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Physicochemical study of crystal guava fruit (*Psidium guajava* l. var. crystal) on differences in maturity and storage temperature

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Abstract

Crystal guava is a type of guava that has a variety of superiority compared to other types of guava so that this type of guava has a fairly high economic value. Just like other fruits, guava is a horticultural commodity that is prone to damage during storage. The purpose of this study was to determine the best level of fruit maturity and storage temperature to maintain the physical and chemical properties of Crystal guava fruit during storage. This research used split plot randomized block design with two factors and three replications. The main factor was storage temperature consist of three levels, i.e., room temperature (Sr), air conditioner refrigerated temperature (Sa), and refrigerator temperature (Sk). An additional factor was the maturity level of the fruit based on the color of the fruit when it is harvested which consists of three levels, i.e., fruit with green skin (Wh), fruit with light green skin (Wm), and fruit with yellowish green skin (Wk). The results showed that refrigerator temperature provided the best physicochemical properties with the lowest increase weight loss and the lowest decrease fruit water content. In additional factors, the maturity level of light green gives the best physicochemical properties with the lowest increase weight loss and the lowest decrease fruit water content.

Keywords: Crystal guava; Maturity; Physicochemical; Storage; Temperature

1. Introduction

Crystal guava (*Psidium guajava* L. Var. Kristal) is a variety of guava that has, larger fruit sizes, and the fewest number of seeds compared to other guava varieties, namely less than 3% of the total fruit mass, has a crunchy texture, contains high vitamin C, and can bear fruit throughout the year [1]. The content of vitamin C in guava is four times greater than citrus fruits, which is more than 200 mg per 100 g, and contains antioxidants that are good for the body [2]. Guava fruit is rich in nutrients, vitamins and minerals and can be consumed directly [3]. With its various superiority and advantages, crystal guava has abundant commercial and production value throughout the year [4]. The economic value of crystal guava is higher than other types of guavas [5]. In North Minahasa Regency, the price of crystal guava sold by farmers ranges from Rp. 5,000 – 20,000 per kg and reaches a price of IDR 25,000 – 30,000 per kg when it is absorbed by the modern market [6].

Crystal guava has the opportunity to replace several types of imported fruit such as apples and pears [1]. Guava is a horticultural fruit commodity, where in general the quality of the fruit is very susceptible to damage, especially during storage. The risk of decreasing production and quality of crystal guava is related to the lack of harvesting facilities and post-harvest handling [6]. After harvesting, the fruit will experience a significant decrease in quality so that proper handling is needed to minimize damage and the shelf life of the fruit becomes longer [7]. Maturity level can affect the quality of crystal guava during storage [5].

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Guava fruit is a climacteric fruit where the fruit will still produce ethylene gas and undergo a ripening process after harvest which causes the fruit to quickly decay [8]. Unripe fruit when picked will produce poor quality. Likewise, if delays in picking are carried out, this will increase the risk of damage, quality and decrease in selling value [9]. Storage temperature is related to fruit respiration rate [10]. Increasing the temperature to the optimum limit will cause respiration to be faster, but respiration will decrease when the temperature exceeds the optimum limit [10]. Respiration rate and climacteric peaks can be suppressed by decreasing temperature [11]. So, it is necessary to have the right storage temperature and maturity level to maintain the quality of crystal guava fruit during storage.

2. Material and methods

2.1. Material and tools

The material used in this study was guava fruit according to the maturity level taken from the crystal guava production center in Semanik Village, Petang District, Badung, Bali. The tools used include scales, hand refractometers, fruit graters, cutting knives, ovens, refrigerators, temperature gauges, brown envelopes, and chemical analysis tools.

2.2. Methods

This research used split plot randomized block design with two factors and three replications. The main factor was storage temperature consist of three levels, i.e., room temperature (Sr), air conditioner refrigerated temperature (Sa), and refrigerator temperature (Sk)m while the additional factor was the maturity level of the fruit based on the color of the fruit when it is harvested which consists of three levels, i.e., fruit with green skin (Wh), fruit with light green skin (Wm), and fruit with yellowish green skin (Wk).

2.3. Harvest fruit according to maturity level and cleaning of fruit samples

Fruit samples that have been obtained, then cleaned of dirt until clean. The clean fruit is drained until dry and then sorted based on the level of ripeness and placed in each basket.

2.4. Storage of fruit according to the level of treatment

Storage of crystal guava fruit samples was carried out for 9 days, by making observations on days 0, 3, 6, and 9 days after storage (DAS). Fruit samples are stored according to the level of treatment and consist of fixed samples and destructive samples. The sample is still used to observe weight loss. While the destructive samples were used to observe total dissolved solids, fruit moisture content, and vitamin C content.

2.5. Variable observation

2.5.1. Weight loss

Loss of weight (%), measured by calculating the difference between the initial sample weight and the final sample weight compared to the initial sample weight. Weighing is done every three days of observation until the ninth day after storing with a digital scale.

2.5.2. Total dissolved solids

Total dissolved solids (^{o}brix) were measured using a hand refractometer. The fruit to be observed is grated first and then squeezed using gauze. Drop the fruit juice onto the surface of the reaction prism with three repetitions. Point the tool at the light source and look at the distance where the line on the lens passes.

2.5.3. Water content

The water content of the fruit (%) was obtained by cutting the fruit and measuring its fresh weight. After that, it was baked at 80 ^{0}C, then weighed. If the second weighing achieves a weight reduction of no more than 0.001 g from the first weighing, it is considered constant. Then the cup and dry sample were weighed. After that, calculations can be carried out to find out the percent water content in the fruit. Observations were made every three days of observation after storage

2.5.4. Vitamin C content

The content of vitamin C, measured by the method of iodine titration. Observations were made on the last day of observation. Fruit that has been crushed, weighed 10 g. Then dissolved into 50 ml by adding distilled water, and filtered using filter paper. After obtaining crystalline guava extract, take 10 ml and drip with 1 ml of starch solution, then titrate with 0.1 N iodine until the blue color does not disappear within 30 seconds.

2.6. Data analysis

Observational data were analyzed using analysis of variance (Anova) at the significant effect level of 5% and 1%. If there is a real influence on the interaction, then proceed with Duncan's test. If a single factor has a significant effect, then proceed with the LSD test at the 5% level

3. Results and discussion

3.1. Weight loss

The highest weight loss of crystal guava fruit was at Sa storage temperature and significantly different compared to other treatments at all observation times (Table 1). The lowest increase in weight loss was found at the Sk storage temperature of 19%. Weight loss experienced an increase at all three levels of maturity. The highest weight loss of crystal guava fruit was at Wk maturity level although not significantly different compared to other treatments at three and nine days of storage. The lowest increase weight loss occurred in Wm maturity levels with increase of 31%. This is also in accordance with the results of Akilie research [12], where low temperature storage gives smaller weight loss to papaya than at room temperature. In addition, a study by Sukmawaty et al [13] proved that storage at low temperatures gave lower weight loss of mangosteen, avocado and guava than at room temperature. The level of shrinkage is influenced by internal and external factors, one of which is temperature and humidity or RH [13]. High shrinkage in refrigerated rooms due to air conditioning causes air humidity to be lower than at room temperature so that shrinkage becomes higher. Air-conditioned rooms generally have lower air humidity than room air without air conditioning [14].

Table 1 Effect of storage temperature and fruit maturity level on fruit weight loss at various shelf life

Treatment	**Weight loss on storage time (% DAS)**		
	3	**6**	**9**
Storage temperature			
Sr	2.92 b	3.85 b	5.09 b
Sa	14.48 a	19.44 a	21.44 a
Sk	3.72 b	3.38 c	4.42 b
LSD 5%	1.14	0.29	7.10
Maturity level			
Wh	6.21 a	8.15 ab	10.00 a
Wm	6.94 a	7.77 b	9.09 a
Wk	7.97 a	10.75 a	11.86 a
LSD 5%	ns	2,78	ns

Description: Numbers followed by the same letter in the same treatment and column show no significant difference in the 5% level of low significant difference test (LSD); ns: not significantly different

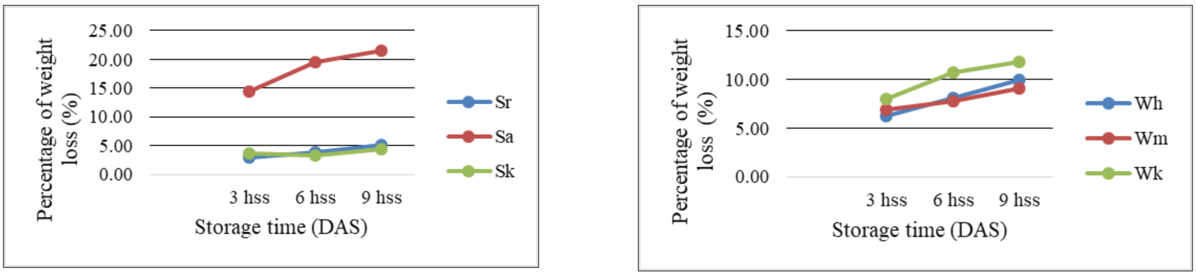

Figure 1 Effect of storage temperature and level of maturity on fruit weight loss

3.2. Total dissolved solids

The total dissolved solids of fruit in Sr, Sa, and Sk increased from day 3 to day 9 (Table 2). This is in accordance with the results of a study by Novita et al. [15] which found an increase in the value of dissolved solids of crystal guava during storage. Sa gave the highest total dissolved solids at all storage times. The highest increase occurred in Sa of 17.1%. Meanwhile, in Sr and Sk, the decline was 4% and 5%, respectively. The total dissolved solids of the fruit also increased at the three stages of maturity. The highest total dissolved solids are found in the Wk maturity levels. The highest percentage increase occurred in Wk of 12.6%. While Wh and Wm were respectively 9.8% and 4.4% (Figure 2). The total dissolved solids and high vitamin C content in the refrigerated room are due to the low water content so that the concentration of the solution in the fruit will be higher. This is in accordance with the results of research by Dewi et al. [5] where TPT values and vitamin C content were higher in fruits that experienced higher shrinkage. Fruit ripening causes a change in total dissolved solids [16]. Overripe fruit gave higher total dissolved solids (Table 2). This is in accordance with the results of research by Taris et al [17] that increasing the age of harvesting papaya also causes the dissolved solids content to increase.

Table 2 Effect of storage temperature treatment and degree of maturity to the total soluble solids of fruit at various shelf lives

Treatment	Total dissolved solids on storage time (^{0}brix DAS)		
	3	**6**	**9**
Storage temperature			
Sr	8.47 a	8.81 ab	8.81 b
Sa	9.00 a	9.60 a	10.54 a
Sk	8.09 a	8.46 b	8.50 b
LSD 5%	ns	1.12	1.03
Maturity level			
Wh	8.36 a	8.93 a	9.18 b
Wm	8.50 a	8.74 a	8.88 b
Wk	8.70 a	9.21 a	9.80 a
LSD 5%	ns	ns	0.57

Description: Numbers followed by the same letter in the same treatment and column show no significant difference in the 5% level of low significant difference test (LSD); ns: not significantly different

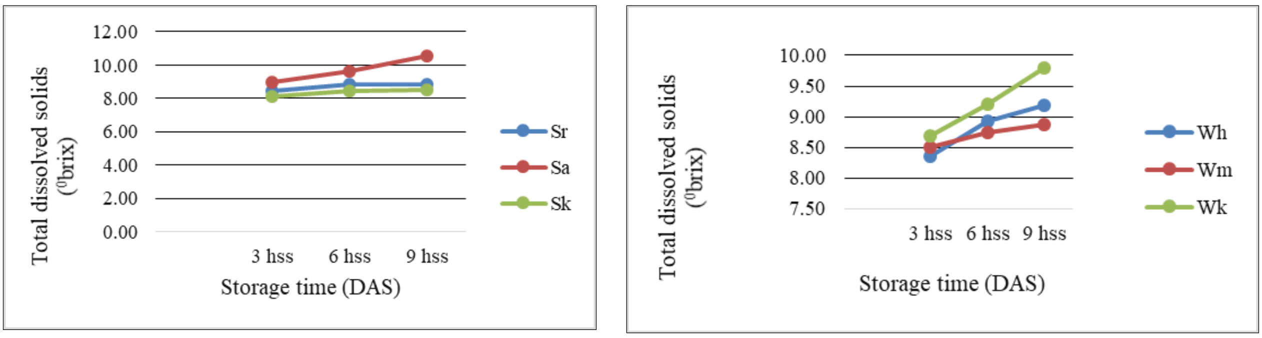

Figure 2 Effect of storage temperature on maturity level total dissolved solids of fruit

3.3. Water content

The water content of Sr, Sa, and Sk decreased from day 3 to day 9 (Table 3). This is also in accordance with the results of a study by Sukmawaty et al. [13] who found a decrease in water content in avocado, mangosteen and guava during storage. The results of research by Angraeni et al [18] also found a decrease in water content of guava during storage.

The air-cooled temperature gave a significant difference with the lowest moisture content for all storage periods (Table 3). The highest decrease in water content occurred at Sa of 8%. Meanwhile, in Sr and Sk, the decrease was 1.36% and 0.034%, respectively. The water content of the fruit also decreased at the three levels of maturity. The highest percentage decrease occurred in Wk of 3.8%. While Wh and Wm were respectively 3% and 2.4% (Figure 3). Water content is closely related to fruit weight loss, where the higher the water loss in the fruit, the higher the fruit weight loss [13]. With the lowest weight loss, refrigerator temperature also provides the lowest reduction in water content until the 9th day

Table 3 Effect of storage temperature treatment and degree of maturity on fruit water content at various shelf life

Treatment	Water content of fruit on storage time (% DAS)		
	3	**6**	**9**
Storage temperature			
Sr	87.37 a	87.05 a	86.18 a
Sa	85.11 b	82.36 b	78.31 b
Sk	87.13 a	87.77 a	87.10 a
LSD 5%	1.26	2.49	3.11
Maturity lavel			
Wh	85.75 a	84.20 b	83.12 a
Wm	86.83 a	86.46 a	84.74 a
Wk	87.02 a	86.52 a	83.72 a
LSD 5%	ns	1.77	ns

Description: Numbers followed by the same letter in the same treatment and column show no significant difference in the 5% level of low significant difference test (LSD); ns: not significantly different

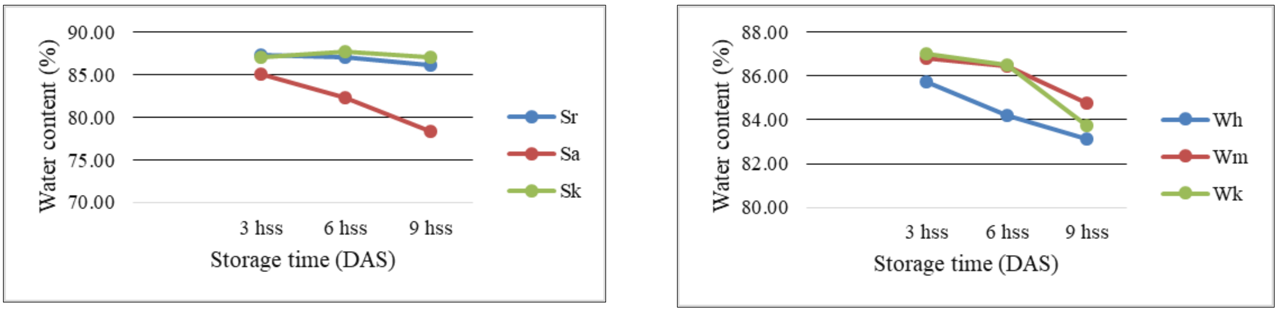

Figure 3 Effect of storage temperature and degree of ripeness on fruit water content

3.4. Vitamin C content

The highest vitamin C content at nine days of storage was in Sa which was 283.11 mg/100 g and was significantly different from the vitamin C content in Sr and Sk. The high content of vitamin C in Sa due to high shrinkage. This is supported by the results of research by Dewi et al. [5] who found a higher vitamin C content in fruit that experienced higher shrinkage. The lowest vitamin C content is found in Sk, which is only 260.30 mg/100 g. This shows that the vitamin C content in Sr and Sa was higher by 0.7% and 8.8% respectively compared to the vitamin C content in Sk at 9 days after storage (Table 4). At the maturity level, Wk gave the highest vitamin C content of 273.07 mg/100 g although it was not significantly different from Wh and Wm. The highest vitamin C content occurs when the fruit is ripe [15].

Table 4 Effect of storage temperature treatment on fruit vitamin C content at 9 days after storage

Treatment	Vitamin C content (mg/100g)
Storage temperature	
Sr	262.31 b
Sa	283.11 a
Sk	260.30 b
LSD 5%	16.89
Maturity level	
Wh	264.07 a
Wm	268.23 a
Wk	273.07 a
LSD 5%	ns

Description: Numbers followed by the same letter in the same treatment and column show no significant difference in the 5% level of low significant difference test (LSD); ns: not significantly different

4. Conclusion

The light green skin maturity level gave the lowest increase weight loss of 31% and the lowest decrease in water content of 2, 4%. Refrigerator temperature storage gave the lowest increase in weight loss of 19% and the lowest decrease in water content occurred of 0.034%. Air conditioner refrigerated temperature storage gave the highest weight loss and lowest water content and was significantly different compared to other treatments at all observation times. The air conditioner refrigerated temperature storage also gave the highest total dissolved solids at all storage times with increase occurred in Sa of 17.1% and gave the highest vitamin C content at nine days of storage of 283.11 mg/100g.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declared that there is no conflict of interest.

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