Physicochemical Characteristics of Local Cocoa Powder

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ABSTRACT
Gunungkidul is one of the cocoa-producing areas in DI Yogyakarta, Indonesia. In addition to being marketed in the form of cocoa beans, farmer groups in the Gunungkidul area also process cocoa beans into cocoa powder. From the selected cocoa beans, the fermentation, drying, roasting, and pressing process is carried out until the cocoa powder is obtained. This study aims to determine the physicochemical characteristics of the original local cocoa powder from Gunungkidul. The analysis procedure to determine the physicochemical characteristics of the original local cocoa powder from Gunungkidul is proximate analysis, namely water content with the thermogravimetric method, ash content with direct enumeration method, fat content with soxhlet extraction method, protein content with micro-Kjeldahl and carbohydrate content by different. In addition, color analysis with a CS10 Colorimeter is carried out, pH and fineness analysis by the method set out in SNI 3747:2013. Based on the results of chemical analysis to determine the characterization of local cocoa powder from Gunungkidul, the water content was processed at 5.0993% (db), ash content of 4.7240% (db), the fat content of 30.0388% (db), the protein content of 18.1661% (db), and carbohydrate content by different 41.9719% (db). The color of the local cocoa powder from Gunungkidul obtained an L* value of 45,755; an a* value of +18,715 and a b* value of +18,060. The pH of local cocoa powder from Gunungkidul is 5.87 with a smoothness level of up to 99.80%. The characteristics of cocoa powder can be the same as other regions, or vice versa where from the same area different characteristics can be obtained due to many factors that affect it. This characteristic of cocoa powder is beneficial because it will affect the choice of processing and formulation in the industry.

Keywords: *Agricultural Technology, Physicochemical, Cocoa*

1. INTRODUCTION

Chocolate is one of the snack foods that many Indonesians consume. This chocolate is derived from the cocoa plant (*Theobroma cacao* L.). The cocoa plant is commercially cultivated in areas along the equator [1], [2]. In 2011/2012, the total production of cocoa beans worldwide could reach more than 4 million tons, which is as large as from West Africa, Asia, Oceania, and Latin America [3], [4]. Indonesia is one of the largest cocoa bean-producing countries in the world [5], [6].

Cocoa production in Indonesia in 2019 amounted to 774.2 thousand tons with 46.3% exported and the rest used by the domestic beverage and food industry. Several regions in Indonesia produce cocoa, one of which is the Special Region of Yogyakarta. The Gunungkidul region is located at 7° 46' - 8° 09' South Latitude and 110° 21' - 110° 50' East Longitude. The average temperature in the Gunungkidul region is 26.65°C and relative humidity (RH) is 82.17%. Gunungkidul has the highest amount of rainfall reaching ± 422 mm which occurs at the beginning and end of the year, and the lowest amount of rainfall in the middle of the year, which is about 2 mm. The wind speed in the Gunungkidul area is 3,67 m.second and the air pressure reaches 991.49 mb [7].

Geographical conditions such as weather and soil properties of cocoa plantations will affect the characteristics of cocoa products [8]. In addition, genetic factors also largely determine the quality of cocoa beans.

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The nature of cocoa at the plantation site and the post-harvest handling conditions, chemical composition, and sensory quality of each type of cocoa is different to identify the origin of each cocoa [9]–[11]. Information on the characteristics of cocoa products is very useful to provide information for cocoa-related industries from small farmers. Information on the characteristics of cocoa products is always updated, such as cultivation practices, post-harvest handling, and climate change in cocoa plantations because this causes changes in the chemical characteristics of cocoa beans [12].

The cocoa tree or Theobroma cacao is classified into four cultivars, namely Criollo, Forastero, Trinitario, and Nacional [13]. Each of these cocoa cultivars differs in flavor precursors, reducing sugars and amino acids [13]–[15]. The quality and flavor of cocoa products produced are also greatly influenced by the cocoa processing process [16]. Cocoa products can be produced through the roasting process of cocoa beans to obtain brown beans and emit a chocolate aroma [17], [18]. After the roasting process, the chocolate beans are ground so that a cocoa mass is produced. Cocoa mass that is pressed will produce cocoa fat and cocoa powder [19]–[21].

During the fermentation process of cocoa beans, flavoring compounds and taste precursors will be formed such as free amino acids and reducing sugars. The chocolate flavor profile will be affected by the confirmation of the compound during the fermentation process [22], [23]. Meanwhile, during the roasting process, there will be a Maillard reaction that converts flavor precursors into taste compounds [24]. The fermentation of cocoa beans is influenced by farmers [25], regions, and countries [26], [27]. The places used for the fermentation process are usually platforms, piles, baskets, and boxes. The use of boxes or other fermentation sites will affect the concentration of sugar, ethanol, acetic acid, or the pH of cocoa produced [28]. Whereas in cocoa beans that are not fermented, the content of free amino acids is very low, so it affects the taste of the final cocoa product [29]. The optimal condition of the fermentation process of cocoa beans is 6 days followed by drying at a temperature of 70°C [30].

Besides, the fermentation process and the drying process of cocoa beans will also affect the quality of the final cocoa product. Too fast a drying process will increase the production of acids, thereby damaging the taste of the final cocoa product. Meanwhile, drying that is too slow causes the pH of cocoa beans to be low so that the color of cocoa beans is not optimally formed. In addition, too slow drying will also increase mold growth [30]–[32].

The characteristics of chocolate are not only influenced by the taste precursors contained in cocoa beans but also influenced by post-harvest handling that will change the taste precursors and aroma formation of cocoa during the process. The process of alkalizing and roasting cocoa beans after fermentation and drying will also affect the taste and color of the final cocoa product [22]. The temperature for the roasting process of cocoa beans is 120 - 150°C. The purpose of the roasting process of cocoa beans is the removal of unwanted compounds with a low boiling point (such as acetic acid), and the formation of the characteristic aroma of cocoa [33]. During the roasting process of cocoa beans, there will also be a Maillard reaction which affects the formation of the color of the final cocoa product. During roasting there will be a decrease in the content of amino acids and sugars, and this is also influenced by cultivars, the fermentation method used, the baking temperature, and the dynamics of the roasting process [34].

Cocoa beans, cocoa liquid, or cocoa powder can be modified with alkali or known as the alkalization process. The alkalization process aims to make the cocoa powder product does not coagulate and sink to the bottom when milk or water is added. In addition, the alkalization process can also influence and modify the taste and color of cocoa powder [35]. Cocoa derivative products such as cocoa liquid, cocoa powder, or cocoa butter are influenced by the chemical and sensory properties of cocoa beans. And this is beneficial to influencing the choice of processing and formulation in the industry. So, the post-harvest handling process of cocoa beans will affect the quality of cocoa final products. In addition, the type of cultivar, region, and country also affect the physicochemical properties of cocoa end products. So, the purpose of this study is to find out the physicochemical characteristics of the original local powdered chocolate from Gunungkidul.

2. METHOD

2.1. Material

The raw material used in this research is a cocoa powder produced by the Kelompok Tani Sidodadi, Gumawang, Gunungkidul, DI Yogyakarta. Chemicals used for analysis include K_2SO_4, $CuSO_4$, H_2SO_4, boric acid (H_3BO_3), indicator *bromcherosol green* 0,1%, and *methyl red* 0,1%, solution of $NaOH - Na_2S_2O_3$, HCl, lead paper, petroleum ether and *aquadest* from Sigma-Aldrich (Singapore).

2.2. Analysis Procedure

Local cocoa powder from Gunungkidul was subjected to chemical tests including proximate analysis, including moisture content with thermogravimetry [36], ash content by direct ashing method [36], total protein content by micro-Kjeldhal [36], fat content by soxhlet extraction [36], and carbohydrate content by difference [36]; color (CS10 Colorimeter); pH [37]; and smoothness (SNI 3747:2013) [37].

3. RESULTS AND DISCUSSION

The original local cocoa powder from Gunungkidul has carried out chemical analysis in the form of proximate analysis, namely water content, ash content, the fat content, the protein content, and carbohydrate content (by different). The results of the proximate analysis show the chemical composition of the original local cocoa powder from Gunungkidul presented in Table 1.

TABLE 1. Chemical Composition of Local Cocoa Powder from Gunungkidul

Component	**Content (% db)**
Moisture	5.0993 ± 0.0460
Fat	30.0388 ± 0.1485
Ash	4.7240 ± 0.0176
Protein	18.1661 ± 0.1070
Carbohydrates	41.9719 ± 0.0656

The chemical composition of cocoa beans allows the same results for different regions. And vice versa, the chemical composition of the same region allows for different results. The chemical composition of cocoa beans is influenced by various factors, including geographical location, environmental conditions, the level of genotype diversity, pests, and diseases of each region. In addition, post-harvest handling and socio-cultural conditions of certain regions will also affect the characteristics of cocoa [12].

The analysis of the moisture content of local cocoa powder from Gunungkidul was carried out using the thermogravimetric method [36]. The results of the analysis obtained the water content of the original local cocoa powder of Gunugkidul is 5.0993% (db). Based on the quality requirements of SNI 3747:2013[37], the water content of local cocoa powder from Gunungkidul does not meet the quality requirements because the requirement is a maximum of 5.0%. The high moisture content in a material is feared to be easier to damage.

The soxhlet method is used for the determination of fat content [36] in local cocoa powder from Gunungkidul. The fat content of local cocoa powder from Gunungkidul was obtained at 30.0388% (db). According to SNI 3747:2013 [37], the quality requirement for fat content in cocoa powder is at least 10%. Thus, this local cocoa powder from Gunungkidul meets the requirements of fat content.

Ash content indicates the content of inorganic minerals in a material after the combustion process is carried out with a furnace. Analysis ash content of local cocoa powder from Gunungkidul by direct enslavement method [36]. The results of the analysis ash content of local cocoa powder from Gunungkidul are 4.7240% (db). Some of the minerals found in cocoa powder include calcium, iron, magnesium, phosphorus, potassium, sodium, zinc, copper, manganese, and selenium [38]. The mineral content in cocoa beans from Gunungkidul is calcium, magnesium, sodium, potassium, phosphorus, sulfur, iron, zinc, selenium, copper, manganese, and chromium [12]. The mineral composition of vegetable products is influenced by geographical conditions, such as climate, soil conditions, cultivation practices, and environmental stress [39].

Determination of protein levels in local cocoa powder from Gunungkidul using the Kjeldahl method [36]. This local cocoa powder from Gunungkidul has a protein content of 18.1661% (db). The results of the analysis protein content of the local cocoa powder from Gunungkidul are the same level as reported by the U.S. Department of Agriculture [38] on cocoa powder with an alkaline process of 18.1 g per 100 g or 18.1%.

Carbohydrate levels in local cocoa powder from Gunungkidul were calculated by the carbohydrate by a different method [36]. Based on the calculation of carbohydrate content in local cocoa powder from Gunungkidul is 41.9719% (db). This result is lower than the carbohydrate content in cocoa powder with an alkaline process reported by the U.S. Department of Agriculture [38].

Color analysis on local cocoa powder from Gunungkidul using CS10 Colorimeter. This instrument uses the CIELAB method where the sample color is expressed in L*, a*, and b* coordinates. The amount of L* value of local cocoa powder from Gunungkidul is 45,755. The value of L* indicates the difference between light and dark. If the value of L* is equal to 100 m, it will indicate a light sample, while if the value of L* together with 0 then the sample is dark. The value of a* indicates the color difference between green (-a*) and red (+a*). While the value of b* indicates the color difference between blue (-b*) and yellow (+b*). The magnitude of the a* value in the local cocoa powder from Gunungkidul is + 18,715, and the b* value is + 18,060.

Determination of the amount of pH and the degree of fineness of cocoa powder using the method set out in SNI 3747:2013 [37]. The measurement results obtained that the pH of the local cocoa powder from Gunungkidul was 5.87. The amount of this pH is close to the normal pH because the local cocoa powder from Gunungkidul has undergone alkalization. Meanwhile, the level of fineness of local cocoa powder from Gunungkidul obtained a result of

99.80%. Based on SNI 3747:2013 [37], the level of fineness of cocoa powder is at least 99.5%. Thus, the level of fineness of this local cocoa powder from Gunungkidul meets the established standards.

4. CONCLUSION

Based on the results of a physicochemical analysis to determine the characterization of local cocoa powder from Gunungkidul, the water content was processed with a water content of 5.0993% (db), ash content of 4.7240% (db), the fat content of 30.0388% (db), the protein content of 18.1661% (db), and carbohydrate content by different 41.9719% (db). The color of the local cocoa powder from Gunungkidul obtained an L* value of 45,755; an a* value of +18,715 and a b* value of +18,060. The pH of local cocoa powder from Gunungkidul is 5.87 with a smoothness level of up to 99.80%. The characteristics of local cocoa powder can be the same as other regions, or vice versa where from the same area different characteristics can be obtained due to many factors that affect it. This characteristic of cocoa powder is beneficial because it will affect the choice of processing and formulation in the industry.

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