Application of edible coating from cassava peel – bay leaf on avocado

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Abstract. Avocados have a fairly short shelf life and are included in climacteric fruits. Edible coating application is one alternative to maintain the shelf life of avocado. Cassava peel starch is potential to be used as raw material for edible coating making. Addition of bay leaf extract containing antioxidants can increase the functional value of edible coating. The purpose of this study is to know the shrinkage of weight, acid number, color change and respiration rate of avocado coated with edible coating from cassava peel starch with an addition of bay leaf extract. The study consisted of making cassava peel starch, bay leaf extraction, edible coating making, edible coating application on avocado, and analysis of avocado characteristics during storage at room temperature. The results showed that addition of bay leaf extract on cassava peel starch edible coating applied to avocado, an effect on characteristics of avocado. Avocado applied edible coating and stored at room temperatures had lower weight loss than avocado without edible coating, lower acid number, tend to be more able to maintain color rather than avocado without edible coating.

1. Introduction
Avocados are classified into climacteric fruits. Climacteric fruit is a fruit that undergoes a sudden period unique to certain fruits, and during the process occurs a series of biological changes that begin with ethylene making process [1]. Climacteric Fruits, after harvesting, will experience changes in the rate of respiration increased so that maturation process will be faster [2]. Therefore, avocado has a fairly short shelf life after harvesting, about 7 days (since picking to ready to be consumed), based on research from Deputy Minister of Research and Technology for Science and Technology Utilization and Socialization. The shelf life of avocado is also influenced by external factors such as microorganisms. High levels of avocado water make avocados susceptible to microorganisms.

Enhancement of avocado shelf life can be done by applying edible film and edible coating. The edible coating is a primary packaging material made of edible components [3]. Edible components used as packing materials consist of polysaccharides, lipids, and proteins. The commonly used polysaccharides are cellulose derivatives, chitosan, starch, alginate, kagarenan and pectin [4]. The edible coating is generally made from starch. The advantage of using starch is a presence of abundant starch in nature, available in commercial form, inexpensive and readily biodegradable [4]. Type of starch that is widely used as an edible coating raw material comes from tubers. Application of cassava starch as an edible coating raw material on Cavendish banana coating can extend Cavendish banana shelf life two days longer than control (without coating) [5]. The Edible coating formulation with 2% cassava starch...
composition, 2% chitosan and 1%, 2%, 3% Lippia gracilis Schauer genotypes (EOM) more effective to inhibit the growth of gram-positive bacteria and gram-negative bacteria, and retard maturation process, reduce browning, and preventing change of color on guava [6].

One type of starch that can also be used as edible coating raw material is starch derived from waste or byproduct processing cassava, cassava peel that still has carbohydrate content (starch) about 64%. Functional characteristics of an edible coating of cassava starch can be enhanced through the addition of other ingredients such as antioxidants or antibacterials. One such ingredient is a bay leaf, it contains active ingredients that function as antibacterials namely tannins, flavonoids, and essential oils [7]. Application of various concentrations of bay leaves had an effect on the beginning of decay, total bacteria, and acceptability of broiler chicken taste, but no effect on pH, color acceptability, aroma acceptability and acceptability of total acceptance [8]. The purpose of this study is to know the shrinkage of weight, acid number, color change and respiration rate of avocado coated with edible coating from cassava peel starch with addition of bay leaf extract.

2. Methods

2.1. Materials
The main materials of this research were cassava peel obtained from industrial home in Lembang, West Java, bay leaves obtained from traditional market in Bandung, avocado with maturity level of green mature obtained traditional market in Lembang. The other materials used were aquades, natrium chloride, natrium meta bisulfite, sorbitol, phenolphthalein 1%, Kalium Hydroxide 1 N, Natrium Hydroxide 0.1 N, ethanol 95% and Hydrochloric acid 0.1 N.

2.2. Process of Making Cassava peel Starch
Firstly, cassava peel was cleaned by removing outer peel and then washed using clean water. Then cassava peel was soaked for 14 hours in a solution of Na-metabisulfite (50 ppm) and 2.5% NaCl to remove HCN on cassava peel. After that, cassava peel rinsed with clean water. Then crushed using a blender with an addition of aquades (1: 4) to obtain cassava peel slurry. After that, the slurry was filtered and precipitated twice. The first precipitation was for 6 hours. The other was separated from the water, then the precipitate was rinsed back using aquades and re-depositioned for 14 hours to produce the second precipitate. The precipitate was then dried for 10 hours at 50°C. Furthermore, the dried precipitate was sieved using a 100 mesh sieve.

2.3. Process od Making Bay Leaf Extract
Bay leaf extract was made with concentration variations of 3%, 4% and 5%. Process of making bay leaf extract was done by boiling method. A total of 30 g, 40 g, and 50 g fresh bay leaves boiled in 1 liter water for 10 minutes.

2.4. Process of Making Edible Coating
5% cassava peel starch added water, stirred until homogeneous. While starting to heat hotplate, 10% sorbitol was added as plasticizer. Then, the mixture was heated to gelatinization process approximately 10 minutes. While heated, the solution was constantly stirred to avoid uneven clumping.

2.5. Application Edible Coating on Avocado
Application edible coating on avocado was done by dipping method. Previously the fruit was washed using clean water. While washed, edible coating solution was ready in a wide bowl that allows avocado to get into it. Avocado were dipped into the prepared edible coating solution. Immersion was carried out for approximately 60 seconds then dried with a dryer.
3. Results and Discussion

3.1. Weight Loss of Avocado

Weight loss is one of phenomena that occur in vegetables and fruits, as well as on avocado fruit. Shrinkage of edible parts can be caused by fungal, bacterial as well as impact of persistence of respiration process [2]. Associated with characteristics and phenomena that occur, weight loss of avocado because avocado fruit is still doing process of respiration after harvest.

Application edible coating on avocado aims to decrease weight loss of avocado. The greater weight loss of avocado, the shorter avocado shelf life. Vice versa, the lower weight loss, the longer avocado shelf life.

Measurement of weight loss on avocado coated edible in this study was conducted to see the best edible coating treatment to reduce weight loss of avocado. It was done by measuring sample weight using scales. Measurement was made for 8 days storage at room temperature. Weight loss of avocado is presented in figure 1.

Generally, the longer storage time, the greater weight loss of avocado. Measurement of weight loss showed that weight loss of avocado samples without edible coating has the greatest weight loss compared to weight loss of avocado sample which is coated by edible coating. The high value of shrinkage of weight on fruit, shows the greater weight loss of fruit, which means the loss is also greater [9]. Thus, it can be seen that application of edible coating on avocado will be more profitable.

Fruit weight loss is closely related to respiration and transpiration that takes place in fruit. Respiration process in fruit will cause H₂O and CO₂ to evaporate. Evaporation of its components contained in fruit causes fruit to experience weight reduction [10]. Based on figure 1, the lowest weight loss is sample of edible coated avocado with 4% concentration of bay leaf extract. It shows that edible coating can be a good barrier for avocado so that weight loss of avocado is lower than avocado without edible coating. Edible coatings on fruit can create relatively low weight loss because edible coating has ability to prevent water loss in fruit [9].
3.2. Respiration Date

Fruits are still doing respiration after harvesting. Regarding respiration, the harvested fruit will undergo ripening during respiratory process until it is complete. Respiration process that occurs in fruit will have a different rate according to type of fruit including avocado. Based on pattern of changes in respiration, fruits are classified into two types, namely climacteric fruits and non climacteric fruits. Climacteric fruit is a type of fruit that increases production of ethylene and CO$_2$ during maturation process, while non climacteric fruit does not increase production of ethylene and CO$_2$ during maturation process [11]. Avocado fruit is one of climacteric fruits. Respiration rate of climacteric fruits with non climacteric fruits has different respiratory graphs. Avocado samples without edible coating of this study had a respiration rate as shown in figure 2.

![Figure 2. Respiration rate of avocado without edible coating](image)

Respiration rate in Figure 2, shows a phenomenon similar to respiration rate of climacteric fruits. Respiration that occurs decreases, then at some time the peak of respiration increases and ends with a decrease in the rate of respiration continuously. This indicates fruit has begun to end process of respiration and fruit maturity. Generally with that pattern of respiration rate, avocado has a fairly short shelf life. To extend avocado shelf life, then respiration rate should be inhibited. Several factors that can inhibit respiration rate are divided into two factors: internal and external factors. Internal factors include commodity and genotypes, stage of commodity development at harvest and chemical composition. While external factors include temperature, oxygen concentration, carbon dioxide concentration, carbon monoxide concentration, ethylene concentration, degradation of materials and humidity [11]

Inhibition of respiration rate can be done with storage at low temperature, decreasing of O$_2$ concentration, decreasing pressure, decreasing of ethylene concentration, increasing CO$_2$, preventing post-harvest damage, wax coating, and controlled atmosphere storage. In addition, the rate of respiration can be decreased by giving nitrogen in sphere as much as 350 cm$^3$ / minutes [11]

Extending of shelf life by inhibiting respiration rate in this study was done by applying edible coating on fruit. Edible coating is a natural coating to prevent loss of moisture. Edible coating can also create sterile surfaces and prevent loss of other important components in foodstuffs [4]. Application of edible coating in this study can modify respiration rate. It intends to hold respiration process which means to hold maturation process so that shelf life becomes longer. To improve functional characteristics of edible coatings, formulations are added with antioxidants that comes from bay leaf extract. Bay leaves are known to contain flavonoids, selenium, vitamin A, and vitamin E that act as antioxidants [12]. Therefore bay leaf extract was added to inhibit oxidation process on avocado.

The results shown in figure 3, that application of edible coating on avocado, respiration rate of avocado became abnormal. It has increased and decreased repeatedly. This happens allegedly because with edible coating, avocado has anaerobic respiration. Respiration in avocado requires oxygen, but with application of edible coating, oxygen was blocked so avocado has anaerobic respiration. Furthermore,
avocado and its color turns to brown only in some parts only. Hardened avocado fruit can occur due to decreased cell turgor pressure. Turgor is the pressure of cell contents against cell wall. The cell wall has plastic properties. Contents of cell can be enlarged because it absorbs water from its surroundings. If water in cell is reduced then cells will become soft and limp [1]. During respiration, water vapor was retained by edible coating so that water in cell wall was not reduced. This caused avocado to become hard.

**Figure 3.** Respiration rate of avocado coated edible with addition of 3%, 4%, 5% bay leaf extract

### 3.3. Acid Number

Acid number is a quality parameter of hydrolysis level of fat. The high acid number indicates the higher number of hydrolyzed triglyceride molecules. Measurement of acid numbers means calculating amount of fatty acids due to hydrolysis. High levels of fatty acids show poor quality of fat to process of saponification [13].

Calculation of acid number in this study was conducted to know fatty acid content contained in avocado flesh during storage period with edible coating treatment. The higher acid number indicates the higher free fatty acid content of fat hydrolysis results. Fat hydrolysis that occurs on avocado will cause a rancid odor and decrease quality of avocado. Incidence of rancid odor is caused by oxidation process that occurs resulting in peroxides and aldehydes [14].

**Figure 4.** Acid number of avocado coated edible with addition bay leaf extract 3%, 4%, 5% and avocado without edible coating (control)

Associated with application of edible coating on avocado, addition of bay leaf extract as an antioxidant to inhibit oxidation process in avocado. This will reduce the decrease in amount of fatty acids found in avocado so it does not easily experience a decrease in quality. Acid number of avocado is showed in figure 4.
Based on figure 4, acid number of avocado coated edible in this study has increased and decreased. All samples had increased acid number after day 4 storage, except samples with addition of 5% bay leaf extract of edible coating. Samples with 5% bay leaf extract decreased acid number after day 4 storage. So the best treatment in maintaining quality of avocado was avocado coated edible with addition of 5% bay leaf extract marked by a decrease in acid numbers.

3.4. Color
Observation of avocado color change in this study was done with CIE (Commission Internationale de l’Eclairage) system L * a * b *. Avocado was observed by shooting it and determining value of L, a, and b values with Adobe Photoshop CS6 application. Value of L represents a value indicating the brightness of a sample [15]. L value ranges between 0 and 100. The higher L sample value can be interpreted that sample has a lighter color. A positive value (+ a) indicates sample has a degree of redness, whereas a negative value (-a) indicates sample has a degree of greenishness. Value of a will increase as sample's color becomes reddish and will decrease as sample color becomes yellowish. Value of b is a value indicating yellowish and bluish degree of a sample. The positive b value (+ b) indicates sample has a yellowish degree, while the negative b (-b) indicates sample has a bluish degree. Generally, edible coating applications on avocado can maintain avocado color. Avocado color change is presented figure 5, 6 and 7.

Figure 5. L value of Avocado coated edible with addition of 3%, 4%, 5% bay leaf extract

Figure 5 illustrates that color change in avocado coated edible tends to be stable in color. In contrast to avocado samples without edible undergo significant color changes. This suggests that avocado fruit with edible coatings can retain color of fruit surface. The higher L value, the brighter fruit color that indicates avocado is getting mature. Rapid color changes in avocado without edible due to degradation of chlorophyll pigments so that its color change from green to yellowish.

As well as L value, figure 6 showed that a value on avocado coated edible has a color that tends to be stable when compared to the samples of avocado control (without edible). Value of a obtained from observation of overall fruit sample is negative (-), while a negative value (-a) indicates the sample has a degree of greenishness [15].
Based on Figure 7, in general, b value of avocado sample has a positive value (+). It indicates sample has a yellowish degree [15]. Value of b on avocado coated edible has a stable value. However, avocado control sample (without edible) has an increase in value b. It shows that application of edible coating on avocado has an effect on inhibition of avocado color surface. Whereas, b value of avocado control (without edible) increased. The higher b value, the more yellow color on avocado. Color change from green to yellow on avocado control sample is due to degradation of chlorophyll pigment. It indicates that application of edible coating on avocado could inhibit degradation pigment degradation.

4. Conclusion
Addition of bay leaf extract on cassava peel starch edible coating applied to avocado, effect on characteristics of avocado. Avocado applied edible coating and stored at room temperatures had lower weight loss than avocado without edible coating, lower acid number, tend to be more able to maintain color rather than avocado without edible coating.
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