Effect of extraction time and pressing temperature on characteristic of cocoa powder quality

S B Anoraga¹, S Wijanarti¹ and I Sabarisman¹

¹Agroindustrial Program, Departement of Bioresources dan Veterinary, Vocational College, Universitas Gadjah Mada, Yogyakarta, Indonesia

E-mail : satriabhirawa@ugm.ac.id

Abstract. The aim of the research was to investigate the effect of extraction time and temperature on cocoa powder quality. The study was conducted at Cocoa Processing Incubation Laboratory, Agroindustry Program, Vocational College, Universitas Gadjah Mada in Juni-Juli 2018. The samples were fermented cocoa beans obtained from Banjaroya, Kulonprogo. First, cocoa beans were roasted and ground. Then, 200 g cocoa liquor were extracted for 20, 30 and 45 minutes at 70, 100 and 110 °C. Cocoa powder characteristics e.g: moisture content, fat content, the weight of cocoa bungkil, and colour level were evaluated. The result showed that cocoa powder which was extracted in 70 °C for 30 minutes had a lowest moisture content (3.12 %). The fat content is about 40-47% for all treatment. The color intensity is similar, with the most brightest are cocoa powder which was extracted in 70 °C. The temperature treatment in 70 °C were accordance with the quality standards of cocoa butter determined by SNI 3747:2009.

1. Introduction

Ministry of Industry as Indonesian Government has required the application of Indonesian National Standard (SNI) provisions to cocoa powder products since November 4, 2009. The policy is regulated in the Minister of Industry Regulation Number 45 / M-IND / PER / 5/2009 about SNI of cocoa powder on mandatory basis. Cocoa powder is a derivative product of cocoa which obtained from cocoa liquor pressed and milled into powder. The characteristics of quality requirements for cocoa powder contained in SNI 3747: 2009 are water content, fat content, smoothness, odor, taste and color [1].

Extraction is an important step on cocoa processing, especially to produce a cocoa powder. Cocoa liquor was pressed to extracted cocoa butter from yield [2]. There are some extraction method commonly used in cocoa industry which have been investigated. Cocoa butter extraction using supercritical carbon dioxide (scCO₂) was conducted by Asep et.al. [3,4]. The extraction yield is influenced by flow rate, pressure, and temperature where the optimum values were 2 mLMin⁻¹, 35 Mpa and 60 °C, respectively. Beside that, the yield can be increased by increasing roasting time and temperature. Particle size, degree of fermentation and roasting also have significant effect on the yield. This method is feasible to be applied in cocoa industry, but it may take an expensive cost.

Different method of cocoa extraction affect the yields and quality parameters of cocoa fat. Roiaini [5] extracted cocoa butter using several method such as soxhlet extraction, ultrasonic extraction, supercritical carbondioxide, and supercritical carbondioxide using solvents. The SFE method with co-solvent produce more cocoa butter than other methods. But this method requires a long extraction time
and a lot of organic solvents so it is not friendly enough for environmentally and cause high costs for operational.

This study used a mechanical press type based on economical value and more in line for Indonesian small medium enterprise condition, which have low investment costs, with operational and maintenance convenience [6]. Chatib [7] extracted cocoa butter using the press tool brands CARVER type Model 3912 Hydraulic Unit. Extraction process conducted in 130°C with pressure presses 8.05 MPa get yield a good fat, free fatty acids, then the number of iod, penyabunan that are not too high. The yield of cocoa extraction was influenced by temperature, cocoa beans moisture content, particle size and pressing time. Maximum extraction of cocoa butter was obtained in 10-15 minutes for one press, with a capacity of 0.5 kg per batch [8]. temperature treatment on extraction process have a significant influence on the quality of cocoa butter, and the water content of the product decreases with increasing extraction temperature [9]. Indarti [10] observed the effect of heating on cocoa butter extraction during pressing. The results showed that the pressure press did not affect the yield of cocoa fat, and the temperature factor had a significant effect on the yield of cocoa fat. So this study observed the temperature variations and pressing time, while pressing pressure is considered uniform for all treatments.

This study aims to determine the effect of temperature and pressing time on the quality of cocoa powder produced. The cocoa powder will be analyzed for water content, fat content, yield, and color, and then compared with applicable standards on SNI.

2. Material and Method

The material used in this research is fermented cocoa taken from Banjaraya Village, Kulonprogo. Those cocoa are previously roasted and peeled to obtain cocoa nibs. Then, cocoa nibs was grinded to be liquor and pressed. The Equipments used in this research ware roaster, grinder, mechanical pressing tool 5 kg equipped with heater jacket, analytic balance, oven, soxhlet, and other supporting equipments such as filter cloth, cup, tray, and measuring cup. This research was conducted in June-July 2018 at The Incubation Center of Cacao Processing, Agroindustry Department, Vocational School Gadjah Mada University.

2.1. Procedure

Cacao beans were roasted at the temperature of 100°C for 10-15 minutes or until the color change and the chocolate aroma appear. After the filtering process, cocoa beans are peeled to obtain cocoa nib. Then nib was pasted to have pressing process.

The cocoa paste was entered into 200 g of filter cloth, and was pressed by using mechanical pressing tool. The pressing process used temperature variations of 70, 100 and 110°C with variations in pressing time for 20, 30, 45 minutes. The temperature variation was determined based on the results of an observation conducted by Indarti [10], that the highest yield of cocoa fat was obtained at 70°C and not significantly different from the yield at 80°C and 90°C. Cocoa cake from pressing was grinded and analysed for the quality characteristics of cocoa powder.

2.2. Analysis

The parameters observed in this study were water content, fat content, and the color of cocoa powder. The characteristics of the cacao powder test results were compared with the requirements of the powdered cocoa quality standard in SNI 3747: 2009. Testing the moisture content using the oven method. The cocoa cake was weighed as much as 3 g with three replicates, then placed into a cup and dried using an oven at 105°C until the weight was constant. Fat content was tested by the Soxhlet method. The color of cocoa powder was measured using chromameter, and the result of brightness intensity (L *) was obtained. The measurement result was obtained by using ANOVA statistical analysis and further testing with the Tukey method in the Minitab 17 program.
3. Result and Discussion

The highest yield of pressed cocoa powder was 92.5% for a treatment temperature of 70 °C for 30 minutes. While the smallest yield was 73.5% for a treatment temperature of 100 °C for 45 minutes. This is in line with the observations made by Indarti [10] that the yield did not increase significantly at heating temperatures 70 °C, 80 °C and 90 °C, even at this time the yield decreased at a temperature of 100 °C. The increase in temperature given around the cocoa paste chamber can increase the yield by about 2 to 3%. The increase in temperature during pressing causes the fat to melt and the viscosity decreases, making it easier to get out fat from the matrix of the cacao cells.

3.1. The level of water content in cacao powder

ANOVA analysis showed that the temperature and duration of pressing did not have a significant effect on the water content of cocoa powder (Figure 1). Pressurized cocoa powder water content for all treatments ranged from 3 to 6%. Where the lowest water content is 3.12% for pressing treatment with a temperature of 70 °C for 30 minutes, and the highest water content of 5.92% for pressing treatment with a temperature of 110 °C for 30 minutes. From Figure 1 shows that the cocoa powder that passed SNI was only the result of pressing with a treatment temperature of 70 °C and 100 °C for 30 minutes, and a temperature of 110 °C for 45 minutes. Where the quality requirement for cocoa powder in SNI 3747: 2009 for water content is below 5%.

![Figure 1. Effect of temperature and pressing time on cocoa powder moisture content](image)

The water content of the majority sample is not in accordance with SNI standards. This is similar to the results of observations obtained by Chatib [7] that the pressed cocoa powder using a temperature of 130 °C, 150 °C and 170 °C also still has high water content and is not in accordance with SNI. Most likely this is caused by the raw materials of cacao beans or seeds which still have high water content. The high water content in cocoa powder is very dangerous because it becomes a medium for microorganism and can reduce product quality. In other words, the shelf life of cocoa powder will be shorter and affects the sale value in the market. The cocoa powder need to be dried further using oven to reduce the moisture content.
3.2. The level of fat in cacao powder
Analysis of variance showed that the pressing time had a significant effect on the fat content of cocoa powder (Figure 2). Pressed fat content of cocoa powder for all treatments ranged from 40-47%. Where the lowest fat content was 40.13% for pressing treatment with a temperature of 100 °C for 30 minutes, and the highest fat content was 47.275% for pressing treatment with a temperature of 110 °C for 45 minutes. These results indicate that the pressed cocoa powder with all treatments is still in accordance with SNI where the requirements for quality of cocoa powder in SNI 3747: 2009 for fat content are above 10%.

Based on the fat content, cocoa powder on the market generally has three levels, they are: high fat content with a content of about 17-22%, medium fat content with a content of 13-17%, and low fat content with a content of about 10-12% [11]. The pressed cocoa powder still has high fat content. Similar result is also obtained by Widayat [12], that the fat content of pressed cocoa powder using hydraulic presses is generally still very high. Presses with a pressure above 40 MPa are needed to remove fat to meet the standards. In addition, cocoa fat extraction can also use solvents to reduce the fat that has not been able to be released by presses. The use of hexane solvents can reduce the fat content of cocoa powder from 32.44% to 4.43%. Moreover, alkalisation process can be implemented to optimize the extraction of cocoa butter. The material structure of cellular wall on cocoa beans can be transformed by alkalisation method and makes it easier for pressing [15].

3.3. The color of cacao powder
The color of cocoa powder is seen from the level of brightness (lightness) indicated by the value of L* on the measurement results using chromameter. The browning of cocoa powder pressed for all treatments was relatively uniform, ranging from 44-52. Where the lowest brightness is 44.89 for pressing treatment with a temperature of 70 oC for 45 minutes, and the highest brightness is 51.72 for the pressing treatment with a temperature of 70 oC for 30 minutes.
Figure 3 shows that the brightness of the color of the cocoa powder decreases with the longer pressing time. The result of analysis showed that the pressing time had a significant effect on the brightness of the color of the cocoa powder. Similar results were also obtained by Hanifah [13], that an increase in temperature can affect the decrease in the brightness value of the powder. According to Supriyanto [14], when there is heat treatment there will be a rapid decrease in water content, where the low water content resulted in a browning reaction that does not take place which is due to very limited mobility between reactants. Based on an observation conducted by Widayat [12], increasing the intensity of the color of cocoa powder (L*) can be done by adding potassium carbonate to the alkalization process, where the concentration of potassium carbonate and the length of the alkalization process are directly proportional to the increase in brown color in cocoa powder.

4. Conclusion
The results showed that the temperature and duration of pressing did not affect the water content of cocoa powder. Only presses with 70 °C and 100 °C for 30 minutes, and a temperature of 110 °C for 45 minutes in accordance with SNI 3747: 2009. On the one hand, the pressing time affects the fat content of the cocoa powder, while the temperature is not very influential. Even though it is in accordance with the standards, the fat content is still quite high when compared to the cocoa powder that is circulating in the market. The same results were obtained for the color test, where the pressing time affected the brightness of the color of the cocoa powder, while the temperature did not have much effect.

References
[1] SNI 2009 SNI 3747:2009 Kakao Bubuk (National Standardization Board)
[2] Mulato S W S and P H K 2008 Pelita Perkebunan 24 62–79
[3] E K Asep, S Jinap, A. R. Russly1, M H A Jahurul K G and I S M Z 2016 The effect of flow rate at different pressures and temperatures on cocoa butter extracted from cocoa nib using supercritical carbon dioxide J. Food Sci. Technol. 53 2287–97
[4] E K Asep, Jinap S, Tan T J, Russly A R, Harcharan S and Nazimah S A H 2008 The effects of particle size, fermentation and roasting of cocoa nibs on supercritical fluid extraction of cocoa butter J. Food Eng. 85 450–8
[5] Roiaini M, Seyed, H M Jinap and S Norhayati H 2016 Effect of extraction methods on yield, oxidative value, phytosterols and antioxidant content of cocoa butter Int. Food Res. J. 23 47–
54

[6] Mulato S, Widyotomo S M and S E 2004 Pelita Perkebunan 20 37–53
[7] Chatib O C, Sandra S and Asbani H M 2015 Study of Equipment Presses of Cocoa Powder (Theobroma cacao,L) to Produce Quality Fat Cocoa and Analysis of the Resulting Int. J. Adv. Sci. Eng. Inf. Technol. 5 510
[8] Manalu L P, Djafar M Y, Wibawa T Y and Adinegoro H 2017 Proses Pintas Pengolahan Kakao Skala UKM Studi Kasus Di Luwu Sul-Sel a Case Study of Sme Cocoa By-Pass Processing in Luwu Sul-Sel J. M.P.I 11 51–60
[9] Junaidi L, Sudibyo A H T F and A D 2008 Pengaruh Perlakuan Suhu Ekstraksi terhadap Karakteristik Mutu Lemak Kakao J. Agro-based Ind. 25 24–34
[10] Indarti E 2007 Efek Pemanasan terhadap Rendemen Lemak pada Proses Pengepresan Biji Kakao J. Rekayasa Kim. Lingkung. 6 50–4
[11] Mulato S, Widyotomo S M and S E 2005 Pengolahan Produk Primer dan Sekunder Kakao
[12] Widayat H P 2013 Quality Improvement Of Cocoa Powder Through Fat Extraction And Alkalisation Process J. Teknol. dan Ind. Pertan. Indones. 5 12–6
[13] Rahma Nur Hanifah, Ahmad Ni’matullah Al-Baarrì Y B P 2017 Determination of Total Yield, Lightness and Greenish Performance of Grass Jelly Powder (Premna oblongifolia) using Various Drying Temperature J. Teknol. Pangan 1 25–7
[14] Cécile GROS, Manda RABE RAVELONA and Jean-Louis LANOISELLE 2002 Cocoa butter expression from cocoa nibs: effects of pre-treatment and process parameters on expression yield Int. Conf. Emerg. Solid/Liquid Sep. Technol. (ICEST 2002)