The Physical, Mechanical, Barrier Characteristics, and Application of Edible Film from Yellow Sweet Potato and Aloe Vera Gel

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ABSTRACT

This study aimed to determine the effect of the concentrations of yellow sweet potato starch and aloe vera gel on the physical, mechanical, and barrier characteristics of the edible film, which is applied as packaging for strawberries. It was carried out using a factorial randomized block design (RBD) consisting of 2 stages where the first step was making edible with varied yellow sweet potato starch and aloe vera gel, followed by the application of the selected edible film. The two factors used as edible films were yellow sweet potato starch *(Ipomea batatas)* at 2%, 3%, and 4% w/v, as well as aloe vera gel *(Aloevera barbadensis)* at 5%, 10%, and 15% v/v concentrations. The formulation was applied to the strawberries to examine their ability to extend shelf life. The parameters tested in the first step were thickness, color, solubility, transparency, tensile strength, elongation, and WVTR, while weight loss, texture, and color were examined in the second stage for four days of storage. The results showed an interaction between yellow sweet potato starch and aloe vera gel on thickness with a range of 0.07-0.16 mm, L value of 66.73-73.23, a* value of 0.8-2.5, b* value of 11.1-14.4, solubility of 33.24-56.16%, transparency 2.68-3.43 A/mm, tensile strength 0.08-0.70 MPa, elongation in the range of 10.95-51.14%, and WVTR of 3.97-4.90 g/m^2/24 hours. This showed that the application of edible coating with the best treatment can prevent a decrease in weight loss, texture andcolor intensity as well as extend the shelf life of strawberries up to two times.

Keywords: Aloe vera, edible film, starch, yellow sweet potato

INTRODUCTION

The edible film is a thin layer made of environmentally friendly materials because they are renewable. Setiarto (2020) stated that tubers are widely used to make edible films due to their starch content, which functions as a polymer. One of the main advantages of the edible film is its role as a barrier, both for gas transfer (O_2 and CO_2), oil, and water. Edible films can maintain the physical characteristics of fresh food ingredients and processed products. Thus, it canbe used as packaging in various products such as sausages, fresh fruits and vegetables, nuts and seeds, as well as meat (Liu et al., 2021).

Fruit is a horticultural commodity that is easily damaged at harvest and after harvesting. In Indonesia, strawberries are one of the most popular fruits, which easily become damaged, starting with an uncontrolled physiological process. This is followed by damage through caused by microorganisms, which causes the shelf life to last 1-3 days at room temperature and also decreases the nutritional content of strawberries (Purba et al., 2021). Currently, several efforts are being made to extend shelf life and minimize quality degradation by

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applying edible film on strawberries through the coating. The edible film is a packaging material in form of a thin layer that can extend shelf life, maintain nutritional content, and protect against physical damage (Sarker & Grift, 2021).

Yellow sweet potato (*Ipomea batatas*) and aloe vera *(Aloevera barbadensis)* are local commodities potentially used to produce edible film. It Yellow sweet potato contains water (71.1%), starch (22.4%), protein (1.4%), fat (0.2%), vitamin A (0.01-0.69/100 g), and some other mineral content (Yudhistira, Putri, & Prabawa, 2021). Previous investigations used yellow sweet potato starch with the addition of other ingredients, including glycerol as a plasticizer (Ballesteros-Mártinez, Pérez-Cervera, & Andrade-Pizarro, 2020; Rahmiatiningrum, Sukardi, & Warkoyo, 2019), red galangal as an enhancer of antimicrobial activity (Cahyani & Pranoto, 2013), chitosan (Mustapa, Restuhadi, & Efendi, 2017), carrageenan (Bharti et al., 2021) to make edible film. There is no study to combine yellow sweet potato and aloe vera gel to produce edible film. Therefore, in this study, aloe vera gel was used as a barrier material on edible films made from yellow sweet potato starch as the basic ingredient.

The addition of aloe vera gel as a constituent of edible films functions as a barrier to gas and water vapor transfer in order to maintain physical characteristics and extend the shelf life of the packaged materials. Therefor, it is expected to minimize the risk of oxidation and microbial contamination in food products. Thus, edible film with the addition of yellow sweet potato starch and aloe vera gel with a certain concentration is expected to improve the physical, mechanical, and barrier characteristics of edible films. Therefore, in its application by coating strawberries, it can extend shelf life and minimize quality loss.

MATERIALS AND METHODS

Materials

The materials used in making edible films consist of yellow sweet potato *(Ipomea batatas)* and aloe vera *(Aloevera barbadensis)* from Batu City, strawberries from Pandanrejo Batu City (harvest age ± two months), glycerol (MERCK, **Darmstadt,** Germany, 85%), aquades, citric acid (MERCK, **Darmstadt,** Germany), and NaCl (MERCK, Germany).

Equipment

Analytical balance (AAA 250 SL Ohaus, Thailand), hotplate stirrer (Barnstead Thermoline Cimarec 2, Indonesia), oven (type MB6 Binder, Hongkong), micrometer (Mitutoyo, Taiwan), texture analyzer (EZ-SX Shimadzu, Japan), a color reader (type CR-10, Konica Minolta, Indonesia), UV-Vis spectrophotometer (Genesys 20, Sigma Aldrich, Merck, German) were used in this study. Other tools that are used include a measuring cup (100 mL), beaker (250 mL), porcelain cup (30 mL), cup petri dish, glass jar, spatula, thermometer, 5 ml dropper, cabinet dryer, desiccator, cuvette, mold (19 x 13 cm), aluminum foil, ruler, stopwatch, spoon, grater, plastic basin, knife, scissors, filter cloth, sieve (80 mesh), and gloves.

Methods

A factorial randomized block design method was used with two factors and three replications. Factor I (P) is the concentration of yellow sweet potato starch (P1 = 2%, P2 = 3%, P3 = 4%) and factor II (A) is the concentration of aloe vera gel (A1 = 5%, A2 = 10%, A3 = 15%). A total of 9 treatments were made from the combination the of 2 factors. Each combination was repeated 3 times, and the replication implementation was used in the experimental group. Based on the design, the analysis of variance (ANOVA) was made to obtain conclusions about the effect of treatment, and Duncan's further test was carried out.

Table 1. Combination of yellow sweet potato starch concentration treatment and aloe vera gel concentration

yellow sweet potato starch concentration	Aloe vera gel concentration		
	A1 (5%)	A2 (10%)	A3 (15%)
P1 (2%)	P1A1	P1A2	P1A3
P2 (3%)	P2A1	P2A2	P2A3
P3 (4%)	P3A1	P3A2	P3A3

Making Yellow Sweet Potato Starch (Mustafa, 2015)

The making of yellow sweet potato starch started with peeling, followed by washing. Subsequently, the potato was grated and the extracted starch (water 1:1) was filtered to obtain a starch suspension, which was precipitated for 12 hours and separated. The wet starch was dried at 50°C for 8 hours, mashed, and sieved with an 80 mesh sieve to obtain yellow sweet potato starch.

Making Aloe Vera Gel (Ardasania, 2014)

The preparation of aloe vera gel started with washing aloe vera, trimming, soaking in a solution of citric acid (aloe vera and aquades 1:2) with a 15% citric acid (v/v), and washing. Subsequently, the aloe vera was filleted to obtain the pulp, mashed with a blender, filtered, and the aloe vera gel was collected.

Making Edible Films (Pangesti, Rahim, & Hutomo, 2014)

The edible films was made by homogenization of starch (2%, 3%, 4% w/v), 100 mL aquades, 0.5 mL glycerol, aloe vera gel (5%, 10%, 15% v/v), and heating with a temperature of 85°C for 10 minutes. Subsequently, it was allowed to cool until the temperature dropped to 50°C, poured on a 19 cm x 13 cm pan, dried with a drying cabinet at 50°C for 24 hours, and cooled at room temperature. This was followed by the analysis of the characteristics of edible film namely color, thickness, transparency, solubility, elongation, tensile strength, and water vapor transmission rate (WVTR).

Best Treatment Application on Strawberries

At the application step, the best treatment was making an edible solution, starting with the homogenization of yellow sweet potato starch (4%), aquadest 100 mL, glycerol (0.5 mL), and aloe vera gel (10%). The mixture was heated at 85°C for 10 minutes and cooled until the temperature dropped to 50°C. Subsequently, the strawberries were soaked in the solution for 10 seconds, dried for 15 minutes, re-immersed for 10 minutes, and dried at room temperature to obtain a strawberry coated with an edible coating. This is followed by an observation of control strawberries and those with edible coating, which were stored for 5 days at room temperature. The observation analysis on days 0, 1, 2, 3, 4, and 5 were analyzed for weight loss, texture, and color intensity (L, a* and b* values).

Analysis

The edible film was analyzed for color intensity (AOAC, 2005), thickness (Cuq et al., 1996), transparency (Al-Hassan and Norziah, 2012), solubility (Saberi et al., 2015), tensile strength (ASTM D882-12, 2012), elongation (ASTM D882-12, 2012), and WVTR (ASTM E96/E96M-16,2016). Determination of the best treatment refers to the Japanese Standard Edible Film, applied as a coating in strawberries, and analyzed of color intensity (AOAC, 2005), weight loss, and texture.

RESULT AND DISCUSSION

Physical Characteristics of Edible Film

The physical character of edible film was analysed through parameters thickness, color intensity, solubility, and transparency. Figure 1 shows the edible film for each treatment.

The physical characteristics such as thickness, color intensity, solubility, and transparency of the edible film produced from the treatment were analyzed as shown in Table 2.

The result showed that the thickness of edible film increased with a higher concentration of yellow sweet potato starch and aloe vera gel. This occurred because an increase in the concentration of yellow sweet potato starch and aloe vera gel resulted in a greater the total solids of the edible film. (Warkoyo, Rahardjo, Marseno,

2%(w/v) starch & 5%(v/v) aloe | 2%(w/v) starch & 10%(v/v) aloe | 2%(w/v) starch & 15%(v/v) aloe

3%(w/v) starch & 5%(v/v) aloe | 3%(w/v) starch & 10%(v/v) aloe | 3%(w/v) starch & 15%(v/v) aloe

4%(w/v) starch & 5%(v/v) aloe | 4%(w/v) starch & 10%(v/v) aloe | 4%(w/v) starch & 15%(v/v) aloe

Figure 1. Edible film from treatments

Table 2. Physical characteristics of edible film

Treatment	Thickness (mm)	Color intensity			Solubility (%)	Transparency (A_{546}/mm)
		L	a*	b*		
2% starch & 5% aloe	0.07±0.02[a]	73.23±0.01[a]	0.8±0.01[a]	11.1±0.01[a]	52.07±0.02[d]	2.68±0.02[a]
2% starch & 10% aloe	0.08±0.01[b]	72.33±0.02[b]	1.0±0.01[b]	11.3±0.02[ab]	53.37±0.01[d]	2.82±0.01[ab]
2% starch & 15% aloe	0.09±0.02[c]	71.47±0.01[c]	1.1±0.01[bc]	11.6±0.01[bc]	56.13±0.01[e]	2.86±0.02[bc]
3% starch & 5% aloe	0.10±0.01[d]	70.83±0.02[d]	1.3±0.02[d]	12.0±0.02[d]	43.75±0.02[ab]	2.96±0.02[bc]
3% starch & 10% aloe	0.11±0.02[e]	69.80±0.01[e]	1.5±0.02[de]	12.4±0.01[e]	46.13±0.02[bc]	3.06±0.01[de]
3% starch & 15% aloe	0.12±0.01[f]	69.03±0.02[f]	1.7±0.01[ef]	12.7±0.01[ef]	49.89±0.01[cd]	3.15±0.02[ef]
4% starch & 5% aloe	0.13±0.01[g]	67.97±0.01[g]	1.9±0.01[f]	13.3±0.01[g]	33.24±0.01[a]	3.25±0.01[f]
4% starch & 10% aloe	0.15±0.02h	67.20±0.01[h]	2.3±0.01[g]	13.7±0.01[h]	35.94±0.02[ab]	3.32±0.01[fg]
4% starch & 15% aloe	0.16±0.01[i]	66.73±0.02[i]	2.5±0.02[g]	14.4±0.02[i]	39.33±0.01[ab]	3.43±0.01[g]

The average value followed by the same letter shows no significant effect according to Duncan's test α = 1%

& Karyadi, 2014). Thickness is one of the most critical parameters to determine the feasibility of edible films. According to the Japanese Industrial Standard (JIS), the international standard value for edible film thickness is <0.25 mm. In this study, the value ranges from 0.07 to 0.16 mm, which indicated that the edible film meets the JIS.

Color is the main indicator of the appearance of edible films, which will affect the formation of a packaged food ingredient. A higher brightness (L) value indicates a brighter edible film, while a lower value indicates a darker edible film. Based on the results, the brightness value (L) ranges from 66.73 to 73.23. The color intensity indicated by the a* value suggested that the edible film is reddish with an a* value range from 0.8 to 2.5. The addition of yellow yam starch and aloe vera gel increased the red color of the edible film. The color intensity indicated by the value of b* showed that the edible film is yellowish with a b* value ranging from 11.1 to 14.4. This indicated that the value of brightness (L) decreased with increasing a* and b*which is directly proportional to the increased yellow sweet potato starch na daloe vera gels concentration. Compared to the previous investigations, the color intensity of edible film from yellow sweet potato starch with the additional aloe vera increased the brightness value as well as a* and b*. This brightness (L), redness (a+), and yellowness (b+) are higher than an edible film with yellow sweet potato from previous study. The edible film with yellow sweet potato has a brightness of 40.13-43.53, redness 0.1-0.6, and yellowness 3.3-7.2 (Rahmiatiningrum et al., 2019). The thinner the edible film, the more transparent it will be, thereby increasing the brightness value (Lindrianti & Arbiantara, 2011). Meanwhile, an increase in the values of a* and b* is related to the presence of natural color pigments contained in yellow sweet potato starch, namely carotenoids, which give reddish and yellowish colors to edible films.

Water solubility is one of the crucial parameters of starch-based films, which indicates the water affinity of the films (Cerqueira et al., 2011). The solubility value of this study ranged from 33.24% to 56.13%, which showed that an increase in starch decreased the solubility value. This is in line with the report by Warkoyo et al., (2014), which stated that the solubility of edible films in water decreased with higher starch concentration. The decrease in solubility is caused by the large number of components of the matrix making up the film that must be dissolved. Therefore, the more total dissolved solids the smaller the solubility value of the film (Rahmiatiningrum et al., 2019). It was also discovered that higher hydrophilic and hydrophobic values of a material increase and decrease the solubility, respectively. The presence of low solubility values in biodegradable films is very good for packaging materials (Nugroho, Basito, & Anandito, 2013).

Transparency is the ability of a material to transmit light, which is influenced by the matrix making up the edible film. The thickness and color value of the edible film affect the transparency. In this study, the value of the transparency of the edible film ranged from 2.68 to 3.43. This showed that the transparency of the edible film increased when the concentration of yellow sweet potato starch and aloe vera gel were added. This is directly proportional to the thickness and color intensity of the edible film because yellow sweet potato starch gives a yellowish color. Therefore, the higher the concentration of starch added, the greater the intensity

Table 3. Mechanical characteristics of edible film

Treatment	Tensile strength (MPa)	Elongation (%)
2% Starch and 5% Aloe vera	0.08±0.03[a]	13.16±0.04[ab]
2% Starch and 10% Aloe vera	0.13±0.05[ab]	16.07±0.03[ab]
2% Starch and 15% Aloe vera	0.14±0.03[ab]	17.19±0.05[ab]
3% Starch and 5% Aloe vera	0.17±0.04[ab]	18.02±0.02[ab]
3% Starch and 10% Aloe vera	0.17±0.02[ab]	22.09±0.04[ab]
3% Starch and 15% Aloe vera	0.24±0.04[bc]	20.66±0.05[ab]
4% Starch and 5% Aloe vera	0.21±0.05[ab]	24.63±0.02[b]
4% Starch and 10% Aloe vera	0.26±0.03[bc]	51.14±0.03[c]
4% Starch and 15% Aloe vera	0.70±0.04[d]	10.95±0.04[a]

The average value followed by the same letter shows no significant effect according to Duncan's test α = 1%

of the red and yellow colors. Since higher transparency indicates the clarity of the edible film, the higher the value, the more turbid the edible film produced (Polnaya, Ega, & Wattimena, 2016).

Mechanical Characteristics of Edible Film

Table 3 shows the mechanical analysis of edible film including tensile strength and elongation.

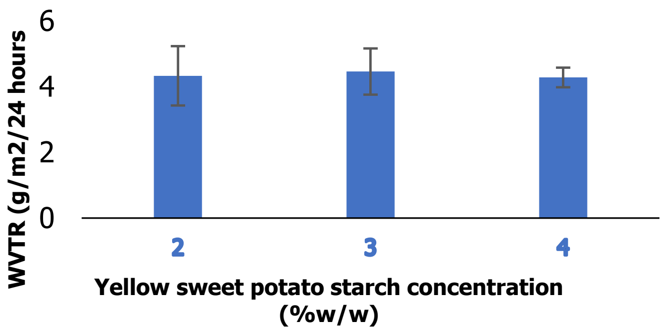
Tensile strength measures the specific strength of the film and the maximum tension is achieved at the point where the film persists before breaking or tearing (Rahmiatiningrum et al., 2019). According to the JIS, the international standard value for tensile strength of the edible film is >0.392 MPa. In this study, the value of the tensile strength ranged from 0.08 to 0.70 MPa, showing that the P3A3 treatment (4% yellow sweet potato starch and 15% aloe vera gel concentration) met the JIS with a tensile strength value of 0.70 MPa, while the others did not because their values were <0.39 MPa. Since the tensile strength of edible film depends on its matrix, thereby a higher concentration of aloe vera gel produces a more influential tensile strength value. This high value is caused by the amount of starch added. This is because when more starch is added, it causes greater cross-pulling on the starch polymer which increases the density, using a higher force to pull the edible film. The intermolecular bonds of the edible film are getting more robust, therefore, the bonds between polymers are becoming stronger, leading to a bigger tensile strength (Wulandari, Harini, & Warkoyo, 2019; Warkoyo, Purnomo, Siskawardani, & Husna, 2021).

Elongation or percent elongation is an important parameter that determines the plasticity of the film. According to the JIS, the edible film is in bad, good, and very good categories when the elongation values are <10%, 10-50%, and >50%, respectively. In this study, a range of 10.95-51.14% was obtained, which indicated that the elongation value increased with the high concentration of the addition of aloe vera gel. A previous report stated that the lower addition of aloe vera and a higher percentage of flour types will increase the value of the percent elongation of the edible film (Afriyah, Putri, & Wijayanti, 2015). The addition of 4% starch and 15% aloe vera gel resulted in thicker and stiffer edible films. This was caused by the state of the suspension of the edible film, which is saturated with starch content. The glucomannan content in aloe vera gel can increase the total solids for the film matrix formed to be more substantial and its elasticity decreases.

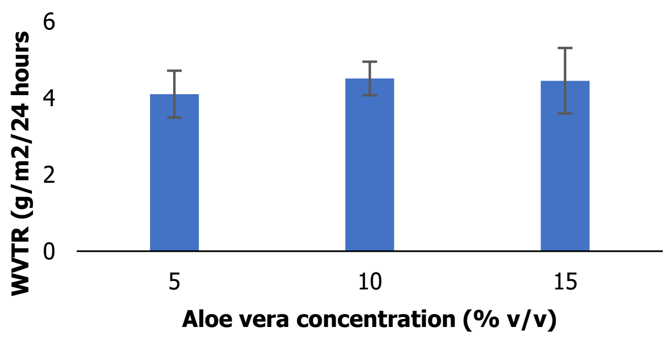
The Barrier of Edible Film

Analysis of the edible film barrier is WVTR, which is the amount of water vapor that passes through a surface per unit area or the slope of the amount of water vapor divided by the area (Afriyah et al., 2015). According to the JIS, the value of WVTR edible film is <7 g/m^2/24 hours. The WVTR effect from yellow sweet potato starch and aloe vera concentrations are presented in Figure 1 (a) and (b), respectively.

Based on Figure 1 (a), the value of the WVTR ranges from 4.25 to 4.45 g/m^2/24 hours, this value had met international standards. However, this value is still lower than polyethylene (PE) and polypropylene (PP), which was 16-23 g/m^2/24 hours (Chen, Wang, Wang, & Yin, 2014). This is due to the use of starch as a polymer making up edible films, one of the hydrocolloid groups that has the advantage of being selective for O_2 and CO_2. An increase in starch followed by a rise in amylose can cause the number of free hydroxyl groups to increase, which leads to a greater WVTR. The increase in inter-



(a)



(b)

Figure 1. WVTR value effect from (a) yellow sweet potato starch; and (b) aloe vera concentration

polymer forces will reduce the transmission of water vapor on the edible film to gas, steam, and porosity. This will increase the function of the edible film as a barrier to the entry of water vapor (Amaliya & Putri, 2014).

Figure 1 (b) shows that the value of the WVTR ranges from 4.1 to 4.5 g/m^2/24 hours, which also fulfills the JIS. The smaller the water vapor migration that occurs in the product packaged by the edible film, the better the properties of the edible film in maintaining the shelf life of the packaged product. Since aloe vera gel as a polymer of the edible film will increase glucomannan levels, the space between cells becomes narrow and function as a barrier. The barrier properties of aloe vera gel coating can regulate the migration of gases, water vapor, and dissolved materials, and maintain the coated material's characteristics (Rahmiatiningrum et al., 2019).

Edible Film Best Treatment

Determination of the best edible film treatment refers to the JIS. The JIS is based on several parameters such as thickness, tensile strength, elongation, and WVTR. In this study, the best treatment for the edible film was the yellow sweet potato starch (4% w/v) and aloe vera (10% v/v) treatment, consisting of 4% yellow sweet potato starch concentration with 10% aloe vera gel.

The best edible film showed the thickness, elongation, and WVTR values according to JIS. However, the tensile strength value of P3A2 (starch 4% & aloe 10%) did not meet the JIS, which is a minimum of 0.39 MPa. The tensile strength of the yellow sweet potato starch edible film with the addition of aloe vera gel can be categorized as close to the JIS. The edible film of P3A2 is elastic with an elongation value of 51.14%, which means the elasticity is excellent because the bonds between the polymers are not strong. Meanwhile, when the bonds between polymers are becoming stronger, the tensile strength is also getting bigger (Safitri, Warkoyo, & Anggriani, 2020). Based on the results, the solubility value in water and transparency are 35.94% and 3.32 (A546/mm), respectively.

Table 4. Comparison of the characteristics of the best edible film against JIS

Parameter	Selected Treatment yellow sweet potato starch (4% w/v) and aloe vera (10% v/v)	JIS
Thickness	0.15 mm	max. 0.25 mm
Tensile strength	0.26 MPa	min. 0.39 MPa
Elongation	51.14%	<10% very bad; >50% very good
WVTR	4.39 g/m^2/24 hours	max. 7 g/m^2 /24 hours
Color intensity	L 67.20; a+$^+$ 2.3; b+ 13.7	-
Solubility	35.94%	-
Transparency	3.32	-

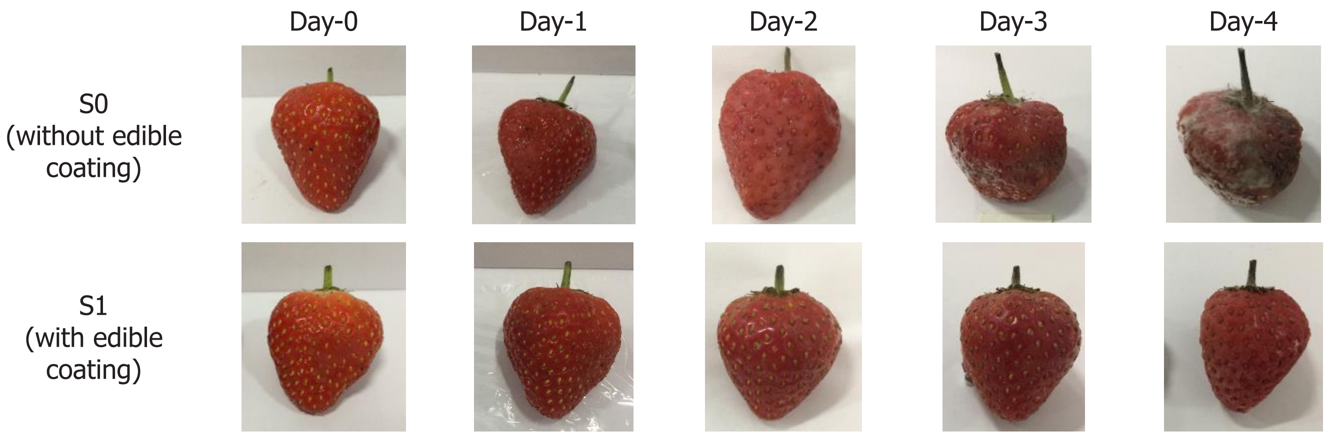


Figure 2. Strawberry without edible coating (S0) and with an edible coating (S1) in each day

Analysis of Edible Film Applications on Strawberries

The best treatment for edible film application as packaging for strawberries is by coating. Storage of strawberries without (control) and with edible coating for 5 days at room temperature, observed weight loss, texture, and color intensity of strawberries every day. The changes from strawberries are shown in Figure 2.

The respiration process from fruits does not only occur on the tree (before harvest) but also continues after harvesting. During this process, oxygen is absorbed in the combustion process that produces energy and is followed by the expenditure of the residues in form of CO_2 and water (Purba et al., 2021).

Strawberries without edible coating were damaged on days 3 and 4, therefore, they cannot be further analyzed. Based on the storage of strawberries with and without edible coating (control) for 5 days at room temperature starting from day 0 until day 4, there was a decrease in weight loss for each observation made daily. The strawberries treated with an edible coating (S1) experienced a much lower weight loss than those without an edible coating (S0). This shows that the edible coating can minimize the weight loss caused by the water deficit in the material due to the respiration process. Yellow sweet potato starch as a hydrocolloid group has several advantages, including being selective for O_2 and CO_2. The polysaccharide composition of aloe vera gel, namely glucomannan, can withstand the loss of liquid and inhibit the transfer of gases (O_2 and CO_2) from the surface of the fruit skin, thereby reducing the rate of senescence and maintaining fruit freshness (Omar et al., 2018).

The previous edible film's WVTR of < 7 g/m^2/day withstood the strawberry senescence process to prevent water loss, where a very low decrease in weight loss occurred. Without an edible coating on the strawberry that functions as a barrier, it causes high oxygen levels to enter the strawberry, leading to an increase in respiration and water loss.

Texture is one of the physical characteristics that determine the quality of a food ingredient. Texture measurement describes the level of hardness, therefore, the more complex a food material, the greater the value of the texture, and vice versa. The texture values of S0 and S1 decreased with storage time. This shows that edible coating on strawberries is significantly effective in inhibiting the softening process of fruit tissue. According to Winarsih (2018), the decrease in hardness levels can reach 76.8% during storage. This makes the edible coating become a barrier to the migration of water vapor as well as a gas into and out of the fruit to affect the metabolic process (Pratiwi, Alisaputra, & Sedyadi, 2021).

The application of edible coating can maintain the hardness of strawberries because it withstands the migration of water from the fruit to the environment (Uge, 2021). Color is the main criteria of appearance, which will affect the look of strawberries. The S0 treatment had the lowest brightness level compared to the S1 treatment. The color intensity with a positive value (+) indicates a red, while a positive b value (+) indicates yellow. This showed that the S1 treatment maintained the color of the strawberries during storage. Aloe vera gel is a polymer constituent of edible coatings, which functions as a barrier to retain gas (O_2 and CO_2) and water vapor, it also improved the material's surface structure and is capable of being antimicrobial. Meanwhile, color changes in strawberries can be caused by the syneresis process of the pigments contained in the fruit. The bright red color of strawberries comes from the anthocyanin

Table 5. Analysis of edible film applications on strawberries

Treatment	Storage time (days to-)	Weight loss (%)	Texture (N)	Color intensity		
				L	a*	b*
S0	0	-	1.28	42.4	16.6	9.2
S1		-	1.81	42.2	14.5	11.4
S0	1	10.7	0.42	37.7	16.7	5.7
S1		1.1	1.74	41.8	15.5	10.1
S0	2	20.5	0.21	33.9	16.8	3.7
S1		1.9	1.58	40	16.4	9.6
S0	3	-	-	-	-	-
S1		3.1	0.7	38	16.8	8.8
S0	4	-	-	-	-	-
S1		5.8	0.43	34.7	17.6	8.6

S0 = strawberry without edible coating
S1 = strawberry with edible coating

content, which also acts as an antioxidant (Anggraeny, Sunarsih, Wibowo, & Elisa, 2021).

CONCLUSION

The results showed an interaction between the addition of yellow sweet potato starch and the concentration of aloe vera gel on the physical and mechanical characteristics of edible film. It was discovered that the combination increased the concentration of yellow sweet potato starch on the thickness, transparency, and color intensity of L, a, and b edible film. Meanwhile, the addition of aloe vera gel has a significant effect on thickness, tensile strength, elongation, transparency, and the color intensity of L, a* and b* of the edible film. The best treatment refers to international standards of edible film, namely P3A2 treatment, which consists of 4% yellow sweet potato starch and 10% aloe vera gel has a thickness value of 0.15mm, tensile strength 0.26MPa, elongation of 51.14%, color intensity value L, a+, and b+ were 67.20, 2.3, and 13.7, respectively, solubility 35.94%, transparency 3.32 and water vapor transmission rate 4.39 g/m^2/24 hours. This showed that the application of edible coating with the best treatment can prevent a decrease in weight loss, texture, color intensity L, a, b, and extend the shelf life of strawberries up to 2 times.

CONFLICT OF INTEREST

The authors don't have any conflict of interest.

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