

The characteristics of fresh-cut rambutan fruit during cold storage

Abstract

Rambutan is a delicious tropical fruit that contains various components that are beneficial for health. Damage to the fruit's skin often causes a decrease in consumer interest. Therefore, fresh-cut rambutan is preferred over whole fruit. A decrease in the quality of fresh-cut rambutan due to cold storage was observed. This study aims to determine changes in the characteristics of fresh-cut rambutan during cold storage. Whole fruit controls were prepared to observe deterioration during storage. The study used a completely randomized design with three replications. Storage time of 0, 3, 6, 9 and 12 days to determine the water content, acidity, total dissolved solids, vitamin C contents, and micrograph of fresh-cut rambutan fruit with Scanning Electron Microscope (SEM). The conclusion is cold storage treatment has an effect on the characteristics of moisture content, degree of acidity, and vitamin C of fresh-cut rambutan fruit. While the total dissolved solid has no effect on the characteristics of fresh-cut rambutan. The decrease in the characteristics of fresh-cut rambutan was sharper than that of intact fruit starting on day 6.

Keywords: rambutan, fresh-cut, cold storage, quality, shelf life.

1. Introduction

Rambutan is one of the horticultural tropical fruits commonly grown in Indonesia. This fruit is popular with lots of nutrients such as sugar, calorie vitamins, minerals, and fibers which are important for the metabolic process of the body (Theapparath *et al.*, 2019). However, the problem associated with rambutan is the short-term damages related to the skin after harvest, which is usually between 2-4 days at room temperature (Suriati *et al.*, 2020). This condition makes it difficult to market, although the fruit's quality is consumable (Hernández-Hernández *et al.*, 2019). Rambutan contains a lot of moisture which acts as a medium of decay and

pathological damage due to bacterial and fungal contamination (Perumal *et al.*, 2021). The fruit is acidic and less sweet when harvested too early, however, it produces a higher taste bland when reaped late. The texture changes are due to the activity of Methyl-esterase and polygalacturonate, which increases the maturity rate (Theapparath *et al.*, 2019). Temperature also contributes to some post-harvest deterioration rates of rambutan such as metabolic and aroma changes, respiration rate, ethylene production, transpiration, texture, and microbial growth (Suriati *et al.*, 2020). The quality and shelf life of intact rambutan are extended through the use of edible coating with an unchanged pulp's firmness when stored at cold temperatures (Díaz-Montes and Castro-Muñoz, 2021; Yousuf and Qadri, 2020).

The damage to its hair tends to lower consumers' consumption rates. Therefore, the fresh-cut acts as a minimal alternative process to solving this problem by removing the inedible portion such as skin, thereby, making the product consumable. Some of its advantages include presenting consumers with a wide range of options in one package, shorter preparation time, reduces household waste, allows consumers to examine the inner state of the product, offer more guaranteed quality, produces the right amount of fresh fruit, facilitate the quality of purchases, and lower product volume at a cheaper rate (Wall *et al.*, 2011; Cruz *et al.*, 2016; Phuong *et al.*, 2020).

The state of the fresh-cut distributed to the consumer needs to be nutritional with a preserved flavor and freshly preserved. It is referred to as the ready-to-use products that facilitate subsequent processing of the product (Suhaimi *et al.*, 2021; Prakash *et al.*, 2020). Peeling stresses the fruit and sends signals into the cell tissues, thereby, increasing the respiration and transpiration rates as well as the production of ethylene (Salgado-Cruz *et al.*, 2021). The raw materials determine the quality, therefore, the intact fruit needs to be characterized to produce good quality. Furthermore, precise and optimum handling is required to extend the storage under cold temperature, used as an alternative preservative measure to suppress the decline rate (Silvetti *et al.*, 2021). Upstream and downstream cooling is essential for fresh-cut fruit because, at low temperatures, the effects of mechanical injuries are minimized, with lower enzyme activity and metabolic rate (Nicolau-Lapeña, 2021; Suriati and Suardani, 2021; Zhang *et al.*, 2021). Therefore this research aims to determine changes in the characteristics of fresh-cut rambutan during cold storage.

2. Research Methods

A 105-day-old Rambutan fruits of the Aceh type obtained from Panji Village Sukasada District Buleleng Regency Bali Province was used. The tools used are chiller, pH meter, refractometer, penetrometer, oven, and plastic packaging mica. This experiment was conducted at the laboratory of Agricultural Technology Food analysis of Warmadewa University.

2.1. Research design

The random design of one factor was used to determine the storage time of 0, 3, 6, 9, and 12 days, the storage temperature of rambutan fruits at $8 \pm 1^{\circ}\text{C}$. Each treatment was replicated 3 times to determine the water content, acidity, total dissolved solids, vitamin C contents, and micrograph with Scanning Electron Microscope (SEM). Whole fruit controls were prepared to observe deterioration during storage.

2.2. Implementation of the research

The fruit was grouped following picking age 120 days, bright red skin color, round or oval fruit, long hair and fresh, the pulp is transparent white, fruit weight 20-30g, soft skin texture. Before cutting, hydro-cooling and washing water are used to lower the temperature during harvest and transportation. This was followed by the distribution and the preparation of the fresh-cut, which is prepared with a stainless knife to suppress mechanical damage and tool contamination. This process only removes the skin while the seeds are allowed to be attached to the pulp. All fruits are partly packed in a plastic box with a hole-filled lid with a diameter of 0.5 cm and distributed on the experimental units. Furthermore, the fruit is stored at $8 \pm 1^{\circ}\text{C}$ with the periodic observation on 0, 3, 6, 9, and 12 days. Data obtained from three replications in this study examined the changes in their characteristics separately for intact and fresh-cut rambutan fruit.

2.3. Statistical analysis

Data were tested by analysis of diversity using Statistical Product and Service Solutions (SPSS). If the diversity of data shows a significant result of treatment, then the test is

continued with Duncan's Multiple Range Test (DMRT) to find out the real difference in the mean data from the treatment.

3. Result and Discussion

3.1. Moisture content

Moisture content is an important component of fruits, which is affected by many factors. However, this research showed that the average temperature difference of moisture content on fresh-cut rambutan. The moisture content of rambutan intact ranges from 81.64 – 90.34% w/w, which decreases the storage rate. This is because the longer the storage time, the greater the dehydration process. Some research on tropical fruits also shows similar results, therefore, a greater chance of the respiration process leads to a higher rate of fruit losses due to water (Gürbüz and Kahramanoğlu, 2021; Deshi *et al.*, 2021; Cofelice, *et al.*, 2019).

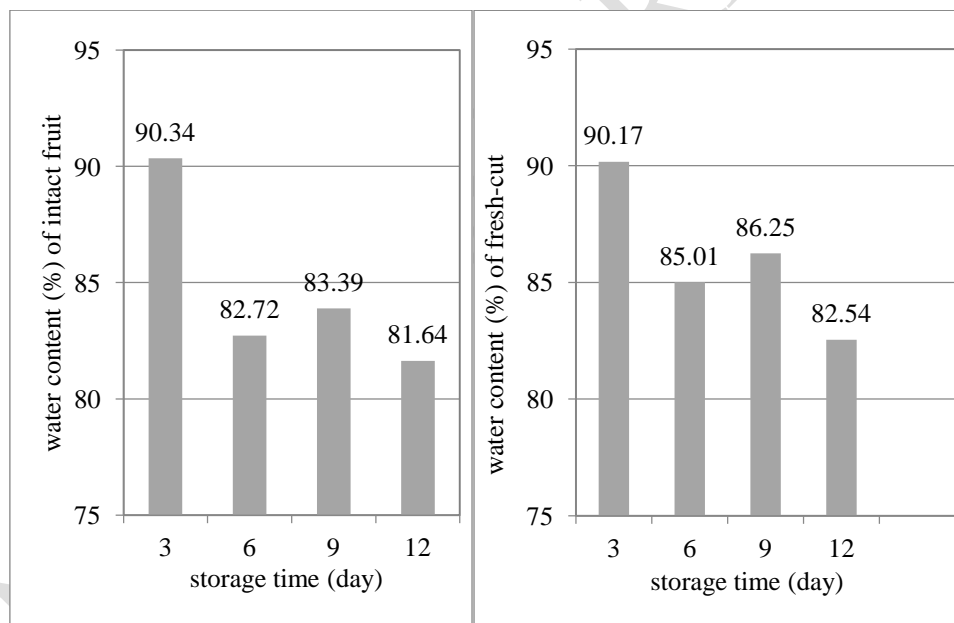


Fig. 1. Water content of intact and fresh-cut rambutan during storage

The average water content of fresh-cut rambutan is 82.54-90.17%, therefore, it is not affected by storage time as shown in Figure 1. The water content of the intact has a sharper decline than the fresh-cut during storage due to the occurrence of anaerobic fermentation. Some research on tropical fruits also shows that longer storage influences the chance of the

respiration process to release water (Ncama *et al.*, 2018; Zhao *et al.*, 2021; Aguilar *et al.*, 2021).

3.2. Degree of acidity

The degree of acidity is used to express the level of acidity or alkalinity of a material. The results showed that the storage time was significantly different to the acidity of fresh cut rambutan. The intact rambutan has a degree of acidity range between 4.18 to 4.36 and is not affected by the temperature treatment and storage time. This is because, under room temperature, the enzyme in the intact rambutan becomes inactive, thereby preventing the repair of organic acids. Storage of fruits in cold temperatures (4-12°C) tends to extend the usability and maintain quality (Suriati *et al.*, 2021). Therefore, the increase or decrease in pH remains in the normal range (Salgado-Cruz *et al.*, 2021; Suriati and Suardani, 2021; Piazzolla *et al.*, 2021). During storage, the degree of acidity of fresh-cut rambutan decreases from 3.23 to 4.30%. Figure 2 shows the average degree of acidity of the intact and fresh-cut rambutan during storage.

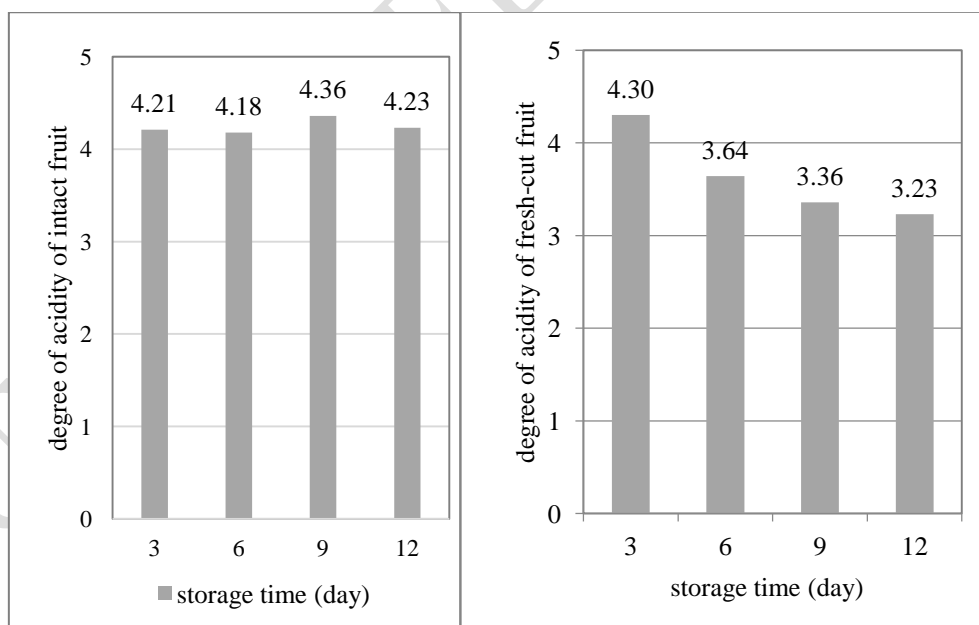


Fig. 2. Degree of acidity intact and fresh-cut rambutan during storage

The degree of acidity of fresh-cut rambutan decreases during storage at temperatures of $8 \pm 1^\circ\text{C}$. This is because stripping the skin promotes the occurrence of organic acid reordering, thereby, tissue decay, physiological, pathological, and physical changes. Furthermore, these damages lead to an increase in tissue respiration, production of ethylene, unexpected metabolites, degradation of sensory components such as color, smell, and taste, decreased fruit integrity, and microbial growth (Liu *et al.*, 2021; Perumal *et al.*, 2021; Deshi *et al.*, 2021).

3.3. Total Dissolved Solids

Storage time produced the same response to the average value of the total dissolved solids on fresh-cut rambutan fruit, as shown in Figure 3. The results showed that the total solids dissolved were 8.70%-10.65% w/w of intact fruit, and 8.58 – 10.65% w/w of fresh-cut fruit, respectively. The highest total dissolved solid of the intact fruit was obtained from the 6th day of storage, while the smallest was on the 3rd at 8.70%. The temperatures of $8 \pm 1^\circ\text{C}$ contribute almost the same increase in the total dissolved solids, due to the presence of sugar reshuffle.

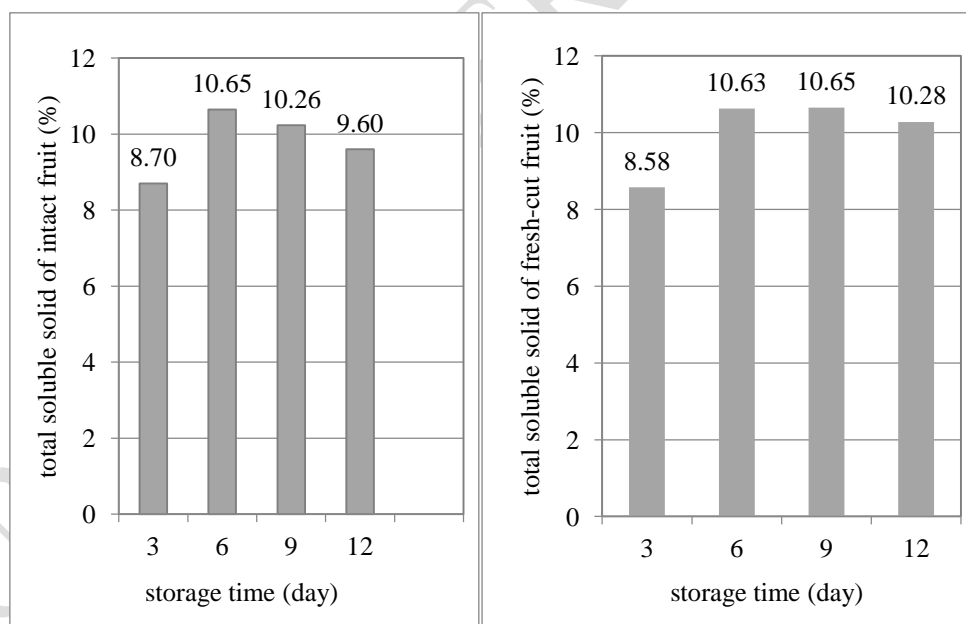


Fig. 3. Total solids dissolved by intact rambutan and fresh-cut during storage

This, in line with the research which stated that low temperature and edible coating are used to store fresh-cut products (Kumar *et al.*, 2021; Xu *et al.*, 2021; Sultan *et al.*, 2021). Rambutan fruit contains non-climacteric sugar and other dissolved solids during storage with the climacteric fruit subjected to maturation by the length of storage (Perumal *et al.*, 2021; Theapparat *et al.*, 2019).

3.4. Vitamin C

The results showed that the long-term storage has significant effect on Vitamin C in the fresh-cut fruit. The average rate for intact and fresh-cut, which ranges from 12.71-54.92mg/100 g and 11.26-54.46 mg/100 g during storage, is shown in Figure 4. The highest level was obtained from the 3rd day of storage while the smallest was on the 12th-day at a temperature treatment rate of $8 \pm 1^{\circ}\text{C}$. The various treatments administered shrunk the vitamin C content with an increase in storage time due to the oxidation process (Suriati *et al.*, 2020; Liu *et al.*, 2021; Sadler *et al.*, 2021). Peeling the skin of the fruit causes several changes that result in damage. Changes in respiration rate, ethylene production, decreased vitamin C, decreased fruit integrity, and microbial growth (Silvetti *et al.*, 2021; Toivonen and Brummell, 2008). ; Li *et al.*, 2021; Suriati *et al.*, 2021).

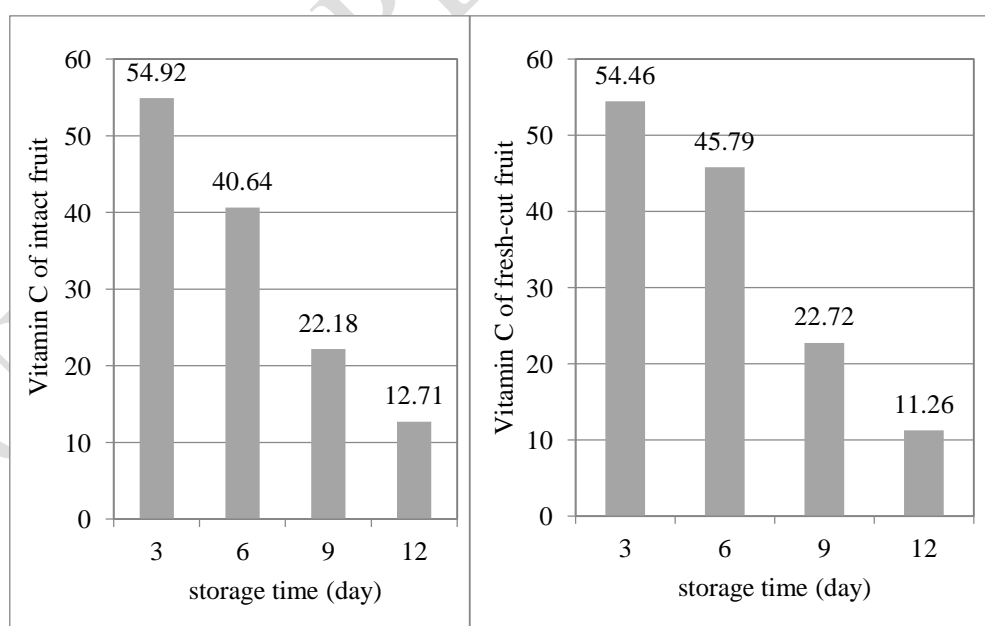


Fig. 4. Vitamin C (mg/100 g) of intact rambutan and fresh-cut during storage

3.5. Micrographs

The micrographs of rambutan fruit observed by SEM can be seen in Figure 5. The surface of the rambutan fruit with horizontal slices in Figure A shows a network structure in the form of neatly arranged circles with almost the same size. Meanwhile, the vertical slice shown in Figure B shows the surface of the rambutan fruit with a fibrous cross section like a straight-line arrangement. Rambutan fruit surface is shiny and smooth. The micrographs of rambutan fruit observed by SEM can be seen in Figure 5.

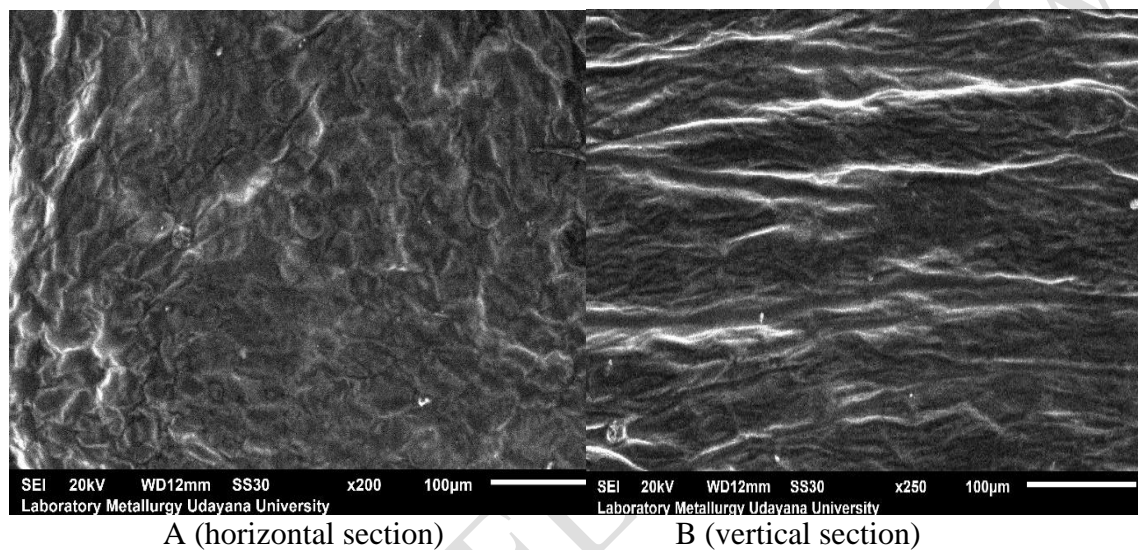


Fig. 5. Micrograph of rambutan fruit by SEM

4. Conclusion

This study could conclude that, the cold storage treatment had an effect on the characteristics of moisture content, degree of acidity, and vitamin C of fresh-cut rambutan fruit. While the total dissolved solid had no effect on the characteristics of fresh-cut rambutan. The decrease in the characteristics of fresh-cut rambutan was sharper than that of intact fruit starting on day 6.

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