The effect of addition natural preservatives from jackfruit wood during storage on pH, total microbes, taste and colour of palm oil sap

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Abstract. There is an increase in the growth of oil palm plantations every year in Indonesia. Every oil palm which is no longer productive will be replanted. Oil palm sap can be produced from oil palm replanted. Oil palm sap is a raw material that is easily damaged. Jackfruit wood can be used to prevent damaged on palm oil sap. This research study used a completely factorial randomized design with 2 factors, the concentration of jackfruit wood added (K): (3%, 6%, 9%, 12%) and storage time (T): (0 days, 1 day, 2 days, 3 days). The result showed that the concentration of jackfruit wood had effect on pH, total microbes, taste and colour. The storage time had effect on pH, total microbes, and taste. Interaction of the concentration of jackfruit wood and the storage time had significant different on pH. The result showed that the best oil palm sap was from the treatment the percentage increase of 12% jackfruit wood and storage for 3 days.

1. Introduction

African oil palm (Elaeis guineensis Jacq) is a cultivated plant. The age of oil palm can reach between 20-25 years. Indonesia has been trying to increase the amount of oil palm plantations and production. In the world, Indonesia is the biggest exporter of African oil palm. Economic potential of palm oil is enormous. Indonesia can get about 9.11 billion dollars from African oil palm. Indonesia exported 23 million tons of oil palm in 2010 [1]. Oil palm expansion in the world only around 12 million hectares in 2011, more than 8 million hectares came from Indonesia [2]. Solid waste from oil palm plantation like uprooted oil palm can make high income, like make palm sugar from palm oil sap. Sap from oil palm is perishable, because sap contain high sugar that needed microbes for fermentation. Several good microbes, like yeast and bacteria are always found in sap. Fermentation in sap can change the taste into acidic. When tapping process was started, fermentation process occurs. Sap contains about 12.04% sugar, 87.66% water, 0.36% fat, 0.36% protein, and 0.21% ash [3]. Sap contains 12.30-17.40 g sucrose, 0.11-0.42 g ash, 0.23-0.32 g protein, and 16.00-30.00 g vitamin C in 100 ml sap with specific gravity about 1.058-1.077 g/cm³ [4]. One of several natural preservatives to inhibit fermentation in sap, is the wood or sap of jackfruit (Artocarpus heterophylla Lamk.). Jackfruit wood contains several chemical contents like morin, cyanomaclurine (tanned substance), flavone, and tannin, several flavonoid substances in the skin of jackfruit wood, i.e. artocarpin, cycloartobilosanton, morusin, artonin E, and...
artonol B. The bioactivity of those flavonoid substances is known empirically as anticancer, antivirus, antiinflammation, diuretic, and antihypertension [5]. The damaged process of sap begins with sucrose inversion, fermentation, and oxidation to produce acetic acid [6]. The causes of sap damage include the length of tapping, lack of plant hygiene, the presence of various types of insects, improper preservative dosage, bad climate [7]. The length of tapping process causing the sap to ferment so that the breakdown of sucrose into reducing sugars, the process of this breakdown occurs due to the low pH of the sap [8]. Jackfruit wood contains morine, alcohol, saponin, glucoside and calcium oxalate. Jackfruit bark contains resin, cyclohydrophyllin, and tannin. Tannin has bacteriostatic, fungistatic properties, and if in large quantities it will be toxic. Bacteriostatic is a substance that works to inhibit the growth of bacteria. Flavonoid compounds from several natural materials are reported to have antibacterial activity, among these components, alkaloids and triterpenoids are thought to act as preservatives in sugarcane juice, are enzyme inhibitors and antimicrobials [9] [10].

2. Material and methods
The research was conducted at Food Technology Laboratory, Universitas Sumatera Utara, from October 2017 until Mei 2018. The materials used were jackfruit wood and oil palm sap which were obtained from Bingkat Village, Serdang Berdagai Regency, North Sumatera. The jackfruit wood was used for natural preservative, then cut into small size, then scaled for 100 g. Five litres of water was heated to boil for 30 minutes, then 100 g of jackfruit wood was put into boiling water and stirred evenly. Afterwards, the natural preservatives were left to cool. Natural preservative was added into container of tapped sap. Preservative was given incrementally to prevent damage to sap during collection. Previously prepared preservative then added into container with concentrations of 3% (K1), 6% (K2), 9% (K3), and 12% (K4) in 1 litre of sap. Afterwards, oil palm sap was left at room temperature for 0, 1, 2, and 3 days of shelf-life. This study was conducted using Complete Random Design which consisted of two factors, i.e. Factor I: Percentage of natural preservatives (K) which consisted of 4 phases, which are K1 (3%), K2 (6%), K3 (9%), K4 (12%), and Factor II: Storage duration (T) which consisted of 4 phases, which are T1 (0 day), T2 (1 day), T3 (2 days), T4 (3 days). The number of treatment combination (Tc) was 4 x 4 = 16. Two repetitions were performed for precision. The analytical parameters for sap and palm sugar include: pH [11], total microbes [12], taste and colour [13].

Data analysis using randomized design were analysed using SPSS version 22 for windows. The data reported in all Tables are the average of triplicate observation subjected to one-way analysis of variance (ANOVA). Difference among the ranges of the properties were determinate using the method of Least Significant Difference (LSD) tests at 95% confidence level (P<0,01). The best treatment test was then compared with the control treatment T-test. De Garmo was used in determining the best treatment method.

3. Results and discussion

3.1. Material analysis (raw material without addition preservatives)

| Parameter             | Value  |
|-----------------------|--------|
| Reduction sugar (%)   | 0.723  |
| Sucrose (%)           | 15.892 |
| pH                    | 6.666  |
| Total Sugar (%)       | 17.603 |
| Total microbes (log CFU/mil) | 4.921 |
3.2. pH
The preservative addition (Table 2) and storage duration (Table 3) showed significant differences \( (p < 0.01) \) to pH in oil palm sap, including the interaction of both \( (p < 0.01) \). There was an increase of pH level in oil palm sap during the addition of jackfruit wood solution to 12\% (Table 2). This was due to the addition of jackfruit wood which inhibited fermentation process and decreased acidic substances in sap, thus pH decrease can be maintained. This was in accordance with Cowani (1999) \[14\], which stated that jackfruit wood contains flavonoid and tannin, where flavonoid as an antimicrobial substance can bind adhesin complex to the walls of microbial cells.

\[
\begin{align*}
T1 &= \hat{y} = -0.5559x + 6.8489 \\
t &= -0.9737 \\
T2 &= \hat{y} = -0.9005x + 6.7832 \\
t &= -0.9911 \\
T3 &= \hat{y} = -0.9783x + 6.5449 \\
t &= -0.99 \\
T4 &= \hat{y} = -1.0554x + 6.258 \\
t &= -0.9997 \\
\end{align*}
\]

**Figure 1.** The interaction of addition of preservatives and storage time with pH value palm oil sap

The decrease of pH value in oil palm sap occurred until 3 days of storage duration in the amount of 3.926 (Table 3). This was caused by sugar fermentation which occurred during storage process which caused acidic content in sap increased continuously because sap is a fertile growth media for microorganism, thus decreased the pH of oil palm sap. This was in accordance with Budiyanto (2004) \[15\], which stated that the longer the storage duration of sap, then the lower the pH because sap is easily damaged by microbial fermentation because it is a fertile growth media for microorganism.

3.3. Total microbes
Preservative addition (Table 2) and storage duration (Table 3) showed significant differences \( (p < 0.01) \) to the total microbes of oil palm sap. Meanwhile, the interaction of both showed insignificant difference \( (p > 0.05) \) to the total microbes of oil palm sap.

There was a decrease of total microbes during the increase of concentration of jackfruit wood solution, in which the highest concentration (12\%) resulted in 5.753 CFU/mg microbes and the lowest was 5.789 CFU/mg in 3\% concentration (Table 2). This was due to the contents in jackfruit wood which can inhibit and halt the growth of microorganism in oil palm sap. This was in accordance with Fauzi, et al. (2013) \[16\], which stated that jackfruit wood had antimicrobial substance which can affect microorganism activities and in lower concentration can act as bacteriostatic, while in high concentration can act as bactericidal.

The increase of total microbes of 5.7797 CFU/mg occurred during storage until 3 days of storage duration (Table 2). This was due to the nutritional value in sap which is a good place for microbial growth, thus spontaneous fermentation process occurred. This was in accordance with \[15\], which stated that the longer the duration of storage, the lower the pH of sap because sap is a fertile growth media for...
microorganism. Other than that, fermentation of lactic alcohol acetate occurred, which is also a spontaneous fermentation which include lactic acid bacteria, khamir, and acetic acid bacteria which reduced sugar level in sap.

3.4. Hedonic taste of oil palm sap
Preservative addition (Table 2) and storage duration (Table 3) showed significant differences ($p < 0.01$) to hedonic taste of oil palm sap. Meanwhile, the interaction of both showed insignificant difference ($p > 0.05$) to total microbes of oil palm sap.

The higher the solution of jackfruit wood was added, the preferable the resulting taste (Table 2). Jackfruit wood contains substances which can reduce the fermentation of sap to inhibit acid taste in the sap, therefore the sap that were given highest jackfruit wood solution (12%) was preferable to the panellist. This was due to alkaloid, saponin, tannin, and flavonoid which inhibited the growth of bacteria. Saponin had a soap property to dissolve dirt, and acted as anti-inflammatory and antimicrobial, while flavonoid acted as antibacterial [16].

The longer storage duration up to 3 days decreased the taste of oil palm sap and were less preferable to the panellist. The highest preferred taste was 0-day storage of 3.1317% and the lowest preferred taste was 3-day storage, which was 2.0500% (Table 3). Oil palm sap with longer storage had less sweet taste compared to sap stored in 0 days. Carbohydrate degradation to acidic substance caused changes in sap taste during storage. This was due to spontaneous fermentation process which occurred during storage process which involved lactic acid bacteria, khamir, and acetic acid bacteria, thus sap taste underwent changes during storage process, with increasing acidity and decreasing sweetness of the sap [17]. Therefore, the longer the duration of oil palm sap, the lower the preference of panellists of its hedonic taste value.

3.5. Hedonic colour of oil palm sap
Preservative addition (Table 2) showed significant difference ($p < 0.01$) to hedonic colour value of oil palm sap. Meanwhile, storage duration (Table 3) and interaction of both showed insignificant differences ($p > 0.05$) to hedonic colour value of oil palm sap.

The higher the concentration jackfruit wood added, the less preferable the resulting taste (Table 1). Sap colour with highest concentration (12%) was cloudier and citrus yellow compared to sap colour with lowest jackfruit wood concentration (%). This was due to substances of flavonoid, tannin, and quinone contained in jackfruit wood which gives citrus yellowish colour to the resulted oil palm sap [18].

| Parameter                      | Additional percentage of jackfruit wood (%) |
|--------------------------------|---------------------------------------------|
|                                | $K_1$ | $K_2$ | $K_3$ | $K_4$ |
| pH                             | 4,674<sup>ID</sup> | 5,077<sup>IC</sup> | 5,432<sup>IB</sup> | 6,015<sup>IA</sup> |
| Total microbes (log CFU/mil)   | 5,789<sup>IA</sup> | 5,773<sup>AB</sup> | 5,763<sup>IB</sup> | 5,753<sup>IC</sup> |
| Taste hedonic value            | 2,391<sup>AC</sup> | 2,625<sup>BC</sup> | 2,858<sup>BB</sup> | 2,925<sup>BA</sup> |
| Colour hedonic value           | 3,775<sup>AA</sup> | 3,641<sup>BB</sup> | 3,550<sup>CA</sup> | 3,416<sup>CD</sup> |

| Parameter                      | Storage Time |
|--------------------------------|--------------|
|                                | $T_1$ | $T_2$ | $T_3$ | $T_4$ |
| pH                             | 6,525<sup>IA</sup> | 5,840<sup>AC</sup> | 4,909<sup>BC</sup> | 3,926<sup>IC</sup> |
| Total microbes (log CFU/mil)   | 5,734<sup>AC</sup> | 5,762<sup>BC</sup> | 5,785<sup>AB</sup> | 5,797<sup>A</sup> |
| Taste hedonic value            | 3,141<sup>IA</sup> | 2,958<sup>AB</sup> | 2,650<sup>AB</sup> | 2,050<sup>B</sup> |
| Colour hedonic value           | 3,341 | 3,558 | 3,633 | 3,850 |
4. Conclusion

The addition of jackfruit wood solution to oil palm sap showed significant differences (p < 0.01) in pH, total microbes, hedonic taste and colour. The storage duration of oil palm sap showed significant differences (p < 0.01) in pH, total microbes, and hedonic taste. Interaction between the addition of jackfruit wood solution and storage duration to oil palm sap showed significant differences (p < 0.01) in pH. From this study, the best oil palm sap was shown by K4T1 treatment, which was 12% addition of jackfruit wood and 1 day storage duration.

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