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Preparation of Edible Film from A Mixture of Carrot Extract *(Daucus carota L.)* with Tapioca Flour, Wheat Flour, and Glycerine

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Abstract. The preparation of edible film from carrot extracts (Daucus Carota, L) with the addition of tapioca flour, wheat flour, and glycerin was carried out. The edible film was prepared by mixing carrot extract, tapioca flour, and wheat flour, and then heated and added with glycerin and stirred up. The homogeneous solution was put into an acrylic plate to form an edible film and dried in an oven at 40°C for ± 2 days. The edible film formed was characterized and analyzed its nutrition content. The tensile strength and elasticity of edible film with a ratio of 5 g tapioca flour and 5 g wheat flour were 0.1028 KgF/mm^2 and 39.83% respectively. The thickness of edible film with a ratio of 2.5 g of tapioca flour and 7.5 g of wheat flour 7.5 g was 0.26 mm. The better nutrition content was found on edible film with a ratio of 5 g tapioca flour and 5 g wheat flour which has 13.94% moisture content, 2.67% ash content, 4.93% protein content, and 2.90% fat, 75.56% carbohydrate content, and 410.34 ppm carotene content. Organoleptic test edible film of color, taste, texture, and aroma gave an average score of 3 (like), because of the shiny color, crunchy taste, smooth texture, and interesting edible film. Based on the test indicated that people accepted the edible film produced.

Keywords: Edible Film, Wheat Flour, Tapioca Flour, Tensile Strength, Elongation, Moisture Content

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1 Introduction

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 that its quality and safety can be maintained (Hui, 2006).

In general, an edible film can be defined as a thin layer that coats a food material and is edible, used on food by packaging or placed between food components that can be used to improve food quality, extend shelf life, increase economic efficiency, inhibit the transfer of water vapor.

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Krochta, 1994). Polysaccharides such as starch can be used as raw materials to manufacture edible films to replace plastic polymers because they are economical, renewable, and provide good physical characteristics. Krochta and Mulder, 1997).

Fresh carrots contain water, protein, carbohydrates, fat, fiber, ash, anticancer nutrients, natural sugars (fructose, sucrose, dextrose, lactose, and maltose), minerals (calcium, sodium, magnesium, manganese, sulfur, copper, chromium, glutathione), vitamins (A, B1, B6, C, E, and K) pectin, biotin, folic acid, carotenoids (beta carotene, alpha-carotene, lutein, lycopene), phytofluene, umbelliferone, caffeic acid, chlorogenic acid, crallic acid, luteolin- 7-glucoside, pyrrolidine, and asparagines. The dark orange color of carrots indicates a high beta-carotene content. The more orange the carrot is, the higher the beta-carotene content. The level of beta carotene contained in carrots is more than in papaya and other fruits (Yaniar, 1993).

Polysaccharides such as starch can be used as raw materials in the manufacture of edible films. Starch is often used in the food industry as a biodegradable film to replace plastic polymers because it is economical, renewable, and provides good physical characteristics (Bourtoum, 2007). Tapioca flour or wheat flour is often used as an additive or filler because of its high starch content (Hui, 2006). Wheat flour contains gluten, which is a protein that provides elastic, chewy, and not easily broken properties (Sutomo, 2008).

Based on research from Suliastini, 2011 "Fabrication of Edible Film from a Mixture of Carrot Extract (Daucus carota L.) with Starch and Glycerin as Packaging Materials", the researchers were interested to improve the elasticity of edible film by adding wheat flour, so that it can be applied as food packaging. The edible film was prepared by casting the mixture of tapioca flour, wheat flour, and glycerin. This research purposed to determine the nutritional content of edible films that can be used as food packaging materials and to investigate the physical characteristics of edible films.

2 Materials and Methods

2.1 Materials

Glycerin, Selenium, H_2SO_4(P), H_3BO_4, NaOH, HCl, N-Hexane, Tashiro Indicator, Aquadest, Carrots, Tapioca Flour, Wheat Flour.

2.2 Preparation of Edible Film

Carrots are peeled, washed, and shredded into the slurry. Then the extract of carrot was separated by filtration. 100 mL of carrot extract was put into a beaker glass and added 2.5 g of tapioca flour and 7.5 g of wheat flour were. The mixtures were stirred until homogeneous and heated on a hotplate. Then 1 mL of glycerin was added and stirred again continuously until the mixtures were homogeneous and thickened. The mixtures were cast into a plastic plate while

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flattened. Finally, the edible film was dried in the oven for ± 2 days at 40°C. The same procedure was carried out for a variation of 5 g of tapioca flour and 5 g of wheat flour.

2.3 Measurement of Edible Film Thickness of Carrot Extract

The thickness of the edible film from carrot extract was measured using a caliper at four different places and then the average thickness of the edible film was calculated.

2.4 Tensile Strength Analysis

Tensile strength is one of the parameters for determining the mechanical properties of polymer materials. Tensile strength is defined as the maximum load (Fmax) used to break the specimen divided by the initial cross-sectional area (A_0).

Tensile Strength Test Calculation:

$$\text{Tensile strength} = \frac{Fmax}{Ao} = \frac{Load}{Ao},$$

which is load was kilograms force (KgF), Ao was specimen areas (mm^2), and tensile strength was $KgF.mm^{-2}$.

2.5 Morphological analysis by SEM (Scanning Electron Microscopy).

The morphology of the edible film was investigated by SEM EVO MA 10 carl Zeiss Bruker operating at 20 kV. Samples were recorded at a magnification of 500 and 1000x from their original size.

2.6 Determination of Water Content

2 g of edible films of carrot extract were put into a porcelain cup and then dried in the oven at a temperature of 100-105°C for about 6 hours. Cooled and stored the edible film in a desiccator. After cooling, the dry weight was determined. This is repeated continuously until a constant weight is obtained. Then the water content is calculated by using the equation below:

$$Water\ content = \frac{wet\ weight - weight\ after\ drying}{weight\ after\ drying} x\ 100\%$$

2.7 Determination of Ash Content

2 g of edible films of carrot extract was put into a porcelain cup and pyrolyzed in the furnace at 600°C for 3 hours. The obtained ash was cooled and stored in a desiccator. The weight of ash was measured by digital balance at a constant weight. Furthermore, the ash content was calculated. by using the equation below:

$$Ash\ content: \frac{weight\ of\ residue\ (g)}{initial\ weight\ of\ sample\ (g)} x100\%$$

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2.8 Determination of Protein Content

5 g of edible film of carrot extract was put into a 100 mL Kjeldahl flask and then added 5 g of selenium and 25 mL of sulfuric acid were. The mixture was heated until the solution becomes clear and greenish (approximately about 2 hours). Next, after the mixture solution has cooled, then dilute with distilled water in a 100 mL volumetric flask. Then, 50 mL of the solution was pipetted and put into a distillation apparatus followed by adding 30 mL of NaOH 40%, and 50 mL of distilled water. It was distilled for about 10 minutes. The distillate was accommodated in an Erlenmeyer glass containing 25 mL of a 4% borate solution that had been mixed with the Tashiro indicator. The mixture is titrated with 0.1 N HCl solution.

$$Protein\ Content = \frac{(V1 - V2)\ x\ N\ x\ 14{,}008\ x\ f.k\ x\ f.p}{Wx1000} x\ 100\%$$

2.9 Determination of Fat Content

10 g of edible film of carrot extract was put into a beaker glass and added 30 mL of 25% HCl and 20 mL of distilled water. The beaker was covered with a watch glass and heated for 30 minutes until the solution turned black. It was filtered with Whatman filter paper no.41 and washed with hot distilled water. Then it was extracted with 150 mL of n-hexane for 5 hours at a temperature of ± 80^{o}C and distilled n-hexane solution from fat extract at a temperature of 100-105^{o} C. Finally, the fat was cooled in a desiccator, weighed and the fat content was calculated by using the equation below:

$$Fat\ Content: \frac{weight\ of\ fat}{weight\ of\ sample} x\ 100\%$$

2.10 Determination of Carbohydrate Content

Carbohydrate content was calculated by summing the total percentage of moisture, ash, fat, and protein content. Carbohydrates are known by calculating the difference between 100% and the sum of these percentages (Winarno, 1992)

$$Carbohydrate\ Content = 100\% - \%(protein + fat + water + ash)$$

2.11 Determination of Carotene Content

A total of 0.1 g of edible film from carrot extract was dissolved with distilled water in a 25 mL volumetric flask. Inserted into a cuvette and then measured the absorbance at a wavelength of 446 nm. The absorbance was recorded. Then calculate the value of beta carotene by using the formula below:

$$Carotene\ Content: \frac{Abs\ at\ 446\ nm\ x\ 383\ x\ volume\ of\ solvent}{weight\ of\ sampel\ (g)\ x\ 100}$$

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The value of 383 is the determination of the beta carotene search formula.

2.12 Determination of Organoleptic Value

This test includes color, smell, taste, and texture determined by a preference test by 15 panelists, where the panelists are not smokers and before tasting it are required to drink water first.

3 RESULT AND DISCUSSION

3.1 Result in Detail

From the research that has been done, the results of the analysis of the characteristics and nutritional content of edible films are obtained, as shown in Table 1.

Table 1. The results of the analysis of the characteristics and nutritional content of edible films

No.	Test Parameters	5 g Tapioca : 5 g Flour	2.5 g Tapioca : 5 g Flour
1.	Tensile Strength	0.0194 KgF/mm2	0.0167 KgF/mm2
2.	Thickness	0.24 mm	0.26 mm
3.	procrastination	38.6%	34.3%
4.	Water content	13.94%	16.18%
5.	Ash Level	2.01%	3.06%
6.	Fat level	2.90%	1.85%
7.	Protein Level	4.93%	3.99%
8.	Carbohydrate Level	64.18%	50,375
9.	-carotene levels	410.282%	299.502%

3.2 Tensile Strength Analysis

Tensile strength analysis was used to determine the number of forces that can be achieved in each unit area of the film to stretch or elongate (Krochta and Mulder, 1997). Based on the results of the tensile strength measurement, the edible film produced from the study with the ratio of 5 g tapioca flour and 5 g wheat flour was 0.1028 KgF/mm^2, while in a ratio of 2.5 g tapioca flour and 7.5 g wheat flour the tensile test was 0.0921 KgF/mm^2. The edible film with a ratio of 5 g tapioca and 5 g flour has better mechanical properties. This is because wheat flour contains gluten, and the extensive intermolecular interactions in gluten would produce an edible film that is rather easily torn. Furthermore, the bigger ratio addition of flour causes the edible film to tear easily and produce a lower tensile strength value. The low value of tensile strength indicates that the film cannot be used as packaging because its physical character is not strong enough and broke easily.

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3.3 Percent Elongation and Thickness

Based on the results of the elongation test, the edible film with a ratio of 5 g of tapioca flour and 5 g of wheat flour was produced with a percent elongation of 39.83%. while the ratio of 2.5 g of tapioca flour and 7.5 g of wheat flour is 35.367%. From these results, the edible film with a ratio of 5 g tapioca flour and 5 g wheat flour produces a higher % elongation. This is because the higher the tensile strength of the edible film, the higher the percent elongation of the edible film will be.

Meanwhile, the thickness of the edible film in the ratio of 2.5 g of tapioca flour and 7.5 g of wheat flour was higher at 0.26 mm compared to the thickness of the edible film in the ratio of 5 g of tapioca flour and 5 g of wheat flour. This is because the higher the concentration of wheat flour, the thickness of the edible film increases, making it harder for air to escape from the material, causing anaerobic respiration. The addition of wheat flour will slow the transfer of C02. So that the thickness of the edible film at the ratio of 2.5 g of tapioca flour and 7.5 g of wheat flour is higher.

3.4 Water Content Analysis

Water is one of the important elements of food. Although water itself is not a source of nutrients like other foodstuffs, it is very essential in the continuity of the biochemical processes of living organisms (Sudarmadji, 1989). The water content of the edible film produced in a ratio of 5 g of tapioca flour and 5 g of wheat flour is 13.94% while comparing 2.5 g of tapioca flour and 7.5 g of wheat flour is 16.18%.

These results obtained edible film with a higher ratio of 2.5 g of tapioca flour and 7.5 g of wheat flour. This is because the water content in wheat flour is more significant than in tapioca flour, namely, in wheat flour 13% while tapioca flour by 12%. Where in the treatment, the weight of wheat flour is greater than the weight of tapioca flour. For this reason, an edible film with a ratio of 2.5 g of tapioca flour and 7.5 g of wheat flour has moisture more significant so it is not suitable for use as an edible film.

3.5 Ash Content Analysis

The ash content produced in the ratio of 5 g of tapioca flour and 5 g of wheat flour is 2.67%, while the ratio of 2.5 g of tapioca flour and 7.5 g of wheat flour is 3.42%. Ash is an organic substance leftover from the combustion of organic material. Ash content has something to do with the minerals of a material. From the study results, it can be seen that the ash content with a ratio of 5 g of tapioca flour and 5 g of wheat flour is less. This is because the mineral content contained in wheat flour is lower than in tapioca flour so the more and more wheat flour is added to the edible flour film, the higher the ash content in the edible film.

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From the study results, it can be seen that the ash content with a ratio of 5 g of tapioca flour and 5 g of wheat flour is less. This is because the mineral content contained in wheat flour is lower than in tapioca flour so the more and more wheat flour is added to the edible flour film, the higher the ash content in the edible film.

3.6 Analysis of Protein Content

The protein content produced in the ratio of 5 g of tapioca flour and 5 g of wheat flour was 4.93%, while the ratio of 2.5 g of tapioca flour and 7.5 g of wheat flour was 3.99%. This protein content can be affected by temperature, pH, and humidity. From the results obtained, the protein content with a ratio of 2.5 g of tapioca flour and 7.5 g of wheat flour was lower. This affects the water content of edible films. The water content of the edible film is in a ratio of 2.5 g of tapioca flour and 7.5 g of high wheat flour. So that the protein content in this ratio is lower, due to the high water content, the speed of the protein hydrolysis reaction by enzymes on the edible film will be faster.

In the hydrolysis process, the N group contained in the edible film will be liberated. The N group will turn into nitrite because nitrate levels in protein analysis were not detected. As a result, the protein content of the edible film with a ratio of 2.5 g of tapioca flour and 7.5 g of wheat flour decreased.

3.7 Fat Content Analysis

The fat content produced in the ratio of 5 g of tapioca flour and 5 g of wheat flour was 2.90%, while the ratio of 2.5 g of tapioca flour and 7.5 g of wheat flour was 1.85%. From these results, the fat content in the ratio of 5 g of tapioca flour and 5 g of wheat flour was higher. This is because the fat content in tapioca flour is less than the fat content in wheat flour. So the addition of less tapioca flour will affect the fat content of the edible film and cause the fat content to decrease.

3.8 Analysis of Carbohydrate Content

The carbohydrate content produced in the ratio of 5 g of tapioca flour and 5 g of wheat flour was 75.56%, while the ratio of 2.5 g of tapioca flour and 7.5 g of wheat flour was 74.56%. This carbohydrate content was obtained due to the addition of tapioca flour and wheat flour to the edible film. The addition of tapioca flour and wheat flour can affect the carbohydrate content of the edible film.

From the results obtained, the ratio of 5 g of tapioca flour and 5 g of wheat flour is excellent. This matters because the carbohydrate content in tapioca flour is more excellent, namely 86.90% while in wheat flour is 70% so the carbohydrate content in the ratio of 5 g of tapioca flour and 5 g of wheat flour is higher.

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3.9 Analysis of Carotene Content

The level of -carotene produced in the ratio of 5 g of tapioca flour and 5 g of wheat flour was 410.34 ppm, while the ratio of 2.5 g of tapioca flour and 7.5 g of wheat flour was 297.338 ppm. The content of carotene comes from carrot extract, which is the primary material for preparing edible films. But with heating at high temperatures will damage the content of carotene. From the results obtained edible film with a ratio of 2.5 g of tapioca flour and 7.5 g of wheat flour is lower. This is due to the addition of too much wheat flour causes a reduction in the content of carotene.

3.10 Scanning Electron Microscopy Analysis

Scanning Electron Microscopy (SEM) analysis shows the morphology and the changes of the structure in a material surface, such as fractures, indentations, and other structural changes. Any changes in the structure can be detected by the reflected electrons and absorbed and converted into electron waves that can be captured by the instrument so that the picture was obtained.

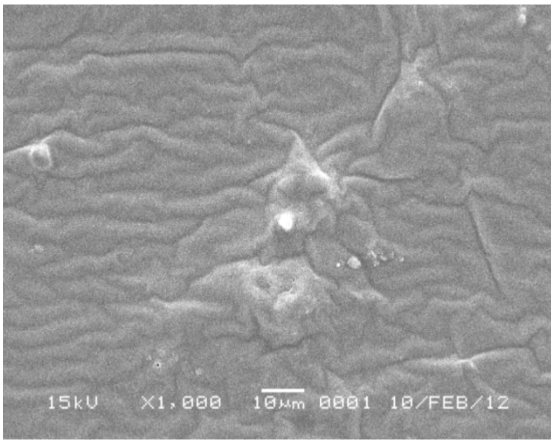

Figure 1. SEM of the edible film with a ratio of 5 g tapioca flour and 5 g wheat flour and with a magnification of 500x

The results of SEM on a ratio of 5 g tapioca flour and 5 g wheat flour with 500 times magnification shows in Figure 1. The results of this analysis show a surface with more minor, more even, and smoother lumps. This is because the starch is soluble in glycerol and carrot extract.

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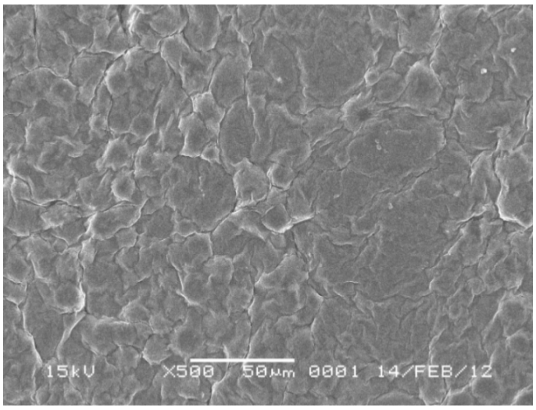

Figure 2. SEM of the edible film with a ratio of 2.5 g tapioca flour and 7.5 g wheat flour and with a magnification of 1000x

Figure 2 shows a photograph of the SEM of the edible film with a ratio of 2.5 g of tapioca flour and 7.5 g of wheat flour, and a magnification of 1000 times. The results of the analysis show an uneven surface, and larger lumps are still visible because of the attraction of starch lumps that are not completely dissolved with glycerol and carrot extract.

3.11 Organoleptic Test

Organoleptic tests on the texture, color, taste, and aroma of the edible film were carried out on the panelists. The best organoleptic test of edible film on taste and color was in the ratio of 5 g of tapioca flour and 5 g of wheat flour because it was more desirable with its crunchy and slightly sweet taste and bright color. And the best organoleptic test for texture and aroma is the ratio of 2.5 g of tapioca flour and 7.5 g of wheat flour because the texture is smoother and more attractive. So that the panelists like it more.

4 Conclusion

From the results of research that has been done regarding the manufacture of edible films from a mixture of carrot extract (Daucus carota, L), it can be concluded as follows:

1. The nutritional content produced from the best edible film is in the ratio of 5 g tapioca flour and 5 g wheat flour with 13.94% water content, 2.67% ash content, 4.93% protein 2.90% fat content. And carbohydrate content of 75.56%, -carotene content of 410.34 ppm. While the organoleptic test of the edible film on color, taste, texture, smelling with an average of 3 (likes) because the edible film is brighter in color, tastes crispy, the texture is smoother, and more attractive so the panelists prefer this edible film.

2. The characteristics of the edible film include tensile strength obtained at 0.1028 KgF/mm2, elongation of 39.83%, and thickness of 0.243 mm. The results of the SEM test with the best results are in the comparison of 2.5 g of tapioca flour and 7.5 g of wheat flour because it has a smooth surface, tiny pores, and is tight, and more compatible.

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