KARAKTERISTIK FISIKOKIMIA KOKOA NIBS (*Theobroma cacao L*) DENGAN VARIASI SUHU DAN WAKTU PENYANGRAIAN

Physicochemical Characteristics of Cocoa Nibs (Theobroma cacao L) by Differences in Temperature and Roasting Time

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ABSTRAK

Kakao merupakan salah satu komoditas unggulan di Indonesia. Luas areal penanaman biji kakao mencapai 1.651.539 hektar. Dalam beberapa tahun terakhir, terjadi penurunan produktivitas kakao yang cukup signifikan. Hal ini dipengaruhi oleh potensi klon yang mulai menurun dan serangan hama yang merusak buah kakao sehingga mengakibatkan penurunan produktivitas pada setiap musimnya. Penelitian ini bertujuan untuk mengetahui komponen fisikokimia biji kakao di Kota Mojokerto. Parameter uji mutu biji meliputi uji kadar air, mutu, lemak, pH, polifenol, rendemen, dan intensitas warna. Metode penelitian yang digunakan adalah Rancangan Acak Kelompok yang diuji menggunakan ANOVA dan Dilanjutkan dengan Uji Jarak Berganda Duncan (DMRT). Hasil penelitian menunjukkan bahwa pada parameter kadar air (3,48%-5,54%), kadar lemak (36%-62%), kadar pH (4,96-5,54) dan intensitas warna terdapat interaksi sedangkan pada parameter rendemen dan polifenol tidak terdapat interaksi.

Kata kunci : Kokoa Nibs, Rendemen, Mailard, Warna

ABSTRACT

Cocoa is one of the superior commodities in Indonesia. The area for growing cocoa beans reaches 1,651,539 hectares. In recent years, there has been a significant decline in cocoa productivity. This is influenced by the potential of clones starting to decline and pest attacks damages cocoa pods resulting in reduced productivity in each season. This research aims to determine the physicochemical components of cocoa seeds in Mojokerto City. Seed quality test parameters include water content test, grade, fat, pH, polyphenols, yield, and color intensity. The research method used was Group Randomized Design which was tested using ANOVA and Continue with Duncan Multiple Range Test (DMRT). The research results show that at parameters water content (3.48%-5.54%), fat content (36%-62%), pH content (4.96-5.54) and color intensity there is an interaction while with the yield parameters and polyphenols, there is no interaction.

***Keyword** :cocoa nibs, yield, mailard, colour*

INTRODUCTION

The process of roasting cocoa nibs aims to produce flavor and typical cocoa color due to heating. Roasting will help it form the flavor and color unique to cocoa and will reduce the acid levels present in cocoa (Aldas-Morejon et al., 2023). However, the color and flavor formed are still Varies depending on the roasting temperature and length of roasting time. The temperature and length of roasting time will determine the success of the process roasting (Prasetyo et al., 2024). The roasting process will also affect the water, fat, and polyphenol content of seeds. The longer the time Roasting means the beans will become drier so the moisture content of the cocoa beans will increase getting lower. Apart from water content, the fat content will also be influenced by temperature due to the Maillard reaction and degradation of chemical compounds that will change the fat content of seeds (B. Andi Pallawa et al., 2024).

The roasting process is purposeful to form cocoa flavor and reduce the water content to 5-6% (Wijanarti et al., 2019). The most crucial thing about roasting is to create a distinctive aroma and taste of cocoa. The higher the roasting temperature, the shorter the roasting time needed to form the taste and aroma of cocoa. The aroma and taste of cocoa are influenced by chemical components in the form of volatile compounds (aroma) such as aldehydes, and ketones, while the taste is influenced by polyphenol compounds, theobromine, and flavor-forming organic acids (Quelal et al., 2023).

Existing previous research includes research by (Rojas et al., 2022) who used roasting temperatures of 110 °C to 160 °C for several minutes. The results of this research show that average water content ranges from 2.67%-4.41%, average fat content from 42.56%-45.35%, and an average pH of 6.49-6.62. Other research by Ummah (2019)using temperatures of 110 °C and 115 °C with a roasting time of 30 – 120 minutes, shows the average value of water content obtained in this study is around 2%-4%. The roasting process does not change the fatty acid content significantly, whatever method is used during roasting will still produce 15 types of fatty acids. From the many studies that have been done, the most dominant fatty acids are palmitic acid (C16), stearic acid (C18) and oleic acid (C18:1) but there are still other types of fatty acids in small amounts (Awaliyah et al., 2023). Based on SNI cocoa beans 2323:2008, the moisture content of cocoa beans is a maximum of 7.5%, Therefore, this research was carried out with temperature treatments (110 °C, 120 °C, and 130 °C) and time (8, 12, and 15 minutes) which were different from previous studies. There is to determine the moisture content of cocoa nibs according to SNI standards. This research The aim is to obtain data on the characteristics of cocoa beans from a physical and chemical perspective with parameters tested including water content, fat content, pH, polyphenols, color rendering and intensity.

METHOD

The materials used in this research include dry cocoa beans Multi-variety fermentation obtained from Mojokerto, distilled water, 70% ethanol, sodium carbonate (Na2CO3), follin ciaocalteu reagent, petrolium ether, and pH buffer. The tools used include roasting machines, pH meters, ovens, blenders, ovens, analytical scales, Soxhlet, measuring flasks, water baths, and other laboratory equipment.

This research used a factorial Randomized Group Design. The first factor is temperature 110 °C (S1), 120 °C (S2), and 130 °C (S3). The Second Factor is roasting duration 8 minutes (T1), 12 minutes (T2), and 15 minutes (T3) there were 9 treatments repeated 3 times to obtain 27 experimental units. Observation parameters carried out after the roasting process include water content, fat content, pH levels, polyphenols, yield, and color intensity. Data obtained then tested using ANOVA (Analysis of Variance) $\alpha = 5\%$.

The roasting process using machine CBR-101 Coffee roaster. This machine has capasity about 200 – 300 g. The kakao bean weight and put into the tube and set the tie and duration. After the roasting process done, the machine will be cooling down automatically.

The parameters analyzed include Yield (Aneani et al., 2013)**,** Water Content (Anita-Sari et al., 2018)**,** The moisture content (AOAC,2005), Fat Content (AOAC, 2005) pH (Priambodo et al., 2022)**,** Phenolic Content (Utami et al., 2016)**,** Color Intensity (Zyzelewicz et al., 2014)

RESULT AND DISCUSSION

Moisture, Fat, pH and Yield

Based on the results of the analysis of variance, it shows that there is an interaction between roasting time and temperature on water content, fat content, pH level, and yield of cocoa nibs. Temperature and time treatment had a significant effect on water content, fat content, pH level, and yield. The treatment averages for water content, fat content, pH level, and yield can be seen in Table 1.

Table 1. Results of Average Water Content, Fat Content, pH, and Yield

Treatment	Parameter			
	Moisture	Fat	pH	Yield
S1T1	4,97[ab]	40,30[a]	4,97[a]	32,1
S1T2	4,97[ab]	55,33[cd]	5,30[bc]	35,8
S1T3	5,30[b]	62.00[d]	5,54[c]	37,4
S2T1	5,54[b]	49.00[ab]	5,32[bc]	35,2
S2T2	5,32[b]	49,33[bc]	4,98[a]	37,8
S2T3	3,48[a]	47,33[bc]	5,54[c]	43,4
S3T1	5,54[b]	36.00[a]	5,17[a]	37,9
S3T2	5,17[b]	54,67[cd]	4,96[a]	40,2
S3T3	4,96[ab]	50,33[c]	5,49[c]	42,1

The results of statistical analysis of water content data based on table 1 show that differences in temperature and roasting time have a significant effect on the water content of cocoa beans. The highest water content is shown by treatments S2T1 (5.54%) and S3T1 (5.54%) and the lowest water content is shown in treatment S2T3 (3.48%). This can be influenced by differences in temperature and roasting time as well as different bean sizes so that it takes a certain time to reduce the water content. The desired water content of cocoa beans is between 4-10% (Ndukwu et al., 2011). Cocoa beans that have a water content of more than 8% will be easily attacked by fungi and insects, increasing the risk of seed damage. However, if the water content of the beans around 8.7%, it will cause the beans to break easily (brittle) (Priambodo et al., 2022).

Water content is the amount of water contained in a material expressed in percent (%). Water content is one of the most important characteristics of food ingredients because it can affect the appearance, texture and taste of the material (Blahovec, 2007). The water content of the beans is very important to maintain the quality of cocoa beans during storage. In connection with this, the standard water content in SII has been set, which is below 7.5%. Cocoa beans in this condition can withstand biological and chemical activities so that the quality of dry cocoa beans can be maintained during storage (Ackah & Dompey, 2021).

The average fat content results showed that the S1T3 treatment had the highest fat content, which was 62%, significantly different from the other 8 treatments with the lowest fat content of 36%. This difference can be influenced by the process of refining cocoa beans into powder. This is in accordance with (Silveira et al., 2022) the effect of refining (paste), together with the heat formed from the refining process, causes solid nibs to become liquid, and will solidify if the temperature drops below its melting point so that some fat is still trapped in the cell structure.

The optimum roasting time can produce low-fat cocoa beans. The cocoa fat content in Indonesia ranges from 49-58% (Hatmi et al., 2021). In addition, according to (Chumthong et al., 2024) that the fat content of cocoa beans is greatly influenced by genetic factors (clone) of plants and environmental conditions (season). Drying temperature affects the fat content, acidity, and free amino acid content. The higher the drying temperature, the lower the fat content, but the acidity and free amino acid content increase.

The average pH value results show that the average pH has a significant effect on the difference in roasting time and temperature. The highest pH value was shown by the S1T3 and S2T2 treatments at 5.54%. The lowest pH value was shown by 6 other treatments with pH values ranging from 4.98 to 5.49. Cocoa beans with an acidity value expressed in pH units at 5.20 to 5.50 can be accepted as cocoa beans with an optimal acidity level (Riza et al., 2023). This is in accordance with what was stated by (Afoakwa et al., 2013) that the acidity of cocoa beans is generally within a pH limit of 5.0 to 5.8. In addition, according to (Septianti et al., 2020) that the cause of low pH in beans occurs during the fermentation process where the pH of the cocoa bean mass will increase while the pH of the inside of the cocoa beans will decrease because the organic acids formed during fermentation (acetic acid and lactic acid) will diffuse into the cocoa bean cotyledons.

The average yield results showed that temperature and time treatments did not significantly affect the yield of cocoa nibs. The results showed that temperature and roasting time factors did not affect the yield. The high and low yields were caused by the heating that occurred during the roasting process. This is in line with research by (Remitar & Magbalot-fernandez, 2023), that the higher the drying temperature, the lower the water content of the material. As the water content evaporates, the yield content produced also decreases. According to (Rojas et al., 2022), the optimum combination of temperature and time can produce cocoa beans with a high yield. Yield can be influenced by other factors such as the type of cocoa, fruit ripeness and so on. In addition, the size of the beans affects the percentage of cocoa yield produced (SCCP Swisscontact, 2013).

Phenolic Content

During roasting, cocoa beans experience heating which can cause physicochemical changes in the components inside. Cocoa beans contain polyphenolic compounds. Most of these compounds originate from the flavonoid and alkaloid compounds (Purwaningtiyas et al., 2023). The graph of the 5% level ANOVA test results is presented in Figure 1.

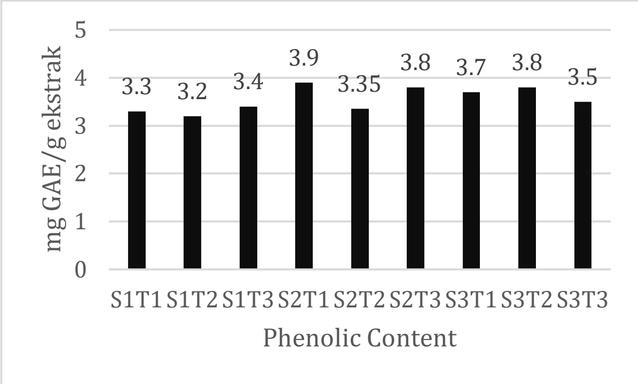

Figure 1. Phenolic content of cocoa nibs

During roasting, cocoa beans undergo heating which can cause physicochemical changes in the components inside. Cocoa beans contain polyphenol compounds. These compounds mostly originate from the flavonoid and alkaloid compound groups. The most dominant flavonoid in cocoa beans is the epicatechin type (C15H14O6) which is included in the polyphenol compound (Vázquez-Ovando et al., 2016).

The study's results showed that the polyphenol value was not significantly different, which could be affected by heating during roasting. Heating during roasting triggers polyphenol degradation and Maillard reactions. In addition, heating damages cell membranes and cell walls, thereby releasing phenolic compounds from insoluble ester bonds (La Mantia et al., 2023)

Color Intensity

Color is important in the appearance of a food product; the color produced also depends on the color of the ingredients used. The results of the 5% ANOVA test are presented in Table 2.

Table 2. Color Intensity of Cocoa Nibs

Treatment	Colour Intensity		
	L	a	b
S1T1	38,6^{c}	2,5^{a}	0,8^{ab}
S1T2	38^{bc}	2,3^{a}	2,7^{e}
S1T3	37^{ab}	3,5^{b}	0.6^{a}
S2T1	38^{bc}	3,5^{b}	1,8^{d}
S2T2	38^{bc}	2,8^{a}	1,2^{bc}
S2T3	37^{ab}	2,3^{a}	1.9^{d}
S3T1	39^{c}	4,9^{c}	2,6^{e}
S3T2	36^{a}	2,2^{a}	1,5^{cd}
S3T3	37^{ab}	2,7^{a}	1,1^{abc}

Based on the analysis of the variety of treatments, the length of time and temperature had no significant effect on the color intensity of cacao nibs at the L, a, and b values. In the color intensity test, the average L value ranged from 36 to 39, the a value from 2.2 to 3.5, and the b value from 0.6 to 2.7. The decreasing color value was due to heating which caused a dark brown color (La Mantia et al., 2023). The L notation with a value of 36 to 39 illustrates that in the 9 treatments, the color of the cocoa nibs tended to be dark because, during the roasting process, the cocoa beans were heated so that the Maillard reaction occurred (Lee et al., 2024). According to (Hosen et al., 2021), the Maillard reaction occurs in materials containing high sugar and protein which are heated so that they cause a dark brown color.

The notation a describes that the color of cocoa beans tends to be red. The red color in cocoa extract is produced from the presence of polyphenolic compounds such as anthocyanins in the cocoa bean skin which gives color to the cocoa bean skin extract. Anthocyanins are flavonoid compounds that have red, purple, and blue pigments found in cocoa (Brillouet & Hue, 2017). The b* value notation describes the yellow color because it has a value in the range of 0 to 7 (Hartuti et al., 2019).

CONCLUSION

Temperature and time treatment significantly affect water content, fat content, pH, polyphenols, color intensity, and yield. The process of roasting cocoa beans aims to reduce the water content of cocoa beans to form a chocolate flavor and reduce the astringent and bitter taste. Based on the results of the study, the percentage of water content, fat content, pH, polyphenols, color intensity, and yield are still classified as good physical quality so that the nibs can be processed into a product with more added value.

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