



Review Article: Postharvest Handling of Local Avocado (*Persea Americana*) in Indonesia

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Abstract. Avocado (*Persea americana*) has a high nutritional content but has perishable properties. The fruit ripening process lasts 5 to 7 days at 25°C. The problem is that 30% of avocados are still damaged and lost after harvest. Product losses or damage is caused by improper postharvest handling and inadequate technology. This review journal aims to provide knowledge about the postharvest handling of avocados and the process of preserving avocados so that they can maintain quality and extend shelf life in Indonesia. Postharvest handling of avocados is essential to maintain their quality and extend their shelf life. Postharvest handling of avocados starts with cleaning, sorting, storing, packaging, and transporting. Avocados are also preserved with *edible coating* for storage at room temperature, *cold shock treatment*, and low-temperature storage to extend the shelf life during the storage before the avocado ripens. Based on the review, it was found that preservation using *edible coating* was the longest for 28 days using the raw material of moringa leaf extract 2 and 1% CMC, with the immersion method for 1 min. Meanwhile, the cold shock treatment's most extended storage for avocados is 8 to 10 days. The low-temperature storage of avocados can maintain avocado quality for up to 10 days.

Keywords: Avocado · Postharvest handling

1 Introduction

Avocado (*Persea americana*) is a commodity with high nutritional content but is easily damaged. Avocado flesh contains 67–87% water, 0.8–4.8% carbohydrates, 13.5–24% lipids, 1.0–3.0% protein, 0.8–1.5% ash, and fiber 1.4–3.0% [1]. The texture of the avocado is soft and yellowish-green when it is ripe. Avocado has no obvious physical or visual properties during the ripening process. However, some cultivars change color from dark green to light green with time. Avocado comes from Central America and spread to tropical and subtropical countries. Countries such as South and Central America, the West Indies, and Africa use avocado as a traditional medicine to treat high blood pressure, abdominal pain and diarrhea, diabetes, and heavy menstrual bleeding. The seeds can also be used in lowering blood sugar levels. In 2020, Indonesia is one of the

fifth-largest avocado producers in the world, with a production of 669,260 tons. Total production of avocados in 2020 increased 9.89% from the previous year, and East Java became the largest contributor, with a total of 175.7 tons [2].

Several avocados grow in Indonesia, including Butter avocado, Vienna avocado, Miki avocado, Hass avocado, Mega Merapi avocado, and Kendil avocado. Different types of avocados have different characteristics. Butter avocado is a local avocado that the people of Indonesia love much because it has thick flesh, chewy texture, and yellow flesh color like butter [19]. Avocado is one of the fruits known to the wider community that has a high fat content so that it has an unpleasant taste like fish oil [20]. Avocado fruit is also the only fruit that contains mono-saturated fat which is very good for heart health in addition to being free of sugar and cholesterol [21]. In addition, avocado contains fiber, protein, healthy fats, and vitamins that are rich in benefits. Avocado has many benefits, especially for health, including the treatment of cancer, inflammation, cardiovascular disease, and diabetes. The potassium content in avocados helps control blood pressure. The content of antioxidants such as zeaxanthin and lutein can maintain eye health [3].

FAO (2004) classifies avocado as a functional fruit because it has many functions and makes it a commodity for domestic and foreign trade. Avocado belongs to climacteric fruit have metabolic rate which has the potential to cause vapor loss greater water content when it's compared to non-climacteric fruit. Which metabolic rate is closely related to the maturity level of the fruit. The higher of maturity level of the fruit, the metabolic rate will also be faster [18]. Avocado fruit still undergoes a life cycle after harvest and begins the ripening process. The fruit ripening process lasts 5 to 7 days at 25. There are three climacteric stages of avocado respiration, namely the pre-climacteric minimal respiration, the highest climacteric respiration, and the post-climacteric stage, which is identical to a decrease in respiratory activity. In the pre-climacteric and climacteric stages, there are many changes in the fruit. Increased respiration rate can accelerate aging, making avocados poor quality. To improve the postharvest handling of avocados, lowering the temperature, increasing carbon dioxide, and reducing oxygen concentration within limits are crucial to reducing respiration [4]. Postharvest handling is carried out from the product that has been harvested until the product is consumed or further processed. Postharvest handling aims to maintain avocado quality in terms of texture, taste, nutrition, and safety and to extend shelf life. Avocado product quality can be identified through sensory attributes, nutritional attributes, chemical constituents, mechanical properties, functional properties, and defects. Important attributes used by consumers to choose quality avocados are color, texture, taste, and aroma. The urgency of the problem is that 30% of avocados are still damaged and lost after harvest. Product losses or damage are caused by improper postharvest handling and inadequate technology. This review journal aims to provide knowledge about the postharvest handling of avocados and the process of preserving avocados so that they can maintain quality and extend shelf life in Indonesia. This review also compares several methods of postharvest handling of avocados that are most effective in extending the shelf life of avocado during storage using the contrast review method to comparing several journals too see the differences between the reviewed journals and then drawing the conclusion [22].

2 Harvest Handling of Avocado

After harvesting the avocado from the tree, proper postharvest handling must be considered. Proper postharvest handling can prevent postharvest losses so that losses can be minimized. The postharvest handling of avocados can be started by cleaning, sorting, storing, packaging, and transporting the fruit.

2.1 Cleaning and Sorting

Avocado fruit that has been picked from the tree is cleaned to remove all kinds of dirt. Cleaning is carried out based on the type of dirt attached to the surface of the fruit skin. If the dirt attached to the surface of the fruit skin is thick, then cleaning can be done by rinsing it with water, while if the dirt is not too thick, cleaning can be done only by using a wet cloth. Cleaning is done to simplify the sorting process. Sorting is done to classify avocados based on existing quality standards. Based on SNI 01–3168-1992, an excellent and qualified avocado is an unblemished fruit with smooth skin without spots, quite old but not yet ripe, and has a uniform shape and size. Avocado fruit sizes are classified into 3: large avocados weighing 451–550 g per fruit, medium avocados weighing 351–450 g per fruit, and small avocados weighing 250–350 g per fruit. At the same time, the shape of a good avocado is bell-shaped. Sorting activities carried out will affect the selling value of avocados. So, it is crucial to separate low-quality commodities from high-quality commodities.

2.2 Storage and Ripening

According to its nature and characteristics, avocado fruit will undergo a ripening process about 7 days after the fruit is picked from the tree so that it can only be consumed after that. The maturation process is known as ripening. Ripening is done to accelerate the ripening process by regulating the environment. The Avocado left without any treatment will ripen in 7 days. However, the avocado will ripen in less than 7 days with ripening treatment. Ripening can be done in simple ways, for example, by putting the fruit in a bag and then closing it, storing avocados in rice, and storing avocados together with other fruits that produce ethylene, using carbide. Furthermore, according to [5], ripening avocados can be done by putting chili seeds at the end of the avocado stalk. Capsaicin contained in chili seeds will increase the temperature so that the activity of fruit respiration increases. Increased respiration will result in the function of ethylene working more actively so that the ripening process will take place more quickly. The activity of ethylene in the ripening process of fruit is influenced by several factors, one of which is temperature. According to [17], ethylene activity is also influenced by air composition, fruit characteristics, fruit age when picked, and mechanical damage to the fruit. This ethylene activity in climacteric fruit such as avocado will significantly affect the ripening process and will increase gradually after the avocado is harvested. One way to control ethylene activity is by storing it at a specific temperature, coating it, and extending the fruit's shelf life before it is ripe for distribution.

Storage to extend the shelf life of avocados is carried out using low temperatures is carried out in a *cool box* has been studied by [7]. Storage at low temperatures aims to

slow the respiration rate, so the ripening process will also take longer. Changes in the characteristics of fruit stored in *cool boxes* were minimal compared to products stored in polyethylene packaging and room temperature storage. Another method that can be used to extend the shelf life of avocados before consumption is coating. The components that make up the *coating*, namely hydrocolloids, lipids, and composites, function as a *barrier* to water vapor and gas exchange in the coated product so that the fruit effectively suppresses the respiration process. [8] stated that the coating is made from carrageenan and glycerol to extend avocados' shelf life up to 10 days. The coating material can also be made from aloe vera gel which has the advantage that the color is transparent, so it does not damage the appearance of the avocado fruit, is easy to obtain and inexpensive, and contains antimicrobial, protein, and bioactive compounds.

2.3 Packaging and Transportation

Packaging of avocado is done to prevent damage from the product distribution process and keep the product safe until it reaches the consumer. Individual-based packaging of fruit is a trend in the export market. Individual-based avocado packaging is designed using corrugated cardboard to distribute and store the avocados at cold temperatures [9]. Each Avocado was placed on cardboard with a partition to reduce the vibration impact of each fruit during transportation. Packing avocados using different fillers can also be an alternative to fruit packaging in the distribution process. Avocado fruit is packed in wooden boxes, which are differentiated based on the filling material of the packaging. The fillers tested were packaging without fillers, paperboard packaging fillers, and dried banana leaves. There is no damage to the paperboard filling material because the filler material minimizes vibrations, reducing friction on the fruit, and reducing fruit damage during long-distance transportation [10].

3 Avocado Preservation Method

Avocado is a horticultural product that requires handling to prevent quality and quantity degradation, one of the efforts to overcome this is to carry out proper packaging. One of the materials used for packaging is plastic, but now plastic is starting to be abandoned because it has properties that are not heat resistant, easy to tear, and can contaminate the packaged material. Besides that, plastic has the disadvantage of being difficult to decompose. Based on these shortcomings, developing packaging from organic and economical materials is essential. Edible packaging is one of the environmentally friendly packaging, food grade or safe for consumption, can maintain the appearance of the original product, and friendly to the environment. Edible packaging can be grouped into two, edible coating and edible film. Edible coatings are more acceptable to the public because they have antimicrobial and antioxidant abilities. Besides edible coatings, other literature uses cold shock treatment and low-temperature storage [11].

3.1 Edible Coating

The edible coating is a food coating that is safe for consumption and is thin with a thickness of 0.35 mm. The coatings method should be safe to be used on foods especially

horticultural products, biodegradable, and the material of coatings from biological component, such as starch and cellulose [16]. The application of edible coatings is to coat the material's surface so that it inhibits the rate of liquid diffusion and protects against mechanical damage by reducing water vapor transmission. The application of edible coatings is generally carried out in various ways, including spraying, dyeing or dipping, wrapping or casting, and basting or brushing. [11] design the avocado preservation process by developing edible coating using cornstarch, distilled water, and various glycerol concentrations. The edible coating was sprayed on the fruit's outside and then dried and stored at room temperature. The best coating on the weight loss and color change test was edible coating formula with 2.5 ml of glycerol. The coating significantly affected weight loss and sensory tests with 15 days of storage. The drawbacks of this study are that it does not explain the type of avocado used, only uses the spraying method, does not test for hardness, and does not test for dissolved solids. A related study of edible coating application on avocados was also carried out by [12], using aloe vera gel that had been treated in a 10% citric acid solution for 30 min and washed in a 1.9 g of ascorbic acid solution in 15 min and then blended for 30 s. The application process was carried out by immersion for 30 s at room temperature, and the best results were obtained in avocado with a 50% aloe vera gel percentage with total damage of 68.33% or could extend shelf life for 4 days with a change in water content of 75.36%, total dissolved solids 4.21 Brix, change in hardness of 1.76 kgf, and weight loss of 10.22% with a storage time of 10 days. The use of aloe vera gel is considered a polysaccharide that can suppress the qualitative properties of the fruit.

Based on [7], edible coatings are made using carrageenan as a producer of polysaccharides that can improve flavor, texture, color, increase storage stability, and reduce spoilage. Glycerol is used as a plasticizer to make coatings that can inhibit the exchange of gasses and water vapor. The best results were obtained at the percentage of carrageenan: glycerol concentrations of 2:2%, 2:3%, and 3:3%, which were characterized by bright fruit flesh color, hard texture, fresh aroma, and good taste. However, this study only describes the initial conditions before treatment and the end after the study and does not include observations or observations made during the storage. Moreover, [13] developed the edible coating using cassava peel as raw material with the addition of sorbitol as a plasticizer and was immersed for 60 s with a storage time of 10 days. The tests carried out were weight loss, respiration rate, pH, and color. The best results were obtained on avocados using 4% and 5% treatment or 40 g and 50 g of cassava starch in edible coating. Another study stated that the storage time of avocados using edible coating can be done for 28 days. The raw materials used are moringa leaves and chitosan or CMC as a thickener. The method of application is immersion for 1 min. The tests were conducted with firmness, CO₂, carbohydrate, electrical conductivity, crude fat, protein, polyphenol oxidase, and lipids. The best results were obtained in 2 g of Moringa leaf extract with the addition of 1% CMC [14].

3.2 Cold Shock Treatment

Avocado fruit will continue to carry out respiratory activity after being picked from the tree so that the fruit can ripen. The ripening process occurs about 7 days after the Avocado is harvested. This time can be extended again, one of which is the cold shock treatment

method. This method is done by putting or dipping avocados after harvesting them into ice water at a temperature of 4 °C for 30 min. The goal is to delay ripening processes such as skin discoloration, flesh softening, respiration rate, and ethylene production during the distribution or storage process before ripening avocados. This method is quite effective in extending the shelf life of green avocados. In addition, this method is quite simple and inexpensive, so it can be used as a practical alternative to extend the shelf life of avocados during the storage process. With the application of cold shock treatment on avocados after picking the results, it turns out that avocado ripening takes longer. Avocados stored in a room without being immersed in ice water will begin to ripen on the sixth day, while the samples dipped in ice water begin to show signs of ripeness on the 8th day, and the chilling injury to the Avocado is overlooked [15]. Even though avocados tend to be very sensitive to cold temperatures during ripening or 7 days after the Avocado is harvested from the tree, the sensitivity will decrease once the fruit is ripe.

3.3 Low-Temperature Storage

Damage to agricultural products can be distinguished according to the cause, including microbiological, physical, chemical, mechanical, and physiological damage. Collisions, exposure to harvesting, and transportation equipment (squeezed and depressed) cause mechanical damage to avocados. Mechanical damage to avocados includes bruising, tearing, or cutting on the skin's surface, which can lead to further damage. Physiological damage is damage due to metabolic processes in the material or by the activity of the enzymes contained in it, resulting in the process of damage and decay. Signs of physiological damage include changes in hardness, color, and size. Storing at low temperatures (cooling) can prevent physiological damage to avocados. Cooling is done to lower the temperature of the product to slow down the rate of respiration in the material so that the damage process can be slowed down. Low-temperature storage is carried out in a *cool box* with a temperature of 10 °C. Character changes saved in a *cool box* are lower than storage with polyethylene packaging and storage at room temperature [6]. Low-temperature storage, storage in a controlled atmosphere, or packaging of fruit with plastic are some of the alternative ways of handling postharvest fruit. However, this method still has drawbacks, such as the use of more incredible energy for cooling and relatively high investment costs. Improper use of plastic packaging can cause damage because plastic is not heat resistant, and it is easy for moisture to accumulate in the packaging. Low temperature storage in cool box with 10 °C temperature only able to maintain the quality of green avocados for 10 days.

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