Physical characteristics of instanised Cocoa drink sweetened with Palm Sap Sugar: A preliminary study

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Abstract. Palm sap sugar is a natural sweetener made from sap collected from the flowers of several species of palm tree. This sugar is highly produce in South-East and South Asian regions, such as Indonesia, Philippines, Thailand, Malaysia and India. Its use improves the taste, colour and aroma of drink and food products. This work investigated the impact of palm sap sugar and processing method on the solubility and appearance of instanised cocoa powder. In this study, three cocoa powder blends with different palm sap sugar proportion, namely 15%, 30%, and 45% were used as a sweetener. The results showed that the solubility of cocoa drink increased as the proportion of palm sap sugar was increased. With regard to the appearance, the lightness of the cocoa drink decreased as the proportion of palm sap sugar was increased. This study revealed that the lightness of the cocoa drink decreased and the solubility increased as the number of agglomeration process repetition was increased.

1. Introduction

Indonesia is the third biggest cocoa production in the world and it serves as one of the top export commodities. However, cocoa is mainly exported in the form of raw beans. Such circumstance does not give high benefit for Indonesia. Therefore, government of Indonesia applied Export Duty policy toward export of cocoa beans in 2010. This policy was established to reduce export volume of raw cocoa beans and increase the volume of ground cocoa beans as raw material. The policy affects the development cacao processing industry in Indonesia.

The typical hot weather in tropical area as in Indonesia causes the demand of cold drink to increase. Cold cocoa drink is one of favorite drinks in Indonesia. This encourages the increasing number of cocoa drink industries in Indonesia. Nevertheless some products available in the market do not possessed good quality. Cocoa powder as the base of cocoa drink base still contains high amount of fat (10-25%)[1]. The powder contains, at a molecular level, a large number of polysaccharide-based hydrophobic hydrocarbon groups compared with the hydrophilic hydroxyl and carbonyl groups[2]. A good instant cocoa powder should be easily dissolve in water or requires little effort for its dissolution [3]. Agglomeration is often used for intanization of powder. It improves the handling properties and the appearance of the powder. ‘Instantized’ or ‘instant’ means that agglomerated powder can be readily dissolved in cold water or in milk [4].

Coconut sugar is natural sweetener made from coconut sap. This sugar is widely produced in Southeast and South Asia, such as Indonesia, Philippines, Thailand, Malaysia, and India [5-7]. Indonesia and the Philippines are the largest coconut sugar producer in the world. Addition of coconut sugar as
sweetener is used to improve taste, color, and aroma of the products [8-12]. Thus, the use of coconut sugar as a sweetener for instant chocolate drinks is expected to create chocolate beverage products with distinctive characteristics. In addition, the use of coconut sugar in chocolate drinks will increase its utilization.

Based on the explanation above, an appropriate (effective and affordable) technology which can be used to produced high quality instant chocolate drinks sweetened with coconut sugar. In this research, a small scale of steam jet agglomerator was used to achieve this goal. With this technology, small and medium industries are expected to be able to independently process and produce cacao-based drinks made with coconut sugar. Using this technique, the degree of solubility of cocoa drinks was expected to increase. To be more specific, this research was carried out to examine the effect of adding coconut sugar and the use of steam jet agglomerator machines to the physical properties and the degree of solubility of cocoa powder.

2. Method

2.1. Research Location
This research was conducted in Laboratory of Food and Postharvest Engineering, Department of Agricultural Engineering and Biosystems, Faculty of Agricultural Technology, Universitas Gadjah Mada Yogyakarta.

2.2. Tools and Materials

2.2.1. Tool. A stem jet agglomerator was used in this research. This tool was designed and made in Laboratory of Agricultural Energy and Agricultural Machinery, Faculty of Agricultural Technology, Universitas Gadjah Mada Yogyakarta.

2.2.2. Materials. Cocoa powder used in this research was obtained from “Chockless”, a small scale cacao powder producer in Yogyakarta. Coconut sugar obtained from local supermarket in Yogyakarta was used as a sweetener. The type of coconut sugar used in this research was palm sap sugar. Palm sap sugar was chosen because of its powdery consistency, thus it could be easily mixed with cocoa powder.

2.3. Preparation and Process of Making Instant Cocoa Drink Powder
Instant cocoa drink powder was produced with sucrose proportion of 15%, 30% and 45%. To ensure that the palm sugar and cocoa powder could be mixed well, the mixing process was carried out using a mixer with a speed of 58 rpm for 4 minutes. The process of producing instant chocolate drinks was conducted using steam jet agglomerator. This process began by heating water in the steam boiler until steam was formed. When the mixture of cocoa powder and sugar was subjected to steam, the steam pressure was kept constant at 1 bar. The process of agglomeration (steaming) was conducted in 1, 2, and 3 cycles (agglomeration cycle). In addition, the wet (steamed) instant cocoa powder was dried using an air-circulated dryer oven at 80 ° C for 5 hours. The samples were named based on the proportion of the sugar and the cycle of agglomeration process (Table 1).

| Cycle of Agglomeration Process | Proportion of Palm Sap Sugar |
|-------------------------------|-----------------------------|
|                               | 15% | 30% | 45% |
| 1                             | S15 C1 | S30 C1 | S45 C1 |
| 2                             | S15 C2 | S30 C2 | S45 C2 |
| 3                             | S15 C3 | S30 C3 | S45 C3 |
2.4. Analytical methods

2.4.1. Moisture Content. Moisture content of the instant cocoa drink powder was measured before and after drying process. The principle of this method was complete evaporation of all water in the samples. Moisture content was reported as dry basis by comparing the amount of water evaporated to the solid mass of instant cocoa drink powder. Analyses were done in triplicate.

2.4.2. Lightness. Lightness was measured using chromameter (Minolta CR-4000). CIE L* a* b* was used to determine the color. The cacao powder sample was flattened perfectly using a spatula. Triplicate were carried out for each sample.

2.4.3. Solubility. Solubility of the samples was determined following the modified developed by method of Vissotto et al. (2010). The solubility test was conducted by dissolving 0.75 gram of cocoa (diameter 0.4 - 4 mm) in 10 ml of distilled water in a 250 ml cup. Prior to measurement, the sample was stirred using a magnetic stirrer and hot plate (SRS710HA, advantec S072982) at 330 rpm and a temperature of 105°C. Stirring was carried out for 5 minutes. Afterwards, the solution was put into a test tube to be centrifuged for 15 minutes at 5000 rpm. After the separation between solids and liquids, the liquid was removed and the precipitated solid was taken with a spatula. It was then into an aluminum container and heated for 24 hours at ± 105°C. The measurement was carried out in triplicate [13]. Solubility was calculated as shown below:

\[
\% \text{ solubility} = \frac{(\text{solids in the supernatant})}{(\text{solids in solution})} \times 100\%
\]  

Where:
- Solids in the supernatant = 0.75 grams - the mass of the solids produced by the oven for 24 hours
- Solids in solution = 0.75 grams

2.5. Statistical Analysis

All measurements were made in triplicate for each sample. The data were analyzed using software of SPSS version 22.0. One-way analysis of variance (ANOVA) was used to test differences in water content, color, and solubility with a significance level of 5%. Before the ANOVA test was carried out, the homogeneity test was conducted by Leven's test. Beside, principal component analysis (PCA) was used to visualize relationships between samples.

3. Results and Discussion

3.1. Influence of Proportion of Palm Sap Sugar, Cycle of Agglomeration Process and their interaction on The Instant Cocoa Drink Powder

The parameters of the characteristics of instant chocolate drink powder studied in this research were moisture content, color, and solubility. Based on table 2, it can be seen that the moisture content of instant cocoa drinks powder before and after the drying process, color, and solubility were significantly (p <0.05) influenced by the proportion of palm sap sugar, cycle of agglomeration process and their interaction.

Table 2. Interconnection between proportion of palm sap sugar and cycle of agglomeration process

| Parameters                  | Moisture Content Before Drying Process (% db) | Moisture Content After Drying Process (% db) | Lightness (L* ) | Solubility (%) |
|-----------------------------|-----------------------------------------------|----------------------------------------------|-----------------|----------------|
| Palm Sap Sugar (S)          | *                                             | *                                            | *               | *              |
The result of Principal component analysis (PCA) in this research is shown in Figure 1. From the figure, it can be seen that the total variance on PC 1 and PC 2 was 98.5%. The moisture content after the drying and solubility process were predominantly influenced by PC1. While the moisture content before the drying and lightness process (L *) was more predominantly influenced by PC 2 compared to PC 1. Based on PC1, it can be seen that the higher the water content after drying, the lower the solubility of the powder was and vice versa. Based on PC 2 the moisture content before the drying process was inversely proportional to lightness (L *).

Based on PC 1 (Figure 2), it can be seen that the solubility of instant cocoa drink powder and moisture content after drying were influenced by the proportion of palm sugar. The higher the proportion of palm sap sugar, the higher the solubility of the powder was. This phenomenon showed that samples which had a higher proportion of sugar dissolved more easily. This was reasonable considering that samples with a higher proportion of cocoa powder had more cocoa and fiber solids, as stated by Afoakwa (2010), besides reducing sugars, cocoa beans also contain fiber, minerals, etc. which do not dissolve easily in water [14]. According to the moisture content after drying, from Figures 1 and 2, it can be seen that samples with a higher proportion of sugar had lower moisture content than samples with a lower proportion of palm sap sugar. This was possible because palm sap sugar contained high amorphous sugar. Amorphous sugar has a very hygroscopic character thus it easily absorbs moisture/water [15, 16].

Based on PC 2 (Figure 2), it can be seen that lightness (L *) of instant cocoa drink powder decreased as the cycle of agglomeration increased. This condition was possible because samples made with more cycles had higher moisture content. This produced powder with wet and dark impression.

![PCA loading plot of moisture, lightness and solubility of cocoa drink powder formulated with palm sap sugar](image-url)

Figure 1. PCA loading plot of moisture, lightness and solubility of cocoa drink powder formulated with palm sap sugar
3.2. Moisture Content

In this research, moisture content was measured twice, before and drying process. Measurement of moisture content before the drying process was carried out to determine the effect of the cycle of agglomeration process on the moisture content in the material. While measurement of moisture content after drying process was conducted to ensure that the sample was dry enough. Thus, it was safe from microbial/fungal growth. In addition, the drying process aimed to create dry and porous conditions which help the dissolution of the powder.

Based on Figure 3, it can be seen that with the same proportion of sugar, the powder moisture content of instant cocoa drinks increased as the number of agglomeration cycle increased. This was due to the fact that when sample was exposed to more agglomeration cycle, it was exposed to steam for longer period of time.

Figure 2. PCA score plot of cocoa drink powder formulated with palm sap sugar
3.3. Lightness (L*)
Based on Figure 5, it can be seen that the higher the proportion of palm sap sugar and the more the cycle of agglomeration process, the lower the lightness value of the powder (L*) was. The decrease in lightness (L*) of the product could be due to the increase in moisture content giving rise to powder with wet and dark impression. Moreover, higher moisture content might be more favorable for maillard and caramelization reaction. This could also contribute to the dark color of the sample [13, 17].

![Figure 5. Lightness of instant cocoa drink powder](image)

3.4. Solubility
The more the number of agglomeration cycle applied, the longer the material was exposed to hot steam. This condition caused the brittle of particles to increase. Subsequent drying of the sample resulted in more porous and brittle sample making it easily dissolved. Jinapong et al. (2008) reported that powder with greater granular porosity will have shorter dissolution time [18]. In addition, the proportion of palm sap sugar also influenced the solubility of the samples. In general, sugar is more soluble than cocoa particles. Therefore, when the proportion of sugar was higher, the solubility of the samples was found to be higher. In addition, the fact that palm sap sugar contains high amount of amorphous sugar also plays a role in increasing sample’s solubility. As stated by Qian et al. (2010), amorphous crystal is more unstable than the crystalline one [19]. This causes sugar which contains high amount of amorphous crystals will have higher solubility.

![Figure 6. Solubility of instant cocoa drink powder](image)
4. Conclusion
Based on the results of this study, it can be seen that the proportion of palm sap sugar and cycles of agglomeration process had significant influence on the characteristics of instant cocoa drink powder. Solubility as the most important main parameter for instant cocoa drink powder could be increased by the use of steam jet agglomerator. Therefore, the use of small-scale steam jet agglomerator is suggested to be very suitable method for small-scale businesses (SMEs) in Indonesia.

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