Analysis of pH value and Color of Palm Sap (*Arenga pinnata* Merr) during Storage

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Abstract. Palm trees as non-timber forest plants can produce sap after going through the tapping process. Palm sap has been widely consumed by the public as a fermented beverage. However, this palm sap is easy to change in quality. Therefore, the purpose of this study was to analyze the pH value and color of palm sap during storage. Samples of palm sap were obtained from farmers in Sesaot, West Lombok, West Nusa Tenggara, Indonesia. The research parameters were changes in pH and color of palm sap after tapping. Research samples were stored at various temperatures of 15, 30, and 40 ºC. Observation data was carried out every 2 hours for 2 days of storage. The results showed that the pH levels and the color of the palm sap changed after storage. After 10 hours of storage, the pH level of palm sap changed from 7.0 to 2.6 at 40 ºC; 4.8 at 30 ºC; and 6.6 at 15 ºC. Palm sap stored at 15 ºC had the lowest decrease in pH value compared to 30 and 40 ºC. The higher the storage temperature, the greater the decrease in the pH value. Along with the decrease in pH value, the color of palm sap also decreased significantly at various storage temperatures.

Keywords: color, palm sap, pH, storage, tapping

1 Introduction

Indonesia has the potential for sugar palm (Arenga pinnata Merr) which is very abundant. This plant belongs to the Arecaceae family group which can thrive in areas with high and even rainfall, such as several areas in Indonesia. If cultivated properly, the number of palm trees per hectare can reach 156 trees [1]. Palm trees as non-timber forest plants have long been cultivated in Indonesia [2]. This plant can produce sap through the process of tapping on male flowers that have not yet bloomed. This palm

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sap is the most popular product because it has been widely consumed, both at home and abroad as a fermented beverage. The commonly used indicators of the quality of palm sap are the pH value (pouvoir Hydrogene) and color. The pH value indicates the acid content in the juice, while the color indicates the level of quality and hygiene of the juice. This quality indicator is very easily damaged by the influence of temperature [3]. Methods to prevent a decrease in the quality of palm sap have been widely reported. For example, putting mangosteen peel powder into a storage container [4]. This mangosteen rind contains anti-microbial that can prevent the proliferation of bacteria and fungi [5]. Another method that is often used is to put coconut belts into storage containers [2].

Palm sap that has just been tapped has a pH value ranging from 6.0 to 7.5 [6]. Because palm sap is easily damaged, the storage method needs attention [7]. According to Mulyawanti et al. (2011), the shelf life of palm sap is only 4 hours after tapping.

Processing quality palm sugar requires large volumes of palm sugar for one processing [2]. If the amount of sap that is tapped in the afternoon and in the morning is not enough 10 liters, then the crafter must wait for the sap that is tapped the next day. This is a challenge to maintain the quality of palm juice at a pH condition that allows it to be processed into palm sugar [8]. Based on this argument, the purpose of this study was to analyze the pH value and color of palm sap during storage to determine changes in the physical characteristics of the sap.

2 Material and Method

2.1 Tools and Materials

The material used is palm sap taken from farmers in Sesaot, West Lombok, NTB. This palm sap begins to be tapped at 17.00 WITA (afternoon) to 07.00 WITA (morning) by farmers without using preservatives. This tapping occurs in the dry season. Research equipment used, among others, pH meter, color meter, and cool box.

2.2 Preparation of Palm sap

Palm juice taken from farmers was stored at 3 variations of storage temperature, namely cold temperature (15 ºC), ambient temperature (30 ºC), and warm temperature (40 ºC). This treatment variation was used to determine the effect of storage temperature on changes in the pH value and color of palm sap during storage.

2.3 Measurement of pH value

The measurement of the pH value of palm sap was carried out using a pH meter (Mettler Toledo, Switzerland) at various storage temperatures of 15, 30, and 40 ºC every 2 hours for 2 days of storage. Calibration was carried out using a pH buffer of 7.0 [9].

2.4 Measurement of Color

Sugar palm juice was put into a clear plastic bottle and then the color change was measured using a color meter (Chroma Meter-CR-400, Konica Minolta) at various storage temperatures of 15, 30, and 40 ºC for up to 2 days of storage. The color of palm sap is expressed in values of L*, a* and b*, where L* indicates lightness, ranging from 0 (black) to 100 (white), a* from -60 (green) to +60 (red), and b* ranging from -60 (blue) to +60 (yellow) [10].

2.5 Data Analysis

The research data were analyzed using two-factor analysis of variance. If the F-count value is greater than the F-table, it means that there is a significant difference in effect. To find out the most optimal treatment, a DMRT (Duncan's Multiple Range Test) further test was carried out [11].

3 Result and Discussion

3.1 pH value

The results showed that the pH value of palm sap decreased significantly ($p<0.05$) during storage (Figure 1). In Figure 1 it can be seen that the decrease in the pH value of palm sap after 10 hours of storage from 7.1 to 2.6 (63.38%) at 40 ºC, 4.8 at 30 ºC (32.39%), and 6 ,6 at 15 ºC (7.04%). These data indicate that palm sap stored at 15 ºC has the lowest decrease in pH value compared to 30 and 40 ºC. This happens because the storage at a temperature of 15 ºC bacteria, fungi, and other microorganisms present in the palm sap cannot grow and reproduce properly. The same thing has been revealed by other researchers that cold storage can inhibit microbial growth and enzymatic and chemical reactions of sap [12]. In addition, it can also inhibit physiological, enzymatic, and microbiological damage to materials [13].

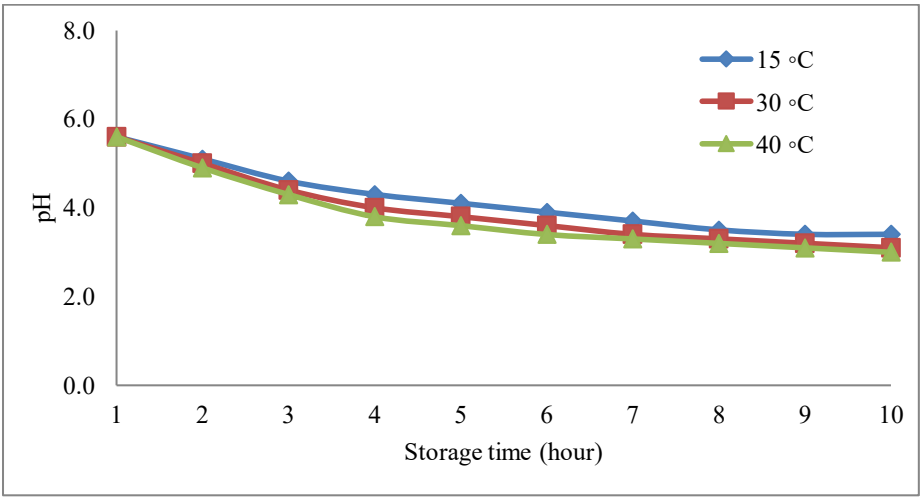

Fig. 1. Decreasing the quality of the pH value of palm sap on variations in temperature and storage time.

The pH value of palm sap indicates the level of acidity which is a measure of free hydrogen ion activity. At the beginning of the tapping the pH value of palm sap ranged from 6.0 to 7.5. This value range is in accordance with the results of measurements carried out by other researchers, such as Mulyawanti at al. (2011) which ranged from 6.0 to 7.5. The decrease in the pH value of palm sap is caused by a rapid acid fermentation process into alcohol [14]. Researchers Ansar et al. (2021) have also explained that naturally palm sap contains microbes that can produce the amylase enzyme then converts it to alcohol.

Another aspect that needs to be revealed in this study is that the storage temperature of 30 ºC has a significant effect ($p<0.05$) on changes in the pH value of palm juice from the initial pH of storage = 7.1 to 4.8 at the end of storage. High environmental temperatures can trigger the proliferation of bacteria in the palm sap. The higher the temperature, the higher the rate at which sugar changes to acid. The same thing has been explained by Elijah et al. (2012) that the microorganism Saccharomyces cerevisiae is generally found in palm sap which produces a fermentation reaction and rapid conversion of sugar into acid.

The decrease in the pH value of palm sap at a storage temperature of 40 ºC can affect the stability of the sucrose content in the sap. This level of sucrose is degraded due to the process of hydrolysis of sucrose into acid. The hydrolysis process occurs spontaneously, so that the sucrose content ferments quickly and turns into acid. The results of this study are in line with the results of research reported by Ilyas et al. (2019) that glucose which is a simple unit of sucrose is converted into pyruvic acid, then pyruvic acid is converted by the presence of hydrogen atoms into acetaldehyde compounds catalyzed by enzymes produced by yeast which ultimately produces ethanol alcohol, so that the availability of sucrose in the sap decreases with the length of storage time.

3.2 Color

The results showed that the color of L* a* b* changed at 30 ºC and 40 ºC, but did not occur at 15 ºC (Figure 2). The value of L* (lightness) changed significantly ($p<0.05$) at 30 ºC storage temperature from 86.10 to 54.21. Likewise at storage temperature of 40 ºC from 86.10 changed to 43.40. The value of b* (yellowness) also decreased significantly ($p <0.05$) from 58.00 to 32.40 at 30 ºC storage and from 58.00 to 25.00 at 40 ºC storage. However, the value of a* (redness) did not change significantly ($p> 0.05$) at various storage temperatures after tapping. This shows that the color of the palm sap is more dominated by yellow. The same thing was reported by Manel et al. (2011) that the color of the sap which was originally clear yellowish changed to a brownish yellow color after 5 hours of storage.

Another aspect that needs to be disclosed in this observation is that the values of L* and b* have a very close relationship with the pH value of palm sap. Observational data showed that when the pH value of palm sap decreased, the value of L* and b* also decreased. The same thing has been revealed by Victor & Orsat (2018) that there is a close and consistent relationship between pH and color change of palm sap with other findings such as fruit color. The pH value of palm sap is a function of the value of lightness (L*) and yellowness (b*), and not of redness (a*). Referring to color, this study is in line with the results of research by Naknean & Meenune (2015) which reported that the pH value was strongly related to color.

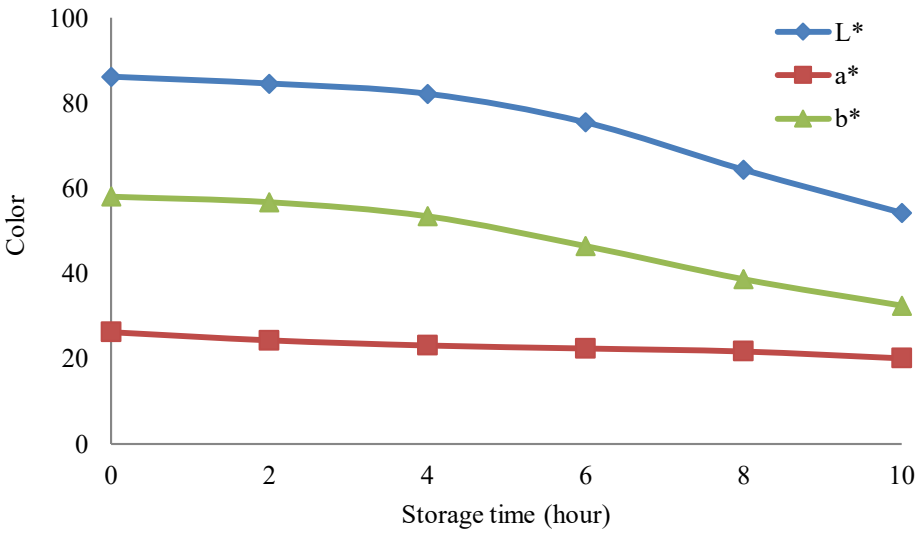

Fig. 2. Observations of changes in the color of palm sap during storage.

The effect of color changes during storage can be used as an indicator of the quality of palm sap. The results of this study indicate that the pH value is a function of lightness (L*) and yellowness (b*), but is not positively correlated with redness (a*). This finding is in line with the results of research conducted by Gonçalves et al. (2007) that a high pH value appears to be clearer palm juice, while a low pH value appears cloudy palm juice. Thus, indicators of changes in the quality of palm juice can be related to the pH value to analyze the decline in the quality of palm juice during storage.

The average decrease in the color quality of palm sap stored at variations in temperature and storage time ranged from 23.28 to 56.90%. The results of the analysis of variance (α=0.05) show that the F-count value (5.5693) is greater than the F-table value (3.3258). This shows that variations in temperature and storage time have a significant effect ($p<0.05$) on the decrease in the pH quality of palm sap (Table 1). The lowest reduction in the color quality of palm sap was obtained at a storage temperature of 15 ºC. The same thing also happened to variations in storage time, the longer the storage time, the greater the decrease in the color quality of the palm juice.

Table 1. Analysis of variance in color quality degradation of L* a* b* palm sap on variations in temperature and storage time.

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	1599.868	5	319.9737	5.569381	0.010412	3.325835
Columns	6258.47	2	3129.235	54.46668	4.2E-06	4.102821
Error	574.5229	10	57.45229			
Total	8432.862	17				

4 Conclusion

Parameters of pH value and color of palm sap decreased in quality during storage at variations in temperature and storage time. After 10 hours of storage, the pH value of palm sap changed from 7.0 to 2.6 at 40 ºC; 4.8 at 30 ºC; and 6.6 at 15 ºC. Palm sap stored at 15 ºC had the lowest decrease in pH quality compared to 30 and 40 ºC. The higher the storage temperature, the greater the decrease in the pH value. Along with the decrease in pH, the color of palm sap also decreased significantly.

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