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Physico-chemical Characteristics of Tongka Langit Banana (*Musa troglodytarum* L.) at Different Maturity Stages

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Abstract

Tongka Langit Banana is a specific plants in Maluku and Papua, usually damaged after harvest. Maturity stage was an important factor to inhibit damage after storage. This study aimed to assessing and analyze the effect of maturity stage on physiological, and chemical characteristics. This study was designed using randomized complete block design. Variable measured were respiration rate, pH, total titratable acidity and ascorbic acid. Results of this study showed that maturity stage affected the physiology and chemical characteristics during storage. Respiration rate, pH, total titratable acidity and ascorbic acid were affected significantly.

Keywords: Musa troglodytarum; maturity stage.

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1. Introduction

Tongka Langit banana (*Musa troglodytarum* L.), is one type of banana plants in Indonesia which is only found in eastern Indonesia, namely in Maluku and Papua [1]. Banana is unique compared to other cultivars because of their stems that grow up and when it is ripe, red fruit skin color flesh color brown with yellow to orange [2].

Tongka langit banana including a group of climacteric fruit (Fig.1), which fruit maturation process occurs of changes in chemical and biochemical that cause rapid maturation and ripening. During maturation and ripening, an increase in respiration rate and ethylene, so as to accelerate the damaged of fruit [3].

Figure 1: Tongka Langit Banana

During the maturation process occurs of changes in banana that causes changes in color, texture, taste and in line with the other chemical changes such as changes in acidity, carbohydrates, pectin, protopectin, tannin and volatile substances. The problem faced fresh fruits, fast damage after harvest because the metabolic process was still ongoing, but the people tend to consume fruits in fresh condition, safe and remains available all the time.

Maturity stage is an important factor and influential in determining the physiological and chemical characteristics of the fruit and directly involved the changes in the biochemical and physiological processes [3,4, 5]. Maturity determine the shelf life and quality as an indicator of the postharvest handling and quality, can help farmers in harvest, transportation and marketing efficiently [6]. During the process of growth and development, changes the biochemical process that affected the formation of ethylene and increased respiration. Several factors affected the process of respiration is the level of maturity, tissue type, temperature, O_2 and CO_2 concentration. The purpose of this study to assessing and analyze the effect of the maturity stage to changes in physiological and chemical characteristics of Tongka langit banana.

2. Materials and methods

Materials used are harvested in the Tongka langit banana plantation farmers in Central Moluccas. The banana samples used in this study consists of three levels of maturity i.e. harvested one week before optimum maturity (53 days after the the first finger appeared, smooth surface, rounded - shape with corners but do not taper), harvested at optimum maturity (60 days after the the first finger appeared, smooth surface, rounded - shape with corners but do not taper), and harvested one week after optimum maturity (67 days after the first finger appeared, slightly rough surface with brown spots, rounded – shape, and most of the corners of the fruit have

disappeared), also chemical materials for analyzed.

The study was conducted using randomized complete block with three replications. Treatment of maturity stage (M) with 3 levels i.e harvested one week before optimum maturity (m1), harvested optimum maturity (m2), and harvested one week after optimum maturity (m3). The parameters observed were respiration rate, pH, total titratable acidity and ascorbic acid. The respiration rate, pH, total titratable acidity and ascorbic acidity were measured at five and ten days of storage.

Respiration rate

Samples were inserted in a glass jar and then covered for 3 hours to let CO_2 accumulates. For the measurement of the concentration in the jar made holes connected by plastic pipes. Respiration rate measurement is done by taking gas in a glass jar containing a banana and put in a plastic hose that was connected to the gas analyzer tool. Respiration rate were measured expressed in the amount of CO_2 produced (ml CO_2 kg^{-1} h^{-1}). The equation used to calculate the respiration rate is as follows

$$\mathbf{R} = \frac{dx}{dt} \boldsymbol{x} \frac{V}{W} \qquad \textbf{(1)}$$

Where: R = respiration rate (ml / kg/hour), x = concentration of CO_2 (%), t = time (hours), V = free volume of respiratory chamber (ml), W = weight of the fruit (kg).

pH measurement

pH of banana pulp, extracts were determined at room temperature using pH meter after being standardized with pH 4 and pH 7 buffers.

Total titratable acidity measurement

10 g pulp banana, plus up to 200 ml with distilled water. The filtrate was 20 ml. added 2-3 drops pp indicator and then titrated with NaOH until the color changes to pink.

Total Titratable Acidity (%)

= ml NaOH x N NaOH x total volume x acid equivalent weight x 100 (2)

Ascorbic acid measurement

10 g pulp banana, plus 100 ml of distilled water, and crushed taken 10 ml sample was added with 2 drops of the starch solution as an indicator, then titrate Iodine solution before use, conducted standardization.

$$\text{Ascorbic acid (mg/100 gram)} = \frac{V \; x \; N \; x \; 0.08 \; x \; FP \; x \; 100\%}{0.01 \; x \; W} \qquad (3)$$

Where: V = Volume of iodine used (ml), N = normality iodine standardization results, FP = dilution factor, W = weight of the sample (g)

The data observed were analyzed using SPSS version 16 and if there was significant difference among treatments, Duncan test was conducted at 95% levels.

3. Results

Results of analysis of variance for the effect of maturity stage treatment indicate that maturity stage have a significant effect of respiration rate, pH, total titratable acidity and ascorbic acid during storage. Results of Duncan's Multiple Range test as shown in Table 1 show the significant effects of maturity stage on the mean values of respiration rate, pH, total titratable acidity and ascorbic acid during storage.

3.1. Respiration rate

Respiration rate is an index to determine the shelf life of fruits after harvest. The amount of respiration rate was affected by two factors: internal factors (level of organ development, the size of the product, growth regulating compounds) and external factors (temperature, ethylene, oxygen, carbon dioxide and nutrients growth regulator) Table 1 showed that maturity stage affected respiration rate of Tongka langit banana (in ml CO_2 $kg^{-1}h^{-1}$) insignificantly ($P>0.05$) at fifth days of storage while at tenth days of storage it was significantly ($P<0.05$) Samples harvested one week after optimum maturity stage showed lower respiration rate and insignificantly samples harvested one week before optimum maturity and sample harvested optimum maturity at five days of storage. Samples harvested one week before optimum maturity stage showed the higher respiration rate and significantly samples harvested optimum maturity and sample harvested one week after optimum maturity at tenth days of storage.

Table 1: Result of Duncan's Multiple Range on the effects of experimental variables on respiration rate, pH, titratable acidity and ascorbic acid.

Treatment	Physicohemical characteristic							
	Respiration rate (ml CO_2 kg^{-1} h^{-1})		pH		Total titratable acidity(%)		Ascorbic acid (%)	
	5 days	10 days	5 days	10 days	5 days	10 days	5 days	10 days
Maturity stage(M)								
m1	8.9352 [a]	7.0613[a]	6.8 [a]	5.6 [a]	0.1917 [a]	0.2717 [a]	3.2300 [a]	5.9533 [a]
m2	8.6587 [a]	6.5549[b]	6.4 [b]	5.1 [b]	0.1950 [a]	0.2883 [a]	3.5383 [b]	5.7500 [b]
m3	8.5308 [a]	5.0735[c]	6.1 [b]	5.1 [b]	0.2069 [b]	0.3017 [b]	3.6767 [c]	5.6303 [c]

m1 = harvestd one week before optimum maturity, m2 = harvested optimum maturity, and m3 = harvested one week after optimum maturity

3.2. pH

The pH tended to increase during storage. Table 1 showed that maturity stage affected pH and significantly ($P<0.05$). Samples harvested one week before optimum maturity stage showed significantly higher pH value than those sample harvested optimum maturity and sample harvested one week after optimum maturity as indicated by measurement results at fifth and tenth days of storage. The higher pH value measured at sample harvested one week before optimum maturity stage, followed by harvested optimum maturity and than harvested one week after optimum maturity stage.

3.3. Total titratable acidity

The total titratable acidity to increase during storage. Results of analysis presented in Tables 1 showed that maturity stage affected titratable acidity significantly ($P<0.05$). Samples harvested one week after optimum maturity showed significantly higher total titratable acidity than those sample harvested optimum maturity stage and harvested one week before optimum maturity as indicated by measurement results at fifth and tenth days of storage. The lower total titratable acidity measured at harvested one week before optimum maturity stage, followed by harvested optimum maturity and than harvested one week after optimum maturity stage.

3.4. Ascorbic acid

The ascorbic acid tended to increase during storage. Results of analysis presented in Tables 1 showed that maturity stage affected ascorbic acid were significantly ($P<0.05$). Samples harvested one week before optimum showed significantly lower ascorbic acidity than those optimum maturity stage and harvested one week after optimum maturity as indicated by measurement results at fifth of storage. Samples harvested one week before optimum showed significantly lower ascorbic acidity than those optimum maturity stage and harvested one week after optimum maturity as indicated by measurement results at tenth days of storage. The lower ascorbic acid measured at harvested one week before optimum maturity stage, followed by harvested optimum maturity and than harvested one week after optimum maturity stage.

4. Discussion

Respiration rates of tongka langit bananas during storage as affected by maturity stage at harvest were relatively different. The overall results suggested that maturity during harvest can significantly affect physiological changes during storage, thus it can significantly affect shelf life. Respiration rate of Tongka langit banana after fifth days during storage, maturity stage insignificantly. Bananas have entered the stage of ripening so that maximum of CO_2 production is the same. Respiration rate of Tongka langit banana after tenth days of storage, maturity stage were significantly. Samples were harvested a week before optimum maturity stage, respiration rate was higher compared with samples harvested at optimum maturity stage and the samples harvested at one week after optimum maturity. This is because the fruit has entered a phase of aging so that the lower CO_2 production on samples with full maturity level. During storage, the more perishable fruit and have a short shelf life [7]. According to [8], the respiration process of the fruit after harvest is influenced by internal and external factors. Reported by [9] that the respiration rate of banana late harvested was highest than the early harvested.

The results showed that the samples were harvested one week before optimum maturity stage, the pH value was higher than sample at harvest optimum maturity and sample harvested one week after optimum maturity stage. This is because pH tended to increase during storage and affected to chemical characteristics. The results showed previously clearly indicate that maturity at harvest affected pH of tongka langit banana during storage. The higher level of pH on samples harvested one week after optimum maturity may indicate that the samples have already undergone ripening process before the first measurements were conducted at the fifth and tenth days of storage. The increased pH due to the increase of organic acids acid biosynthesis.

The results showed that the samples were harvested one week after optimum maturity stage, the total titratable acidity was higher than sample at harvest optimum maturity and sample harvested one week after optimum maturity stage. The total titratable acidity in the Tongka langit banana at early harvested stage, harvested optimum maturity stage were lower and significantly than at late harvested. This were [10, 11] suggested that acid content increase during maturation. Ripe bananas have followed with increasing total titratable acididity content low acidity level in the development phase and then increased when mature to ripe. This was because excessive oxalic acid biosynthesis when mature and ripe fruit [12]. The results showed that the samples were harvested one week after optimum maturity stage, the ascorbic acid was higher than sample at harvest optimum maturity and sample harvested one week before optimum maturity stage. The more ripe bananas, ascorbic acid increased. Increased content of ascorbic acid resulting asm organic acids accumulated during the process of maturation and ripening. The higher the maturity stage of the total titratable acidity including ascorbic acid tends to increase. Total titratable acidity increasing during storage because decarboxylation due process oxalic acid which is a component cause astringent taste (astrigensi) in young banana fruit by the enzyme oxalate oxidase. In the phase of the climacteric, malic acid into organic acids predominant in bananas [13, 14, 15]. Ascorbic acid is an important quality characteristic of fruit, specially desired for its antioxidant properties [11, 16, 17, 18]. These results are consistent with those reported by [19,20] that ascorbic acid increased with increasing levels of maturity. Organic acids in fruit is one of the main constituent component of the cell and will undergo changes during ripening. Organic acids in fruits, during the growth and development process, there is an increase and then decrease after the maturation stage. In bananas, the acid content increases towards ripening[21,22]. The relationship between organic acids and respiration , so the highest respiration, low organic acid content because the organic acid content can be used as a substrate respiration.

5. Conclusion

The effect of the maturity stage on respiration rate, pH, total titratable acidity, ascorbic acid during storage of tongka langit banana were significant.. Samples harvested a week before the optimum maturity and harvested optimum maturity, the higher respiration rate, pH value while the total titratable acidity and ascorbic acid were lower at fifth and tenth days of storage.

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