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Utilization of red dragon fruit peel as an antioxidant in edible film sago starch packing *lempok* durian

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ABSTRACT

Lempok durian is a traditional food product typical of Riau, which in storage often experiences a decrease in quality due to oxidation. The utilization of edible film with the addition of antioxidants form natural source in food products has the potential to protect food products such as lempok durian to be more durable. This study aimed to obtain the best concentration of dragon fruit peel extract in making the edible film of sago starch as Lempok durian packaging. This study was conducted experimentally using a completely randomized design of four treatments, each with four replications to obtain sixteen experimental units. The treatments in this study consisted of P0 = Without the addition of dragon fruit peel extract, P1 = addition of 6% red dragon fruit peel juice, P2 = 8% red dragon fruit peel extract, P3 = Addition of 10% red dragon fruit peel extract. The data obtained were analyzed statistically using Analysis of Variance (ANOVA). If the calculated F is greater than or equal to the F table, the analysis will continue with Duncan's Multiple Range Test (DMRT) further tests at the 5% level. The results of the study concluded that the addition of dragon fruit peel extract with various concentrations had a significant effect on the characteristics of the edible film of sago starch and the storage of the Lempok durian produced, moisture content according to standards, increasing thickness, suppressing the rate of water vapor transmission, increasing antioxidant activity, reducing free fatty acids, and aroma hedonic test. The best formulation in this study was P3 treatment with 15.93% moisture content, 0.22 mm thickness, 6.73 g/m^2/hour water vapor transmission, 133.15 ppm antioxidant, free fatty acids on the ninth day of 1.50 %, and the ninth-day hedonic aroma test was 2.86 (somewhat likeTherefore, the utilization of edible film with the addition of natural antioxidants from dragon fruit peel has the potential to be developed into packaging that can prevent rapid oxidation.

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INTRODUCTION

Packaging is one of the important factors needed in a food product. In addition to protecting products from environmental contamination, packaging can also provide an attractive appearance. Food product packaging is a packaging process with appropriate packaging materials to maintain and protect food in the hands of consumers so that its quality and safety can be maintained. One type of eco-friendly packaging that can protect food products is edible film.

According to Suput et al. (2015), *Edible* film is a thin layer (film) made of agricultural raw materials used as a surface coating packaging for food components. It can be directly consumed by humans, which is environmentally friendly. Edible films offer two main advantages over the direct incorporation of antimicrobial or antioxidant agents into bulk food: 1) to control the diffusion of active compounds at the surface of the food and 2) to reduce the number of preservatives added to the food Benbettaïeb et al. (2018). One of the raw materials used to manufacture edible films comes from polysaccharides such as cornstarch, tapioca, jackfruit seed flour, and sago starch.

Research on making edible films from sago starch has been conducted by Suwarda et al. (2019), which shows a decrease in the characteristics of edible film as a wrapping material. So that these properties must be improved so that they can be used in food products that have a higher moisture content. Research conducted by Ekramian et al. (2021) makes edible films that add methanol extract from *Artemisia sieberi* Besser as an antioxidant compound that can potentially be used to package food products that are easily oxidized. The edible film of sago starch can coat traditional food products prone to damage, such as rendang rice, lunkhead, *wajik*, and *lempok* durian. According to Alfiana et al. (2021), the edible film from sago starch can be used as active packaging for tuna fish wrappers.

Lempok durian is made from the flesh of the durian fruit, which is added with sugar, then cooked and packaged in plastic. Wet foods such as lempuk durian tend to smell rancid quickly, which indicates the product has been damaged if it is not packed with packaging materials such as plastic, so *Lempok* durian cannot be consumed. According to Suhartini (2019), *Lempok* durian easily smells rancid because it contains about 8% fat. So with the a_w and fat content of this durian soft, the penetration of oxygen gas stimulates the process of hydrolysis and fat oxidation, which eventually cause rancidity. Iswari (2021) stated that *Lempok* durian could last three days without packaging. *Lempok* durian with oil paper packaging can last four days longer than unpackaged.

The hydrolysis process in packaged products such as *Lempok* durian can be prevented by adding antioxidant compounds to the edible film so that it is expected to have a longer shelf life. Antioxidant compounds can be found in vegetables and fruit, including the skin of red dragon fruit. Study Utami et al. (2020) stated that there are vitamin B1, B2, vitamin B3, vitamin C, flavonoids, thiamine, and phytoalbumin in dragon fruit peel, some of which are antioxidant compounds. Study Adhayanti and Ahmad (2021) tested the antioxidant activity of the skin of the dragon fruit. They obtained the results of the antioxidant activity of the skin of the fresh dragon fruit was 140.12 ± 5.76 mg/ml.

The potential of antioxidants in dragon fruit skin can be used in edible film to prevent damage to food products. So this study aims to utilize dragon fruit peel extract in making an edible film from sago starch as *Lempok* durian packaging.

METODE

Methods

This research is an experimental study using Complete Randomized Design. The treatment of this study was the concentration of dragon fruit skin juice of 0, 6, 8, and 10%.

Material and Tools

The materials used in this study were sago starch (taken from Rintis Village, Tebing Tinggi Barat District), Red dragon fruit obtained from Simpang Baru Panam Market, *Lempok* durian obtained from *Lempok* Durian (Cik Mas Ayu) production business Selat Baru village, glycerol, CMC (Koepoe-koepoe), aqua dest. The materials used to analyze edible films were a 2,2-diphenyl-1-picrylhydrazyl (DPPH) solution, silica gel, 95% ethanol, 0.5N NaOH, and Phenolphetalein (PP) indicator.

The equipment for make edible films is analytical scales, a hot plate (Favorite), Merck brand magnetic stirring bar 40mm, a spatula, a liquid thermometer, a Merck brand measuring cup, and a Pyrex beaker glass 1000ml. The equipment used for analysis is a porcelain dish,

analysis oven, screw micrometer (model MDC-25M, Mitutoyo, MFG, Japan), juicer (SHARP EJ-150K), spectrophotometer UV-Vis, desiccator, vortex, centrifuge, Erlenmeyer, a set of distillation tools, a set of the sensory evaluation tool.

Making edible films

The process of making edible film sheets follows the method Wattimena et al. (2016) used with some modifications, namely sago starch dissolved in distilled water in a ratio of 1:10. 10 g of sago starch and 100 g of distilled water were weighed and then homogenized after being dissolved and filtered using a filter cloth to obtain a starch solution. The starch solution was heated using a hot plate while stirring using a magnetic stirrer at a temperature of ± 55ºC for 20 minutes. After that, 3 g of glycerol was added. The temperature was raised to 70ºC, and 1 g of CMC was added gradually into the solution while stirring until homogeneous. According to the treatment, the red dragon fruit peel extract, namely 0; 6.60; 8.80; and 10.00%, was added to the edible film solution while stirring for 1 minute until homogeneous. After completion, the solution was transferred to a 25 × 17 cm mold plate. The film solution was dried in an oven at 40°C for 14 hours. Prior to analysis, the films were stored in a container with a relative humidity of 50% and at room temperature Nurhakim et al. (2021).

Application of edible film on Lempok durian

The edible film is then applied as a small-size *Lempok* durian (bite-size). Method refers to Afifah et al. (2019) with modifications to observation time. *Lempok* durian was cut with a size of 5×2×2 cm, and the *Lempok* was then wrapped using edible film according to the treatment with a size of 3×5cm. The *Lempok* is stored for nine days at room temperature with every three days observing the levels of free fatty acids and sensory reviewers..

Observation

The parameters observed in this study consisted of edible film observations, namely edible film moisture content gravimetry method (Wernecke and Wernecke, 2013), edible film thickness, water vapor transmission rate (WVTR)(American Society for Testing and Material (ASTM), 2020), edible film antioxidant activity test (Baliyan et al., 2022), and observations of *Lempok* durian after being coated with edible film for storage, namely the free fatty acid test, and the hedonic aroma test.

RESULTS AND DISCUSSION

Edible Film Moisture Content

The moisture content test was carried out to determine the moisture content in the edible film. Moisture content greatly affects the quality of edible films when stored or applied as packaging for a product. Edible films with low moisture content are usually more durable and not easily damaged. The variance results showed that the edible film of sago starch with the addition of red dragon fruit peel extract had a significant effect on the moisture content produced.

Table 1 shows that the value of the moisture content of the edible film for each treatment was significantly different between treatments. The highest moisture content was obtained in treatment P3 (addition of red dragon fruit peel extract 10%) with a value of 15.93%, and the lowest moisture content was obtained in treatment P0 (without the addition of red dragon fruit skin juice) with a moisture content value of 10.82%. The resulting analysis shows that the more addition of red dragon fruit skin extract, the higher the moisture content of the edible film produced.

Table 1 Average results of edible film analysis

Treatment	Moisture content (%)	Thickness (mm)	WVTR (g/m^2/hour)	Antioxidant Ic50 (ppm)
P0 (without the addition of red dragon fruit skin juice)	10.82[a]	0.090[a]	11.89[d]	498.84
P1 (addition of 6% red dragon fruit skin juice)	12.82[b]	0.115[a]	10.06[c]	397,78
P2 (addition of red dragon fruit skin juice 8%)	14.46[c]	0.162[b]	8.75[b]	304.05
P3 (addition of 10% red dragon fruit skin juice)	15.93[d]	0.227[c]	6.73[a]	133.15

Note: Numbers followed by different lowercase letters show a significant difference (P<0.05)

The higher moisture content of the edible film was due to the influence of the high moisture content in the red dragon fruit peel extract. Jamilah et al. (2011) state that the moisture content in the red dragon fruit peel is ± 92.7%. This high moisture content causes the moisture content of the edible film to be higher as the amount of extract is added. The moisture content is also influenced by the content of sago starch which easily absorbs water. According to Nouri and Nafchi (2014), Sago starch has hygroscopic properties or can bind water in the environment and has hydrophilic properties that can bind water and form hydrogen bonds with water molecules. So that the higher the addition of red dragon fruit peel extract and the added nature of starch that easily absorbs water, the higher the edible film's moisture content.

The water content in this study has met the water content quality standards for edible film. The quality requirement for edible film, according to SNI 06-3735-1995, is to have a maximum moisture content of 16%. The moisture content of the edible film has an important role in the stability of the product it is coated (Bizymis dan Tzia, 2022).

Edible Film Thickness

Thickness is an important parameter that affects the formation of edible films and their use for packaging or product coatings. The variance results showed that adding red dragon fruit peel extract with different concentrations significantly affected the thickness of the edible film produced.

Table 1 shows that the highest edible film thickness was obtained in treatment P3 with a value of 0.227 mm. The lowest edible film thickness was obtained in treatment P0 with a value of 0.090 mm and was not significantly different from treatment P1 with 0.115 mm. The test results of the thickness of the edible film in the P0 treatment with a value of 0.090 mm, namely without the addition of red dragon fruit peel extract, were not significantly different from the P1 treatment with a value of 0.115 mm, namely the addition of 6% red dragon fruit peel extract. This shows that the P1 treatment with the addition of 6% red dragon fruit peel extract was still unable to increase the thickness of the edible film.

This study shows that the higher the red dragon fruit peel extract is added, the thickness of the edible film produced will increase. This increase is due to the higher concentration of components that make up the edible film, the higher the total solids, thereby increasing the thickness of the edible film. This shows that the thickness increase of the edible film is influenced by the addition of components that make the edible film. Qiu et al. (2020) Explain that increasing the concentration of packaging constituents will increase the total solids after drying to produce a thicker film. The thick edible film caused the edible film to become less elastic (Sitompul and Zubaidah, 2017). StudyLim et al. (2021) stated that the more addition of hawthorn berry extract, the thicker the resulting film due to solids and the possibility of polymer bonding. The thickness of the edible film, according to JIS 1975 standard (Japanese Industrial Standard), is a maximum of 0.25 mm (Fatnasari et al., 2018).

Water Vapor Transmission Rate (WVTR) Edible Film

The water vapor transmission rate is when water vapor moves through a medium with a certain thickness quickly—the higher the water vapor transmission rate value. This more water vapor passes through the film. Table 1 shows that the highest water vapor transmission rate was obtained in treatment P0, which was 11.89 g/m^2/hour, and the lowest water vapor transmission rate was obtained in treatment P3, which was 6.73 g/m^2/hour. Thus, the higher the concentration of red dragon fruit peel juice added, the lower the water vapor transmission rate of the edible film.

According to Desniorita et al. (2019), the edible film's thickness will affect the transfer rate of water vapor, gas, and other volatile compounds. The edible film with the addition of red dragon fruit peel tends to show that the higher the thickness value, the lower the water vapor transmission value produced. Thicker edible films can inhibit the gas and water vapor rate from penetrating the packaging so that the product's shelf life will be longer. In addition, the hydrophilic nature of starch and the addition of plasticizers are important factors affecting the water vapor transmission rate. According to Mehraj and Sistla (2022), Edible films mostly consist of at least one component that forms a continuous and cohesive matrix, such as polymeric/hydrocolloid materials. Natural polymers comprise carbohydrates, proteins, lipids, and fats, forming a gel in water. After drying, it can form a homogeneous structure to inhibit water vapor transfer.

Antioxidant Activity of Edible Film

Table 1 shows that the highest antioxidant activity value of the edible film was obtained in treatment P3 (addition of 10% red dragon fruit peel extract) with a value of 133.15 ppm. The lowest antioxidant activity value was obtained in treatment P0 (without adding red dragon fruit peel extract), with a value of 498.84 ppm. The data shows that the edible film's antioxidant activity tends to increase with the addition of red dragon fruit peel extract and vice versa. The antioxidant activity of the edible film will decrease with the decrease in the addition of red dragon fruit peel extract. This is because the material added to the edible film, namely red dragon fruit peel extract, contains high antioxidant compounds, so the higher the concentration added to the edible film, the higher the antioxidant activity of the edible film. According to Febrianti et al. (2019), the red dragon fruit peel extract had an antioxidant activity with the IC50 value of dry skin extract and mixed skin extract, respectively 55.38±3.85 ppm.

If the IC50 value is low, the antioxidant activity produced is higher, and vice versa. The higher IC50, the lower the antioxidant activity value produced. The antioxidant activity of the P0, P1, and P2 treatments was very weak, and the P3 treatments were in the moderate group. According to Winahyu et al. (2019), A compound is said to have very strong antioxidant activity if the IC50 value is less than 50 ppm, a strong group IC50 is 50-100 ppm, a moderate group if the IC50 value is 101-150 ppm, a weak group if the IC50 is between 150-200 ppm and above 200 ppm, is said to be very weak.

Measurement of antioxidant activity in edible film is important because it affects the ability of edible film to prevent oxidation in clay. The antioxidant ability in this study is categorized as weak, and this is because there is damage to the ability of antioxidants at the time of drying. Antioxidants will be damaged by heat and cooking, and The longer antioxidants are exposed to heat, the more antioxidants become damaged (Prasetya, 2021).

Durian Fat-Free Fatty Acids During Storage

The variance in this study showed that adding different red dragon fruit peel extracts to the edible film of sago starch significantly differed from the free fatty acids of *Lempok* durian. Free fatty acids are oil or fat damage indicators that can be determined by titration. The average value of *Lempok* durian-free fatty acids can be seen in Table 2.

Table 2 shows that the increase in red dragon fruit peel extract on the edible film of sago starch can inhibit the increase in free fatty acids of *Lempok* durian. The lowest free fatty acid content on the third day of storage was P3 treatment, with a value of 1.39%. The highest free fatty acid content on the third day of storage was P1, with a value of 1.90%. The sixth day was P1, with a value of 1.96%, and the ninth day was P1, with a value of 2.01%. On the sixth day, P3 was 1.44%; on the ninth day, it was P3 with a value of 1.50.

There is a tendency that the more red dragon fruit peel extract is added, the lower the free fatty acid content in *Lempok* durian. According to Prisacaru (2016), the oxidation reaction of unsaturated fatty acids is caused by the contact between fatty acids and oxygen in the air. Fatty acids that have undergone hydrolysis before, then re-oxidized, will form hydroperoxides(Rorong et al., 2008). An edible film containing antioxidants in *Lempok* durian can inhibit oxidation, thereby inhibiting the formation of peroxides in the look. The content of natural antioxidants acts as the first defense to inhibit, prevent and delay the occurrence of lipid oxidation reactions even though the levels are small (Ratrinia et al., 2022).

Table 2 Average of *Lempok* durian free fatty acids (%)

Treatment	Storage Time (Days)			
	0	3	6	9
P0 (Without the addition of red dragon fruit skin juice)	1.29	1.90^{c}	1,96^{c}	2.01^{c}
P1 (Addition of 6% red dragon fruit skin juice)	1.28	1.77^{b}	1.79^{b}	1.80^{b}
P2 (Addition of 8% red dragon fruit skin juice)	1.30	1.71^{b}	1.74^{b}	1.76^{b}
P3 (Addition of 10% red dragon fruit skin juice)	1.28	1.39^{a}	1.44^{a}	1.50^{a}

Note: Numbers followed by different lowercase letters in the same column show a significant difference (P<0.05)

Table 3 Data on the average hedonic value of *Lempok* aroma during storage

Treatment	Storage Time (Days)			
	0	3	6	9
P0 (Without the addition of red dragon fruit skin juice)	3.36[a]	3.23[a]	2.20[a]	1.60[a]
P1 (Addition of 6% red dragon fruit skin juice)	3.53[b]	3.66[b]	2.23[a]	2.26[b]
P2 (Addition of 8% red dragon fruit skin juice)	3.80[b]	3.86[b]	2.93[b]	2.46[b]
P3 (Addition of 10% red dragon fruit skin juice)	4.00[b]	3.90[b]	3.23[b]	2.86[c]

Note: Numbers followed by different lowercase letters in the same column show a significant difference (P<0.05). Aroma hedonic score: 1. Very dislike; 2. Dislike; 3. Somewhat like; 4. Likes; 5. Really like

Hedonic Aroma

Aroma is one of the important components for panelists' assessment of the quality of the *Lempok* durian produced. The variance result showed that the edible film with the addition of different red dragon fruit skin juice had a significant effect on the aroma of *Lempok* durian. The data on the average hedonic value of *Lempok* durian aroma can be seen in Table 3.

Table 3 shows that the hedonic aroma assessment on day 0 and day 3rd, treatment P0 was significantly different from treatments P1, P2, and P3, while treatments P1, P2, and P3 were not significantly different between treatments. Day 6 showed treatment P0 was not significantly different from treatment P1, treatment P1 was significantly different from treatment P2, and treatment P2 was not significantly different from treatment P3. Day 9 showed treatment P0 was significantly different from P1, treatment P1 was not significantly different from P2, and treatment P2 was significantly different from P3.

The overall assessment of aroma preference for *Lempok* durian decreased due to storage. However, the smallest decrease in the quality of the *Lempok* durian aroma was experienced by the P3 treatment using red dragon fruit peel extract by 10% in the manufacture of edible films. The decrease in aroma preference was due to the inhibition of the oxidation process in the P3 treatment, so the amount of damage caused by oxidation was inhibited. The rancid aroma is due to a peroxide component in the *Lempok* durian in the oxidation process. According to Singh et al. (2020), Antioxidants can play a role in suppressing the rancid aroma of fat components by inhibiting oxidation.

CONCLUSION

The addition of red dragon fruit peel extract will affect the characteristics of the edible film of sago starch and the storage of *Lempok* durian. The increasing extract will increase the thickness, suppress the water vapor transmission rate, increase antioxidant activity, and reduce free fatty acids with moisture content following existing quality standards. Increasing the concentration of dragon fruit peel extract suppressed changes in the panelists' preference for the Lempok durian aroma. The P3 treatment (addition of 10% red dragon fruit skin juice) was the best treatment that met the edible film quality standard, with 15.93% moisture content, 0.22 mm thickness, 6.73 g/m^2/hour water vapor transmission, antioxidant 133,15 ppm. Furthermore, Lempok durian has a free fatty acid content of 1.50% on the ninth day. The hedonic aroma test is 2.86 (somewhat like).

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