Evaluation of Palm Sap (Neera) Quality (Arenga pinnata Merr) in Processing of House Hold Palm Sugar (Case Study on Aren Farmers in Gunung Halu Village, Gunung Halu District, West Bandung Regency)

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Abstract. Palm sap (Neera) is a sweet liquid that is obtained from the cutting of flower buncbes of sugar palm (Arenga pinnata Merr). Nira used as a raw material for making palm sugar. Palm sugar with good quality depends on the quality of the sap processed. The research was conducted to study the different quality of nira in household processing of palm sugar based on differences in storage containers (lodong), namely traditional containers using bamboo and modern containers using aluminium. Harvesting of the nira was conducted in the morning and afternoon time. Observations were carried on chemical quality (pH and total soluble solid), organoleptic perception (color, aroma, and taste), and the number of bacterial colonies (total plate count). The results showed that then treatments using aluminium container had better quality of nira with a mean value of pH 6.95, mean value of TSS 13.7 Brix, the organoleptic perceptions of color is more clear, taste is sweet, and fragrant smell; and the mean number of bacterial colonies is 12.5.

1. Introduction
Palm sugar from Arenga pinnata Merr sap has been consumed by the local people of Indonesia for decades [1] and has been worked as pioneer plant and it could grow in tropical forest, coastal area, and at the top of a mountain. Arenga pinnata Merr serve as land conservation plant that capable to maintain environmental balance. In west java, palm sugar called as gula kawung. Neera is a liquid sap that is tapped from a piece of male flower stem from sugar palm plants. The sugar is considered to be potentially better for your health for which sufficient information is not yet available. The tapping process is carried out for 2-3 months and on average produces 8-12 liters per day. Neera is easily contaminated by microbes, there will be a fermentation process of sucrose by microorganisms in a matter of hours and the taste will turn sour [2]. Arenga pinnata Merr known as a plant that have social and economic value. Palm sugar with good quality is very dependent on the quality of the processed sap [3]. Neera was actually very potential as a raw material of brown sugar commodities, but there were still very few people who process them into brown sugar or palm sugar, but it have limited
market share, actually, because it includes illegal commodity. It was the reason why the farmers replace their aren trees (Arenga Pinnata (Wurmb) Merr) with plantations and crops. Unfortunately, if the empowerment of farmers did not care the important value of aren tree, while aren trees (Arenga Pinnata (Wurmb) Merr) have the value of social, economic, and environment. Although aren trees (Arenga Pinnata (Wurmb) Merr) could grow everywhere, on broad climate and soil variations [4].

The producing process of brown sugar has been done using simple and traditional method. Low level of education and skill also cause aren farmers less able to compete to other industries. Aren farmers not only focus on aren’s cultivation, but also on other plantation, not as a primary thing to do on farming [4]. Processing conditions such as uncontrolled temperature, length of cooking which is only based on estimates, and inconsistent stirring are some factors that can cause the production of brown sugar to be very varied and tend to have low quality. In the end, the brown sugar industry less well developed. The problem that exists today is that the reservoir of palm sap (neera) that is still traditional in nature with a container made from bamboo (called lodong) with cleaning method, fumigation. The one determinant of the quality of brown sugar is the color of sugar. The color of brown sugar is determined by the initial pH of neera [4]. Brown sugar made from neera with a pH of 6 or less will produce brown yellow brown sugar. Nira with a pH of about 7 will produce brown sugar with dark brown color which will get darker with higher pH. Previous research results, that sap which is tapped in the morning has a lower pH with low sucrose levels, so that it will produce a lighter color of sugar. On the contrary, based on the previous research [5], the more the natural preservative given to the sap will cause the brown sugar color to become increasingly brown because the pH of neera is higher.

In recent years, there has been a slowly increasing amount of literature on A. pinnata. However, the evidence presented in this chapter suggests that only few writers have worked on the monitored processing of A. pinnata sap into syrup or sugar. The changes of pH in collected tree sap is likely related to the microorganism activity which mostly comes from the inflorescences and spathes of the tree. The rapid growth of microorganisms reduces the pH by producing organic acids, thus indicating varying levels of deterioration. When acids increase in the sap, the pH decreases since the acids release hydrogen ions in the sap [6]. Because of fermentation, it caused nutrient degradation, loss of sensory qualities, and development of sour taste due to the production of acid during the fermentation process of palm sap which may be due to the action of microorganisms. It is also found that vitamins C, E, and B complex decreased in fermented sap. The sap is nutritious and aids in digestion. Freshly tapped sap possessed tolerable odor and became unpalatable with harsh odor during fermentation process. This may be due to the product of palmitoleic acid, dodecanoic acid, ethyl alcohol, and ethyl esters during fermentation of palm sap. If the sap is fermented, the quality and quantity of sugar and other nutrients decline and become difficult to crystallize the sugar without the use of chemicals [7].

The method of palm sugar processing can affect its characteristics and quality. Conventional method that has been used to produce palm sugar causes palm sugar to be dark brown and taste slightly bitter. The darkening phenomenon is occurred because of high temperatures operation which leads to caramelization. Another negative effect is the loss of active components due to palm sap degradation. Selection of the right technology is required to improve the quality of palm sugar. One of that has been

promising method is spray drying [8]. And also noted that traditional way of tapping the inflorescence is very risky as it needs to climb the tree for slicing and bringing down the previously collected coconut sap. The high risk of falling off the tree during tapping and collecting the coconut sap and climbing the tree with more than 10m height is a physically hard job. Therefore, an improved technology for safely tapping the sap is urgently needed [9]. Season is very influential on the quality of palm sugar produced from the palm trees. During the rainy season, the production of palm sugar tends to be low with poor quality. This is because neera is mixed with dirty rainwater, so that when neera will be processed, then it is necessary to leave it for a few hours to filter it from the rainwater. Therefore, the sugar produced also tends to have a low quality. In contrast with rainy season, neera
will have a very good quality during the dry season. This is because the water produced is pure and not mixed with any substances [10].

The use of bamboo as a container for palm sugar has been used for a long time, because bamboo stove materials are easily obtained in people's gardens and do not require additional costs such as using aluminum. But the use of bamboo does not last long, considering that bamboo is smoked and cleaned using water continuously. Based on these matters, it is necessary to evaluate the quality of palm sap (neera) by using a traditional container using bamboo and modern containers using aluminium, with the aim of finding out the most suitable nira storage container to produce the best quality brown sugar. The financial feasibility of processing business of neera into palm sugar still could be improved by promoting palm sugar as an organic sugar product. As already known that the supply of neera is derived from aren trees (Arennga Pinnata (Wurmb) Merr) that grows wild (natural), without any contamination of chemicals in the process of cultivation. Therefore, palm sugar business could become promotional activities, which could contribute as an incentive for the farmers to intensify the business of palm sugar processing.

2. Materials and methods

2.1. Time, Place and Sampling Techniques

The study was conducted at the Giri Mukti II palm sugar farmers in Gunung Halu Village, West Bandung Regency in 14th-16th on August 2018. The research method used in this study is survey method with explanatory. Data were collected by questionnaire, depth interviews with purposive sampling method, field observations, and literature review. Key informants for this study were palm sugar producers, farmers. Primary data which is collected in this study are the use of evaluation of sap palm.

2.1.1. How to Collecting the Sap (Neera)

a. Knives to cut inflorescence stalk and ijuk (A. pinnata fibers) to cover the cut stalk from outside debris should be kept as clean as possible to minimize microbial contamination.

b. Use of a cover (besides the ijuk) to keep out rain since rain dilutes sap, thus more sap, time and fuel is required to produce the sugar. Container must be kept as clean as possible, and should be used only for collecting A. pinnata sap. The container must be washed in detergent or bleach solution, thoroughly rinsed, and dried before being used to collect the sap. Utilization of alcohol might also be considered.

c. After collecting the sap, the containers must be cleaned and should be stored in a clean and dry location. This post harvesting cleaning should not be postponed, because the thin layer of dried sap on the surface of the container will support the growth of microorganisms. Further, it will be more difficult to remove sap and debris accumulations if washing of the container is delayed.

d. When container is not used for a while for example there is a time lag between tapping one inflorescence to another inflorescence, it is a good idea to wash the container with hot water, rinsed with a bleach solution, and thoroughly rinsed to make sure all possible sources of contamination and all traces of the bleach solutions are removed.

2.2. Materials and Tools

The materials in the study was palm sugar obtained from the tapping of farmers from the Giri Mukti II Farmers in Gunung Halu Village, which was taken in the morning (6 am) and in the afternoon (5 pm) (Figure 1); the sap (neera) was obtained from 4 (four) palm trees, have different criteria as described in Table 1; bacterial growth media namely nutrient agar (NA) media, and buffer pH 4 and pH 7. The tool used is aluminum container (sterilization process carried out by heating method using boiling water for 5 minutes), bamboo container (sterilization process is carried out by the fumigation method), refractometer, digital pH meter, wire ose, cool box, and other glassware.
2.3. Method
Fresh palm sap (neera) that has been tapped from the tree using aluminum container and directly analyzed for the chemical quality characteristics and organoleptic perceptions (color, taste, and smell). The pH testing was carried out directly on the sap using a calibrated digital pH meter using a buffer pH 4 and pH 7. Testing of total dissolved solids was carried out by pouring the liquid sap into the sensor from the refractometer, each sample measured in duplicate. Testing of bacterial colonies was carried out by taking the liquid sap using ose wire, then streaked on the NA media, and the media was incubated for 24 hours to calculate the number of colonies. Organoleptic testing was carried out by 10 untrained panelists on palm fluid with test variables including the color of the liquid sap, smell of the sap, and taste of the sap.

![Figure 1. a. Tapped Sap; b. Aluminium Container; c. Bamboo Container](image)

### Table 1. Description of Tapped Palm Trees.

| No. | Characterization of Tree | A₁ | A₂ | B₁ | B₂ |
|-----|--------------------------|----|----|----|----|
| 1   | Arm (from-)              | 1  | 5  | 1  | 4  |
| 2   | Age (years)              | 15 | 20 | 18 | 25 |
| 3   | Tree height (meter)      | 8  | 14 | 10 | 14 |
| 4   | Midrib (pcs/meter)       | 8  | 7  | 7  | 7  |
| 5   | Female Bunches           | 7  | -  | -  | -  |
| 6   | Volume (liter)           | 5.2| 4.7| 2.1| 1.7|

Information: A₁ = Alumunium Container repetition 1; A₂ = Alumunium Container repetition 2; B₁ = Bambu Container repetition 1; B₂ = Bambu Container repetition 2.

By comparing aluminum containers with bamboo containers is a way to introduce an innovation to the farmers and not to continue using bamboo as a storage room for sap, it is better to use bamboo for other purposes. And alumunium container will be more convenience to carry than bamboo, because it is lighter than bamboo container.

3. Result and discussion

3.1. Chemical Composition
Palm sugar contains total phenolic content and free radical scavenging activity [1,6]. The sap (neera) was reported to have 87.20% water content, 11.28% sucrose, 0.20% protein, 0.02% fat, 0.24%, 0.24% ash, and 4.80% reducing sugar. Some nutrients have also been identified in the sap such as K, P, Mg, Na, Ca, Fe, and Cu in addition to polar side chain amino acids particularly asparagine and glutamine.
The chemical composition of the palm sap studied was pH and total dissolved solids. The results of measuring the chemical quality of palm sap tapped using aluminum container and bamboo container are presented in Figure 2 and Figure 3.

**Figure 2.** Effect of container type on pH of palm sap at different tapping times

**Figure 3.** Effect of container type on total dissolved solids of palm sap at different tapping times

The pH of fresh sap that has not undergone a fermentation process to be processed into palm sugar is at the required standard, namely pH 6.5-7.0 [11]. In this case all treatments are in conditions that meet to be processed into palm sugar. The total value of dissolved solids from the results of the study ranged from 12.85-13.70 Brix, whereas according to previous research [12], the corresponding TPT value of sap (neera) was > 17 Brix, so the results of this study were still below standard. The low value of TPT sap (neera) can be influenced by the weather when tapping is done. The weather can affect the quality and quantity of the sap tapped by farmers on sugar palm plants [13]. If there is a dry season, then the quantity of water is small but has good quality to be cooked into palm sugar. During the rainy season, the resulting sap water is high but the quality of palm sugar produced is not good because the sap water has been mixed with rain water, from the following problems also result in palm sugar at the...
location not becoming hard or easily melting even at room temperature. The change factor of the pH of the sap changes to acid occurs because the process of hydrolysis of sucrose becomes reducing sugar by microorganisms and then becomes organic acid.

3.2. Organoleptic Composition of Palm Sugar

In the organoleptic test, the variables observed were the color, aroma, and taste of the sap from the lead. The results of the observations are presented in Table 2.

Table 2. Organoleptic quality of palm sap from aluminum container and bamboo container

| Characteristics | Standard* | Alumunium Container | Bamboo Container |
|-----------------|-----------|---------------------|-----------------|
|                 |           | Morning             | Afternoon       | Morning         | Afternoon       |
| Color           | Yellowish | Yellowish           | Yellowish       | Cloudy yellow   | Cloudy yellow   |
| Smell           | Smell Good| Smell Good          | Smell Good      | Strong scent (like smoke) | Strong scent (like smoke) |
| Flavour         | Sweet     | Sweet               | Sweet           | Very sweet (sharp) | Very sweet (sharp) |

*Information: *[14]

From the results of the organoleptic quality test, both the color, aroma, and taste of palm sap which were tapped using different containers had different qualities. Tapping using aluminium container produces clear yellowish sap, smell good aroma of sap, and sweet taste. While tapping using bamboo container, produces the color of the sap which is rather cloudy, the aroma is refreshing like smoke, and the sweet taste is sharp. Organoleptic quality differences can also be influenced by the nature of the tree that is tapped, based on the hand of how many flower stalks have been taken and also the age of the palm tree. The sweet taste of palm sap is due to its sucrose content which has not gone through the fermentation process. The sap used for brown sugar must be of good quality. Poor sap easily becomes stale (melted), the aroma and taste are sour, and will produce sticky brown sugar. While the sap is of good quality and still fresh has a sweet, fragrant, colorless (clear yellow). The organoleptic test which shows good quality of sap in the study is the sap which is tapped using an aluminum lodong container. Based on organoleptic quality, the aluminum container is better for storing sap (neera) and makes the sap no more fermented than bamboo container. This can be seen from the smell and flavour, the smell of the aluminum container is no more pungent than the bamboo container. Then the flavour of the aluminum container is no sharper than the bamboo container, because the sharp taste can indicate the fermentation of the sap (neera).

3.3. Number of Bacterial Colonies in Palm Sugar Sap (Neera)

Test the number of bacterial colonies in palm sap grown in agar media (NA). Data from the TPC test results presented in Figure 4 and examples of bacterial colonies on NA media are shown in Figure 5.
Figure 4. Number of bacterial colonies in palm sap from aluminum container and bamboo container.

Based on the results of observations on the number of bacterial colonies, it turns out that the microbial abundance of sap is strongly influenced by the container used, the initial treatment method for sterilizing containers, and the time of tapping. Bacterial colonies that grow on media from sugar palm which are tapped using aluminum container in the morning are only 12.5 colonies, and in the afternoon it rises to 200 colonies. Bacterial colonies that grow on the media from sugar palm which are tapped using bamboo container in the morning reach 144 colonies, and in the afternoon it rises to 350 colonies. The use of aluminum container with sterilization using hot water 90-100°C for 5 minutes turned out to make the tapping process more hygienic so that it can prevent bacterial growth to be slower than using bamboo container.

Figure 5. Colony of palm sap bacteria in NA media: a. Nira from aluminum container (tapping morning); b. Nira from aluminum container (tapping afternoon); c. Nira from lodong bamboo shelter (tapping morning); d. Nira from bamboo container (tapping afternoon).

The habit of farmers using traditional methods of bamboo container and the initial treatment of sterilization by fumigation can trigger faster bacterial growth. The sap becomes damaged during tapping, so the sap becomes acidic, bubbly, and slimy. The bacteria that cause fermentation of the sap are Micrococcus, Leuconostac, Streptococcus, Lactobacillus, Acetobacter, and Saccharomyces in the dominant yeast group. The sap is a good food for the growth of these bacteria and does not have sugar levels that are not high enough to inhibit the growth of these bacteria.

4. Conclusion
The results showed that the storage of palm sugar using aluminum container resulted in better quality of palm sap with an average pH value of 6.95 (neutral) and total dissolved solids of 13.7% Brix; clearer colors, natural aromatic fragrance, and fresh sweetness; and the number of bacterial colonies 12.5 in the morning tapping.
5. Policy implications
The policy implication of the results is palm sap tapping method is critical aspect for determining the quality of palm sugar because the sap is very sensitive and easy to deteriorate into other substances. Introducing advanced tools such as aluminium container on sap tapped to improve sugar quality could be achieved.

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