour (5 g : 5 g) was 176.721 ppm. The value of beta carotene comes from one of the ingredients for making edible films, namely papaya fruit. Where the level of beta carotene in papaya fruit is 267 g /100 g or equivalent to 267 ppm. The value of beta carotene produced in the edible film was smaller than the standard value of beta carotene in papaya fruit. This was because the beta carotene in the edible film starts to break down due to heating during the manufacture of the edible film. Where the nature of beta carotene itself is easily damaged by temperatures that are too high. With this beta carotene, the edible film becomes colored so that it has its charm to be used as food packaging.

3.2.7 Tensile Strength and Elongation Analysis

Tensile strength and elongation were mechanical properties related to the chemical properties of the film. Tensile strength was the maximum force that a film can withstand until it breaks. This parameter was one of the important mechanical properties of edible films. The tensile strength that was too small indicates that the film in question cannot be used as packaging, because its physical character is not strong enough and was easily broken. The measurement of the tensile strength of edible films was carried out using tensile strength and elongation apparatus (Jamaluddin, 2009).

Mechanical characteristics of edible film from papaya fruit extract with a mixture of tapioca flour, wheat flour, and glycerin include thickness, tensile strength, and elongation. Where the thickness of the edible film was produced with a ratio of tapioca flour: wheat flour (7.5 g: 2.5 g) was 0.19 mm, the tensile strength was 0.1442 KgF/mm^2, elongation was 48.82%, and for an edible film with a ratio of tapioca flour: wheat flour (5 g: 5 g) has a thickness was 0.22 mm, tensile strength 0.1181 KgF/mm^2 and elongation was 38, 62%. When compared to the research of Dwi Raafiah Ulpa (2011) who made edible films without the addition of wheat flour with a tensile strength of 0.02 KgF/mm^2 and an elongation of 24%, this edible film was much better.

By the comparison of tensile strength and elongation results can be concluded that the edible film of papaya fruit extract with a mixture of tapioca flour, wheat flour, and glycerin with a ratio of tapioca flour: wheat flour (7.5 g: 2.5 g) has the best characteristics. This was because in wheat flour there is gluten, which specifically distinguishes flour from other flours. Gluten is a compound in wheat flour that was chewy and elastic. With the presence of this compound in wheat flour, the edible film produced was more elastic and does not break easily when pulled.

This also happens because, with the addition of 2.5 g of wheat flour, the edible film is at the saturation point so that the plasticizer molecules were only dispersed and interact between the polymer chain structures and making the polymer chains more difficult to move. This was what causes the tensile strength to increase in addition to the intermolecular forces between the starch chains. However, if more flour was added, the saturation point has passed so that the excess plasticizer molecules are in a separate phase outside the polymer phase and will reduce the intermolecular forces between polymer chains on the starch so that *the edible film* was also less well characterized.

3.2.8 SEM Analysis

The SEM results on edible films, the surface of the edible film will usually be shown. This even surfaces or not depends on the constituent materials, whether they are perfectly mixed or not. Where the matrix, filler, and plasticizer must be mixed well to produce a good edible film surface as well. The results of the SEM analysis that has been carried out, the surface of the edible film of papaya fruit extract with a mixture of tapioca flour, wheat flour, and glycerin with a ratio of tapioca flour: wheat flour (7.5 g: 2.5 g) at 1000x magnification as shown in figure 1.

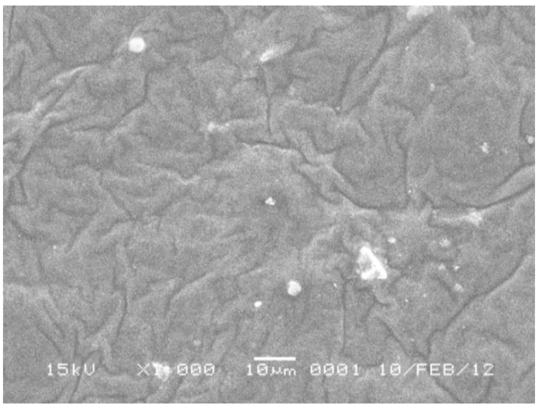

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Figure 1. The SEM result of the edible film with the surface of edible film from papaya fruit extract, tapioca flour, wheat flour, and glycerin with a ratio of tapioca flour: wheat flour (7.5 g: 2.5 g) at 1000x magnification

Figure 1 shows that the surface was flat and compatible. This means that the mixing of the ingredients for the edible film with the ratio of tapioca flour: wheat flour (7.5 g: 2.5 g) was perfect where the matrix in the form of tapioca flour, filler in the form of wheat flour, and plasticizer in the form of glycerin have been mixed well so that produce a surface that looks compatible.

3.2.9 Organoleptic Test

An organoleptic test on the texture, taste, color, and aroma of the edible film was carried out by panelists. Organoleptic test on edible film texture with the ratio of tapioca flour: wheat flour (7.5 g: 2.5 g) has a score was 2.86 and the edible film with the ratio of tapioca flour: wheat flour (5 g: 5 g) was 3.06. It meant that edible films with more tapioca flour additions were less preferred by panelists because the texture was too dense so the crushing process in the mouth takes a little longer. The aroma of the edible film has an average score were 3.26 and 3. Where the edible film produced has a distinctive papaya aroma. Based on the taste test, the average score was 2.73 and 2.6. Therefore, it can be concluded that the panelists do not like the taste of this edible film, which was too sweet, so it got boring quickly. As for the color test, the highest scores were 4.06 and 3.73, which means that the panelists liked the color of the edible film produced because it was light orange, and interesting to look at.

4 Conclusion

Based on the data obtained in this study, it can be concluded that:

1. Fabrication of edible film with a comparison of 7.5 g of tapioca flour and 2.5 g of wheat flour showed the best results.

2. From the characteristics of edible film test results were obtained tensile strength was 0.1442 Kgf/mm 2, elongation was 48.82%, the thickness was 0.193 mm and the SEM results show that the edible film was flat and compatible surface.

3. Nutritional content of edible film for the water content was 16.23%, ash content was 2.921%, protein content was 5.44%, fat content was 1.76%, carbohydrate content was 73.65%,

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and beta carotene of 116.052 ppm. While the organoleptic test of the edible film was obtained the results of the texture test were 2.86, the aroma of 3.26, taste of 2.73, and color of 4.06.

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