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Physicochemical, Fatty Acid and Sensory Profile of Cocoa Butter Produced from Fermented and Non-Fermented Cocoa Butter

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A B S T R A C T

The study aimed to explore the influence of fermentation and non-fermentation on cocoa processing (*Theobroma cacao* L.) on physical properties, chemical properties, fatty acid profiles, and sensory properties of cocoa butter. The study was conducted using an experimental method with two treatments and three replications. Analysis of cocoa butter consisted of yield, color, moisture content, free fatty acids, iod numbers, peroxide numbers, determination of fatty acid profile using GC-MS, and analysis of sensory properties. The results showed that the yield was between 20.82-21.00%. The color of fermented cocoa butter has a value of L* 17.88, a*8.70, and b*7.99 while for nonfermented cocoa butter has a value of L* 14.88, a* 8.96, and b* 6.78, water content between 0.10-0.12%, free fatty acids 0.51-0.56%, iod numbers 26.40-26.50 g I2/100g, peroxide numbers between 0.40-0.70 meq peroxide/kg fat, saponification value between 190.23-191.40 mg KOH/g fat. The fatty acid profile using GC-MS showed that the dominant fatty acid constituents contained in fermented and nonfermented cocoa fats are oleic acid (29.39-29.57%), heptadecanoic acid (25.85-26.77%), and palmitic acid (21.49-21.83%). Based on sensory analysis of cocoa butter with fermented treatment is preferred because it has a more attractive color, taste, and aroma compared to nonfermented cocoa butter.

1. INTRODUCTION

1.1. *Research Background*

Cocoa is a plantation commodity that has an important role in supporting national economic activities, among others, as a source of state foreign exchange and the provision of employment [1]. Three varieties of cocoa are commonly found, namely Forastero, Criollo, and Trinitario. Forestero is the most widely grown, making up 95% of the world's total production. While the type of criollo is cocoa that has a superior quality to others because it has very good taste.

The increase in cocoa production in Indonesia was not comparable to improving quality. The price of Indonesian cocoa beans in the International market is lower and has a cauldron at levels 3 and 4. According to Ref. [2], farmers want faster payments without having to process is the main cause so it has a direct impact on farmers' incomes and the lack of development of the domestic cocoa processing industry. Cocoa beans can be processed into several processed products, namely, cocoa fat, cocoa powder, and cocoa paste [3].

Fat is the most expensive component of cocoa beans, in addition to soil and season, fat content is affected by processing treatment, and types of cocoa. Cocoa beans derived from fertilization of the rainy season generally have high-fat content. While the physical characteristics of cocoa beans post-processing, such as water content, fermentation levels, and skin levels affect the fat yield of cocoa beans [4].

To improve the quality of cocoa fat produced, the pretreatment is carried out in the form of fermentation and non fermentation of cocoa beans. According to research conducted by Ref. [4], fermentation and non-fermentation treatments are very influential on fat yield, fat content, and cocoa powder water content. Good cocoa beans should go through the fermentation process first [6]. The fermentation process is a stage of processing cocoa beans that are very vital and absolute to ensure the production of good chocolate flavors and aromas. Fermentation is also beneficial because it can lead to reduced dissolved polyphenols and at this stage, there is also a reduction of expenditure of theobromine and caffeine as well as volatile components (alcohols, esters, and aldehydes). Unfermented cocoa beans do not form a chocolate aroma when the roasting process even produces a taste of bitter. The taste of bitter is caused by the high levels of unoxidized polyphenols in cocoa beans [5].

1.2. *Literature Review*

1.2.1. *Cocoa Fermentation*

Cocoa bean fermentation is a traditional fermentation involving indigen microorganisms and endogenous enzyme activity. Fermentation of cocoa beans does not require the addition of a starter culture, because cocoa pulp or meat that contains a lot of glucose, fructose, sucrose, and citric acid can invite the formation of the growth of microorganisms so that fermentation occurs.

A good taste of cocoa products will be produced if the fermentation process is perfect. During the fermentation process, the pulp around the cocoa beans will be lost and chocolate flavor precursors are formed. When the cocoa fruit is broken down, the pulp will be contaminated with microbes, so the fermentation process of the pulp occurs by utilizing the sugar contained as a metabolic substrate [6]. The types of microorganisms that develop at the time of fermentation are very numerous but play a role are a yeast, lactic acid bacteria, acetic acid bacteria [7].
Factors that affect the fermentation process of cocoa beans,

Among others, the length of fermentation, uniformity to the speed of stirring or reversal, aeration, climate, fruit problems, containers, and fermentation quantities. Fermentation for *lindak* type of cocoa beans takes longer, which is 5 days, while noble cocoa beans are shorter around 3 days. Prolonged fermentation increases the levels of moldy and germinated cocoa beans, while short fermentation results in high levels of slaty seeds. In addition to the length of fermentation, the fermentation container also determines the quality of cocoa beans produced.

Fermentation aims to release the pulp from the seed pieces, thus facilitating the drying process, the skin of the seeds is easily released from the seed puck. In addition, fermentation also aims to kill the seeds and provides the opportunity for the process to lead to the formation of color, taste, and aroma [8]. The reversal process at the time of fermentation should be done after 48 hours. This is for the acquisition of the uniformity of fermented cocoa beans. Cocoa beans that are not reversed when fermented, will produce optimum heat in the middle, while the above, below, and side will have the opposite effect.

Optimum fermentation of cocoa beans will produce optimum aroma-forming compounds as well [5] The most important attribute that makes cocoa beans commercially acceptable is their aroma, which also determines their quality. Volatile compounds of cocoa aroma are formed during seed roasting, changing the aroma-forming precursor during fermentation of the proteins present in cocoa beans.

In contrast, unfermented cocoa generally directly experiences the drying process and the resulting taste is not good. Most Indonesian cocoa farmers usually do harvesting without fermentation. Generally, cocoa fruit is harvested, removed pulp, dried, then sold.

1.2.2. *Cocoa Butter*

Cocoa butter is a term given to products produced from the suppression of cocoa beans using hydraulic presses [9]. In general, cocoa fat is a product produced by mechanically compressing from roasted cocoa beans that have been crushed. Cocoa fat is the carrier and solvent of particles in cocoa beans and sugars and other ingredients in the manufacture of milk chocolate products [9]. Cocoa fat is a unique fat because it has specific melting characteristics. At room temperature (about 20℃), fat is solid and begins to soften at a temperature of about 30℃.

Cocoa fat melts entirely at temperatures slightly below body temperature. These unique melting characteristics make cocoa fat preferred for the manufacture of chocolate products [9]. Cocoa fat is thin yellow, solid in shape, and shows real cracks at temperatures below 20℃. A very sharp melting point is at 35℃ with a smelting or softening at a temperature of about 30℃ – 32℃. Cocoa fat consists of a number of glycerides from fatty acids, namely stearic, palmitic and oleic, and a little linoleic. Cocoa fat has valuable properties, namely, its volume shrivels at the time of compaction which allows the printing of chocolate blocks to be more attractive.

Fat is the most expensive component of cocoa beans, in addition to soil and season ingredients, fat content is affected by processing treatment, plant material types, and seasonal factors. Cocoa beans derived from fertilization of the rainy season generally have high-fat content. While the physical character of post-treatment cocoa beans such as fermentation level water content and skin levels affect the fat yield of cocoa beans. Indonesia's cocoa bean fat range is between 49%-52% [1].

The high content of stearic acid and palmitic acid in cocoa fat is expected to contribute to the characteristics of liquefaction and crystallization thus providing rapid thawing at body temperature when consumed [10].

1.3. *Research Objective*

This study aims to find out the yield and characteristics of cocoa butter derived from fermented or non-fermented cocoa beans.

2. MATERIALS AND METHODS

2.1. *Material and Tools*

. main raw materials used in this study were fermented and nonfermented cocoa beans. The tools used in this study are fermentation boxes made of wood (40 cm long, 40 cm wide, and 50 cm high), horizontal hydraulic press, pan, analytical scales, spatula, petri dish, hunter lab, dish, chemical glass, oven, Erlenmeyer, measuring glass, pipit drops, goiter pipette, buret, decicator, and others. The main ingredients used in this study were fermented and nonfermented pre-treatment cocoa beans which were then taken up fat. Chemicals used are distilled water, ethanol 95%, indicator pp, NaOH 0.1N, carbon tetrachloride.

2.2. *Design Experiment and Analysis*

The method used in this study was an experimental method with two treatments. The treatment used is fermented and nonfermentable cocoa beans.

2.3. *Implementation of Research*

2.3.1. *Fermented Cocoa Bean Processing*

The cocoa fruit that has been harvested is then broken down. The breakdown of cocoa fruit is done by beating the fruit into a blunt object, this solution aims to separate the seeds with the skin and pith. Then the separated cocoa beans are put into a fermentation box made of wood which is then closed using sacks and squeezed by wooden blocks. Fermentation is done for 5 days and stirring is done every 2 days. Cocoa beans that have been fermented are then washed using running water until the laundry water is clean. And then fermented cocoa beans are dried in hybrid tempering at a temperature of 28-30 ° C for 5-7 days until the moisture content of cocoa beans is obtained by 7%.

2.3.2. Nonfermentation Cocoa Bean Processing

Cocoa beans that have been separated from the skin are directly dried in hybrid tempering at a temperature of 28-30 ° C for 5-7 days until the cocoa bean water content is obtained by 7%.

2.4. Cocoa Butter Extraction (Ref. 4 Modified)

To get fat from cocoa beans do some processing. The stage of processing cocoa beans into cocoa fat is fermented and non fermentation cocoa beans that have been dried by separating from damaged seeds and dirt that participate during the drying process (sorting). After the separation (sorting) is carried out the next process of roasting, fermented cocoa beans and non fermentation roasted (roasting) for 20 minutes at a temperature of 120 ° C, the roasting process is stopped when the cocoa bean skin is easy to separate and has produced a distinctive aroma of chocolate. Then the separation of skin and seeds using a separator machine (deshelled), the separation is repeated as much as 3 times so that the skin and seeds are completely separated. The result of this seed and skin separator is called the nib. This nib is then processed into fat.

Fermented and nonfermented cocoa fats derived from each 1kg of a nib, are then put into a coarse cooking machine. The temperature at the rough cooker is about 40 ° C, the result of this coarse cooker is then accommodated on a cloth which is then tied. After that fat pressing is done using a mechanical cocoa fat pumping tool (cocoa butter pressing), the result of this pumping in the form of cocoa and cocoa butter.

2.5. Observation

2.5.1. Physicochemical Analysis

Cocoa butter testing refers to some parameters of SNI 3748:2009 about cocoa fat. Parameter analysis includes analysis of yield, color, moisture content, free fatty acids, iod numbers, peroxide number analysis, saponification value, fatty acid profiles, and sensory analysis.

2.5.2. Fatty Acid Profile Analysis

Ambil 1 mL fat sample using a micropipette. Then put in the test tube. Added 2 mL hexane and 3 mL isopropanol. Vortex for 3 minutes. Then it is taken 1 mL organic layer (topmost layer) and inserted into a new test tube, then added 1 mL hexane and 1 mL KOH 2M / methanol. Vortexed for 3 minutes. Then heated using a water bath for 10 minutes with a temperature of 70 ° C. After that it is added 1.2 mL HCl 0.1M, then vortex and taken 1 mL top layer and inserted into the vial which is then injected into the GC-MS tool. The GC-MS tool is set as follows.

Column temperature: 120°C
Injector Temperature: 250°C
Pressure: 123.3 kPa
Total Flow: 34.9 mL/min
Column flow: 1.52 mL/min
Linear speed: 46.3 cm/s

2.5.3. Sensory Analysis

Organoleptic testing was performed on samples of cocoa fat. In this organoleptic test, 20 panelists provided an assessment of the color, taste, and smell of cocoa fat presented in the form. Fat is served in the form of solids that are cut into small pieces and placed on a container.

3. RESULTS AND DISCUSSION

3.1. Physicochemical Analysis

Physicochemical Analysis consisting of yield, moisture content, free fatty acids, iod numbers, peroxide number, and saponification value, can be seen in Table 1. Yield is a percentage of the initial weight comparison of the material with the final result of the material. Calculation of cocoa fat yield in this study was done to find out the comparison of ingredients that are cocoa nib with cocoa fat produced after pumping.

The results of calculating the yield value of cocoa fat with fermented and non fermentation pretreatment are between 20.82-21.00% presented in Table 1. Based on research conducted by Ref. [4], cocoa beans with fermented treatment have higher fat yield values compared to nonfermented cocoa beans. The high yield value is thought to occur due to an overhaul of non-fat ingredients that occur in cocoa beans. While in nonfermented cocoa beans there is no reshuffle so that the fat is still bound and difficult to get out [11]. This greatly affects the yield of fat after the pumping process, where cocoa fat from fermented pretreatment cocoa beans will come out more than fat from nonfermented pretreatment cocoa beans.

Table 1. Physicochemical Analysis Result of Cocoa Butter

Treatment	Yield (%)	Moisture Content (%)	Free Fatty Acid (%)	Iod Number (g I_2/100 g)	Saponification Value (mg KOH/g fat)	Peroxide Number (meq peroxide/kg fat)
Fermentation	21.00	0.12 ± 0.03	0.56 ±0.03	26.40 ± 0.03	190.23 ± 0.12	0.70 ± 0.043
Nonfermentation	20.82	0.10 ± 0.02	0.51 ± 0.01	26.50 ± 0.03	191.40 ± 0.27	0.40 ± 0.03

The temperature of the pumping is also very influential on the yield of fat produced. Based on research conducted by Ref. [4] This shows that the higher the temperature of ripening and pumping the more fat will come out and the less cake and cocoa powder produced. Yield is one of the parameters that are important for knowing the economic value or effectiveness of a process. The greater the yield value, the higher the economic value of the product.

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Water content is one of the most important things in fat storage. Fat with high water content will be easily damaged and decrease in quality during storage. Water content measurements are based on SNI 3748:2009.

From Tabel 1 it is known that the fat content of fermented cocoa and non-fermented cocoa is between 0.10-0.12% and has met SNI with a maximum water content of 0.20%. The water content contained in cocoa fat in addition to being affected by the reshuffle that occurs in cocoa beans is also influenced by the process carried out to get the fat. Based on research of Ref. [12], an increase in the extraction temperature interval resulted in cocoa fat moisture content dropping. This is caused by an increase in extraction temperature which results in the process of evaporation of water from cocoa fat extraction will be easier. Fat water content is related to fat resistance to hydrolytic damage during storage. The smaller the moisture content, the more resistant the fat is to hydrolytic damage. Brown fat is more easily hydrolytic damaged because the dominant fatty acid in chocolate is saturated fatty acids [13].

Free fatty acids are fatty acids in a free state and no longer bind to glycerol. Measurement of free fatty acids was based on SNI 3748:2009. From Table 1 it is known that the value of free fatty acids cocoa pretreatment fermentation and non-fermentation is between 0.51-0.56%, and has met SNI 3748:2009 with a maximum free fatty acid of 1.75%. This is according to research conducted by Ref. [14]. the lowest levels of free fatty acids are obtained with a fermentation time of five days and an increase in fermentation time of seven days. These results showed an increase in free fatty acids during fermentation. While the increase in fatty acid levels is an indicator of the occurrence of fatty hydrolyses (triglycerol) into glycerol and fatty acids [10].

According to Ref. [13], fat damage can be caused by four factors, (a) enzyme activity in fatty tissues, (b) the activity of microorganisms, (c) oxidation by oxygen, and (d) odor absorption by fat. Fatty tissues from plants or animals generally contain lipase enzymes. Lipase enzymes belong to the esterase group, so it can cut the bonds of glycerol and fatty acids. Indications of lipase activity can be measured by the increase in free fatty acid content with the following reactions.

$$\text{Triglycerides + Glycerol} \xrightarrow{\text{lipase}} \text{Water + Fatty Acids}$$

At the time of fermentation, the pile of seeds that still contain water is quite high, which is about 60% in seeds and 80% in pulp [13]. High enough water content allows for fatty hydrolysis to be accelerated by enzymes, acids, and bases. The speed of hydrolysis of fat by lipase enzymes found in tissues is relatively slow at low temperatures and will intensify under optimum conditions.

Ref. [15]) states that the presence of free fatty acids becomes an indicator of oil quality, the higher the level of free fatty acids, the lower the quality of the oil. The presence of free fatty acids in cocoa fat should be avoided because it is one of the indicators of quality damage.

The number of iod is the amount of yodium (iodine) in grams that can be bound by 100g of fat. Iodine can only be bound by the double bonds possessed by unsaturated fatty acids, so this number reflects the degree of saturation of the fatty acids that make up the fat. Measurement of the number of cocoa fat iod is based on SNI 3748:2009.

From Table 1 it is known that the value of the number of iod obtained for fermented and nonfermented cocoa fats is between 26.40-26.50 gI2/100g. The value of iod numbers obtained in this study has not met SNI i.e. with a quality requirement of 33-42 g I2/100g. According to Ref. [12], the low value of iod numbers indicates that fat contains more saturated fatty acids or those fats have higher levels of saturation.

The determination of iod numbers is very useful for estimating the hardness of cocoa fat. The higher the value of the iod number means the high levels of unsaturated fatty acid components that contribute to the softness of cocoa fat [18].

Peroxide numbers are the amount of meq peroxide in every 1000g (1 kg) of oil or fat. The determination of peroxide numbers in this study was based on SNI 3748:2009.

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Peroxide numbers are the amount of meq peroxide in every 1000g (1 kg) of oil or fat. The determination of peroxide numbers in this study was based on SNI 3748:2009. The peroxide number is the number used to determine oxidative damage to oil or fat. Oxidative damage to fats or oils causes stress [13]. Based on the results of the analysis it is known that the number of peroxide of fermented and nonfermented cocoa butter is between 0.40-0.70 meq peroxide/kg fat (Table 1). This figure meets the quality requirement of SNI 3748:2009 with a maximum peroxide number of 4.0 meq peroxide/kg of fat. The length of the fermentation process affects the peroxide value of cocoa fat. Based on research conducted by Ref. [15]. the value of cocoa fat peroxide with a fermentation duration of 7 days is higher than the peroxide number value with a fermentation duration of 5 days.

The Saponification Value is indicative of the combined properties of fatty acids in fats [10]. The value of the Saponification Value is expressed in g KOH/g of fat.

From Table 1 it is known that the value of the Saponification Value of fermented and non-fermented cocoa butter is between 190.23-191.40 mg KOH / g fat. The value met SNI with quality requirements for which is 188-198 mg KOH / g fat. The value of the Saponification Value above 200 mg KOH/g of fat describes fatty acids with low molecular weight. While the value of the 190 mg KOH/g fat describes fatty acids with a high molecular weight [12].). According to Ref. [13], the amount of saponification value depends on the molecular weight. Fats or oils that have a low molecular weight will have a higher saponification value compared to oils that have a high molecular weight.

Color is an important quality attribute for food products. In addition, color also has a very important role in the quality of an ingredient, because in general comments before considering the nutritional value and taste, will be more interested in the color of the product. Color testing on cocoa fat was measured using Hunterlab Mini Scan EZ which produced 3 color parameters with notation L*, a*, and b*. The results of the color analysis of fermented cocoa pretreatment and non-fermentation fats can be seen in Table 2.

Table 2. Color Values at Brightness Level (L*)

Treatment	**L***	**a***	**b***	***°hue***	**Color**
Fermentation	17.88	8.70	7.99	85.11	*Yellow red*
Non fermentation	14.84	8.96	6.78	85.46	*Yellow red*

In the hunter system, there are three hunter parameters, namely L*, a*, and b*. Notation L* shows the difference between light and dark (100 = white and 0 = black), notation a* indicates the difference between red and green (+a* = red and -a* = green), notation b* indicates the difference between yellow and blue (+b* = yellow and -b*= blue), while hue indicates the proportion of color in the material.

From Table 2 it is known that pretreatment affects the color of cocoa fat that has been produced. The results of the color test conducted showed that the value of °hue obtained was not much different, namely 85.11 for fermentation pretreatment and 85.46 for non fermentation pretreatment with yellow-red color proportions. The highest brightness value (L*) are fermented pretreatment cocoa fat 17.88 and 14.48 for nonfermented pretreatment cocoa fat. High brightness levels in fat pretreatment fermentation because in the fermentation process there is an overhaul towards the formation of color, taste, and aroma [16]. Cocoa butter with fermented pretreatment has a brighter and more attractive color compared to nonfermented pretreatment cocoa butter.

The high level of brightness of pretreatment cocoa fat produced due to the occurrence of an overhaul during the fermentation process takes place. The fermentation process of cocoa beans is divided into two phases, namely, external fermentation and internal fermentation. External fermentation occurs in the mucus or pulp of cocoa beans, the sugar contained in mucus or pulp is overhauled into alcohol or ethanol which will then be overhauled into organic acids. In the next condition high alcohol, sugar is so low that yeast or yeast formed during the fermentation process will decrease in number and eventually die. The acetic acid that is formed then goes into the seeds so that the seeds die. In this phase it is called internal fermentation, fermentation that occurs in the seeds of Cocoa remodels chemical components enzymatically such as polyphenols, proteins, carbohydrates, and other components.. This reshuffle serves to form a precursor of aroma, taste, and color. The low sugar content produced will improve the color, aroma, and taste formed during the roasting process.

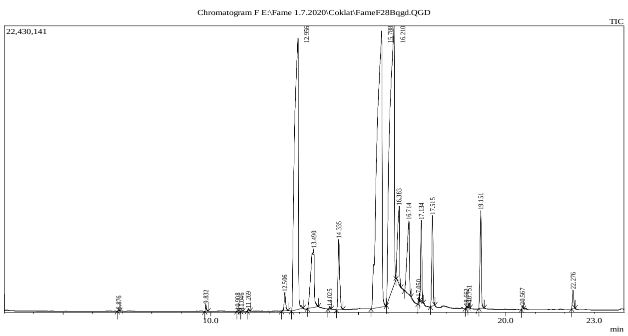
3.2. Fatty Acid Profile

To find out the influence of fermented and nonfermented pretreatment on the composition of fatty acids contained in cocoa pretreatment fermentation and non fermentation fats, an analysis f fatty acid profiles was carried out. Analysis of fatty acid profiles is done using the GC-MS tool (Gass Chromatography-Mass Spectrophotometer). The results of the analysis of the cocoa fatty acid profile can be seen in Table 3.

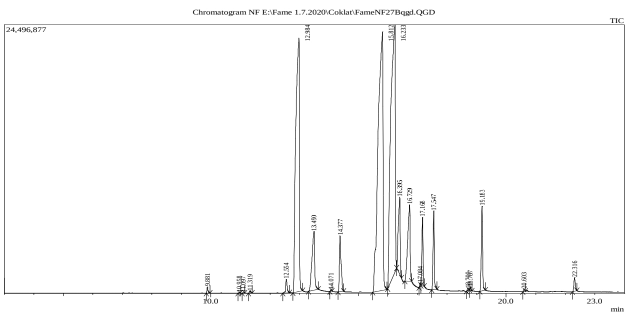
Table 3. Results of Analysis of Cocoa Butter Fatty Acid

Name	Structure	**Fatty Acid (%)**	
		Fermentation	Non-fermentation
Miristic acid	$C_{14:0}$	0.15	0.15
Oleic acid	$C_{18:1}$	29.57	29.39
1,2 B*enzenedicarboxylic acid*		0.02	-
Heptadecanoic acid	$C_{17:0}$	25.85	26.77
Palmitic acid	$C_{16:0}$	21.83	21.49
Pentadecanoic acid	$C_{15:0}$	0.05	0.06
Stearic acid	$C_{18:0}$	3.60	4.33
aracidic acid	$C_{20:0}$	2.77	2.72
Behenic acid	$C_{22:0}$	0.53	0.48

Analysis of fatty acid profiles with gas chromatography showed differences in the amount of fatty acid content in the two treatments, with the same amount of ingredients, the same amount of extract and injection volume, indicating an increase in the number and content of components in the presence of fermentation and non fermentation pretreatment (Figure 1).



(a)



(b)

Figure 1 GC-MS Reading Results of Fermented Cocoa Butter (a) and Nonfermented Cocoa Butter (b)

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The results of the analysis of fatty acid profiles showed that the dominant fatty acids in fermented and nonfermented cocoa fats were oleic acid, followed by heptadecanoic acid, and palmitic acid. The levels of fatty acids in cocoa pretreatment fermentation and non-fermentation fats are not too different, but at the time of fermentation, lipase enzymes are formed that hydrolyze some of the fat in cocoa. The composition of fatty acid changes is caused due to activity during fermentation.). Based on research conducted by Ref. [19] on the content of fatty acids in tempeh, it was concluded that soy fermentation causes tempeh to have much higher levels of fatty acids than boiled soybeans.

The difference in the amount of oleic acid, miristic acid, palmitic acid, stearate acid, and arachidic acid in fermented and nonfermented cocoa pretreatment fats gives different characteristics to both treatments. As well as the content of 1.2 Benzenedicarboxylic acids in fermented pretreatment cocoa fat indicates the presence of aromatic compounds formed. Cocoa fat is a mixture of triglycerides where more than 70% of its constituent glycerides consist of three monounsaturated compounds, namely oleodipalmitin (POP), oleodistearin (SOS), and oleopalmistearin (POS). Brown fat triglycerides have a J-T-J arrangement where T is an unsaturated fatty acid while J is a saturated fatty acid, this causes brown fat to be hard and brittle and has a relatively low melting point (30-40 ° C) which causes brown fat to quickly melt [20].

3.3. Sensory Analysis

To determine the effect of treatment on the sensory physical properties of fermented and nonfermented cocoa fat, especially on aroma, taste, and color, the acceptance test was conducted by distributing questionnaires to panelists. A favorite test is a test to find out the panelist's response to a product being tested. In this study, the panelists used were untrained panelists as many as 20 people.

Color is the first parameter that determines the level of consumer acceptance of a product. Subjective research with vision is still decisive in color organoleptic testing [20].

Table 4. Average Panelist's preference for fermented and non-fermented cocoa butter on sensory attributes

Treatment	**Color ± SD**	**Plavour ± SD**	**Aroma ± SD**
Fermentation	3.7 ± 0.80	2.9 ± 0.71	3.5 ± 0.94
Non-fermentation	3.4 ± 0.68	2.8 ± 0.95	3.5 ± 1.05

Based on Table 4, panelists prefer the color of fermented pretreatment cocoa fat compared to non-fermented pretreatment cocoa fat. This is because the non-fermented pretreatment fat treatment results in a dark brown color (Figure 2).

Factors that affect the color of the resulting fat are fermentation and roasting processes. In the fermentation process, there is a breakdown of polyphenol compounds. According to Ref. [14], the intensity level of color depends on the length of temperature and also the chemical composition on the outer surface of the food. This is related to the higher the content of polyphenols in the seeds that will encourage the Maillard reaction, with the help of polyphenol oxidase produces a cocoa color. Changes in the composition of polyphenols during fermentation marked a reduction in the purple color of the beans and an increase in the intensity of cocoa color. At the same time, there is a reduction in the concentration of polyphenols in the seeds through the oxidation of polyphenol compounds out of the seeds.

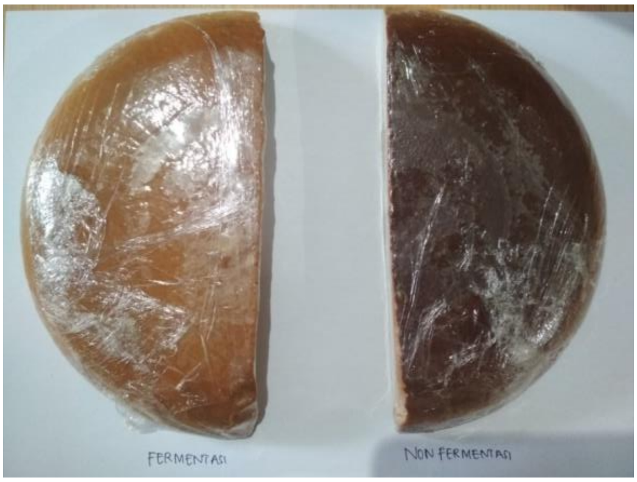

Figure 2. Cocoa Butter

Flavour is one of the most important parameters of a product. The Flavour can be judged as a response to stimuli derived from chemical compounds in a food that gives the impression of sweet, bitter, salty, and sour.

The flavor is one of the very important characteristics of cocoa products and will form during fermentation and drying [21]. During drying, cocoa beans undergo various chemical reactions and biochemical changes that form taste and aroma during processing [22]. The chemical and physical processes that occur during the roasting of cocoa beans cause a decrease in flavor-causing compounds such as theobromine and caffeine.

From organoleptic tests conducted obtained the average preference of panelist flavors to cocoa fat is highest in fermented pretreatment and the lowest average obtained in nonfermented pretreatment cocoa fat. Panelists responded that fermented pretreatment cocoa fat had a better taste and had an aftertaste that was not bitter compared to nonfermented pretreatment cocoa fat.

Aroma is one of the most important factors for consumers in choosing a preferred food product. Ref. [20] says that in many ways the delicacy of food is determined by the aroma or smell of the food.

In the presence of the Maillard reaction, all cocoa aroma precursors interact with each other to produce aroma components. The specific aroma of cocoa is the sweetness, nut flavor, caramel, and chocolate flavor. According to Ref. [23] and Ref. [24] peptides and hydrophobic free amino acids, such as leucine, alanine, phenylalanine, and tyrosine, are precursors that contribute to the formation of brown aromas that develop during the fermentation process.

Overall panelists prefer fermented pretreatment cocoa fat because it has a more attractive color and aroma compared to nonfermented pretreatment cocoa fat.. 15 out of 20 panelists responded that they were attracted to fermented cocoa fat because it gave it better color, aroma, and flavor.

4. CONCLUSION

Based on research that has been done it can be concluded that: In physical analysis, it is known that fermentation pretreatment gives good results to the yield and color of cocoa fat. In chemical analysis, it is known that non-fermentation pretreatment gives better results to the chemical properties of cocoa butter produced. Organaleptically the color, taste, and aroma of fermented cocoa butter differ from nonfermented cocoa butter. Although the chemical analysis of fermented cocoa butter has a higher characteristic value than nonfermented cocoa butter, the value obtained still meets the quality requirements of SNI 3748:2009 regarding cocoa fat. Based on the research that has been done, the authors suggest for further researchers conduct further studies on the influence of fermented and non-fermentation pretreatment on processed chocolate products.

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