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Production Process Technology of Lecithin from Crude Palm Oil on the Physico-Chemical Properties of Halal Dark Chocolate Produced

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***Abstract*— This research was conducted to determine the effect of the addition of CPO (*Crude Palm Oil*) lecithin as an *Emulsifier* on the physicochemical and sensory characteristics of dark chocolate, and to determine the amount of lecithin addition as an appropriate *Emulsifier* to produce chocolate with the best physico-chemical and sensory characteristics. This study used a completely randomized design (CRD) method with a treatment level of 0%. 0.1%, 0.2%, 0.3%, 0.4% with 4 repetitions to obtain 20 experimental units. Parameters observed included color degee, antioxidant activity, fat blooming, stability level, color sensory test, taste, aroma, texture and overall acceptability. The data obtained were analyzed using ANOVA levels of 1% and 5%. If there is a significant effect on the treatment, it will be continued with the Duncan's Multiple Range Test (DNMRT) at the 5% level. The best concentration of adding lecithin to dark chocolate is 0.3% which contains 66.76% antioxidant activity, color degee L*28.58, a* 13.67, b* 22.67, hue 58.75, good stability (melting properties), able to prevent fat blooming, has good color very chocolatey (4.20), very distinctive aroma of chocolate (4.44), bitter taste (2.68), smooth texture (3.36) and the overall acceptance of the panelists really liked it (8.16).**

Keywords— **CPO (*Crude Palm Oil*), *dark chocolate, lecithin***

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I. INTRODUCTION

Cocoa pod production tends to rise year after year. Cocoa production reached 718 tonnes in 2015, and 1,564 tonnes in 2017 [1] . The use of cocoa in product processing technology, both in the form of food and drinks, contributes to the high production of cocoa [2]. The majority of cocoa output in Jambi Province, Indonesia, comes in the form of exporting beans. The low level of processed products produced in Jambi is inversely related to rising demand and consumption, therefore increased development in the manufacturing sector necessitates economic added value from cocoa commodities.

Dark chocolate is higher in solid chocolate and lower in sugar than other forms of chocolate. A high-quality chocolate bar must contain at least 60% cocoa paste. Because high-quality dark chocolate has less sugar than other forms of chocolate, its flavour is more bitter and thick [3] (Atkinson, 2010). Due to a decrease in the viscosity of the mixture in chocolate, there are components or substances that aid in the stability of oil and water emulsions. The emulsifier is often an organic chemical containing two groups that are polar and nonpolar, allowing the two substances to be mixed. Lecithin is a food emulsifier that is used in the production of dark chocolate.

Lecithin is good at lowering the interfacial pressure between fat and water, hence maintaining the emulsion's stability in the dough.

II. MATERIAL AND METHODS

A. Material

This study made use of chocolate tempering and conching instruments, hot plates, centrifuges, ovens, desiccators, magnetic stirrers, thermometers, aluminium foil, refrigerators, and chocolate moulds. A UV-Vis spectrophotometer, a colour reader, a vortex, an analytical balance, and an incubator are among the other analysis tools. In this investigation, the following components were used: CPO (Crude Palm Oil) lecithin, cocoa butter, Chokato cocoa powder (made by the Tanjung Payakumbuh Farmers Group), Claris powdered sugar,

and koepoe-koe vanilla. Among the other ingredients are phosphoric acid, 96% ethanol, N-hexane solution, 1% PP indicator, 0.0990N KOH solution, toluene, acetone, DPPH solution, and distilled water.

B. Methods

This research was conducted using a completely randomized design (CRD), with 5 levels of treatment (CPO lecithin concentration) and 4 replications. The levels of substitution were:

P0= 0% (control)
P1= 0.1% of CPO Lecithin
P2= 0.2% of CPO Lecithin
P3= 0.3% of CPO Lecithin
P4= 0.4% of CPO Lecithin

Production of CPO (Crude Palm Oil) lecithin

The erlenmeyer was filled with 240 mL of CPO, followed by 2% (4.8 mL) phosphoric acid. A hot plate is then used to heat the Erlenmeyer containing a CPO and phosphoric acid mixture. A thermometer was used to adjust the electrothermal temperature until the solution temperature reached 80oC. The heating process takes 30 minutes after the temperature is attained. To help separation, the hot solution was neutralised with 1% NaOH before being covered with aluminium foil and allowed to cool to 25°C.

The solution that had begun to separate was centrifuged at 3000 rpm for 20 minutes. The produced gum was scraped into a petri dish and baked for 5 hours at 105°C to minimise the water content of lecithin [4] (Putri et al., 2019). After getting CPO lecithin, the lecithin purification stage was carried out (Joshi et al., 2006). Purification is accomplished by combining acetone with lecithin at a 1:5 ratio. To achieve homogeneity, the solution was agitated for 1 hour with a magnetic stirrer. The solution was then centrifuged at 3000 rpm for 20 minutes. The supernatant is discarded, and the solid residue is mixed with acetone again. Following that, the purification procedure is repeated. The solids that are not soluble in acetone are next aerated to evaporate the remaining acetone, yielding completely produced lecithin.

Dark Chocolate Production

All raw materials were prepared and weighed according to [5] Febriantama, (2021) (40 g cocoa butter, 30 g cocoa powder, 29.8 g sugar, 0.2 g vanilla, and 1/3 treatment lecithin), and 40 g cocoa butter was preheated at 50°C to produce liquid cocoa butter. The ingredients were then combined by conching at 40°C for 8 hours. The addition of CPO lecithin is done in two stages, with 1/3 added at the start of the stirring process and the remaining 2/3 added before the tempering process. Following the completion of the conching process, the tempering process is carried out. First, the remaining CPO lecithin is mixed into the chocolate, which is then heated to 45°C for 10 minutes, then lowered to 26°C for 10 minutes, and raised again to 30-32°C for 10 minutes. Stirring takes place during the tempering process. After that, the printing is done with a chocolate mold and the chocolate is cooled in the refrigerator until it hardens.

C. Parameters

Color degree analysis

Colour degree analysis was carried out using a colour reader. In general, the colour reader operates by measuring the colour difference created by the surface of the sample. The measuring technique is completed by placing a chocolate sample on the receptor area and then pressing the measurement button. L* (lightness), a* (redness), and b* (brightness) (yellowness) are among the values obtained. The colour reader's L*, a*, and b* values are then utilised to search for the colour description (hue) using color-hex on the website www.colorhexa.com [6] (Andarwulan et al., 2011).

Antioxidant activity test (DPPH Method)

The test was carried out according to [7] Nurhayati et al., (2017) by weighing 4 g of dark chocolate sample using an analytical balance, then heating it using a tempering tool and placing it in a screw tube. The sample is dissolved with 96% ethanol. Then the solution was homogenized using a vortex. After that, the solution was centrifuged for 10 minutes at 3000 rpm. Take as much as 0.2 mL of the supernatant and put it in a closed test tube that has been filled with 3.8 mL of DPPH solution. The mixed solution was then homogenized using a vortex and stored for 30 minutes in a dark room. Absorption was measured using a UV-Vis spectrophotometer at a wavelength of 517 nm. The absorbance data obtained is used to determine the % inhibition. The DPPH ability of the extract is calculated by the following formula:

$$\text{Total AA (\%)} = \left(\frac{\text{A kontrol-A Sampel}}{\text{Akontrol}}\right) \text{x} 100\%$$

Information :
A A = Antioxidant Activity Value (%)
dark chocolate sample solution in 96% ethanol reacted with DPPH solution in 96% ethanol)
A control = Absorbance of standard solution

Fat Blooming Test

The fat blooming test according to Buscato et al., (2018) [8] is a test to see the bound fat in dark chocolate. This fat blooming test is indicated by the presence of white spots in dark chocolate. This test is carried out by packing the sample in a closed cup container and storing it in a room that is not exposed to direct sunlight. The fat blooming test was carried out for 21 days at room temperature (27-30°C) by observing the presence or absence of white spots on the sample surface every 3 days

and observations were made using a CR-10 type color reader from the Konica Minolta brand to see the Whiteness Index. (WI) on the sample surface. Thewhiteness index is measured by the following equation:

$$WI=100 \times \sqrt{100-L^2+a^2+b^2}$$

Information :
WI = Whiteness Index
L* = Brightness (*lightness*)
a* = Red color – green color (*redness*)
b* = Yellow color – blue color (*yellowness*)

Stability Test

The stability or melting properties test was carried out according to the method [9]. The test was carried out by first weighing a sample weighing 7 g and placing it in an incubator at a temperature of 37°C for 30 minutes. Previously, the temperature in the incubator was neutralized for one hour. Then the samples are arranged on a *stainless steel tray* so that the samples do not come into direct contact with the incubator. Next, we observed a change in the shape of *the dark chocolate* from solid to melted. This observation is carried out every 5 minutes by visual observation (eyes) and giving a score for each change that occurs during 30 minutes. The following scores are assigned: 5 (Very Hard), 4 (Hard), 3 (Fairly Hard), 2 (Slightly Melted), 1 (Melted), and 0 (Very Melted).

Sensory Test

Sensory characteristics are the characteristics that determine whether a food product is acceptable or not, according to [10]. The senses of sight, touch, smell, and taste are used to assess sensory characteristics. While the questionnaire is a tool in the form of a list of questions that panelists (respondents) must fill out in order to be measured. The hedonic test method (liking) and the hedonic quality test for color, texture, taste, and aroma were performed on 25 semi-trained panelists from the University of Jambi's
Agricultural Product Technology students. Sensory assessment is determined by a score, as shown in Tables 1 and Table 2.

TABLE 1.
HEDONIC QUALITY TEST ASSESSMENT SCORES

Score	Color	Aroma	Flavor	Texture
5	Very chocolatey	Very typical chocolate	Very bitter	Very smooth
4	Chocolate	Typical chocolate	Bitter	Fine
3	Somewhat brown	Rather typical chocolate	A bit bitter	It's a bit subtle
2	Not brown	Not typical chocolate	Not bitter	Not subtle
1	Not very brown	Very uncharacteristic of chocolate	not very bitter	Very unsubtle

TABLE 2.
HEDONIC TEST ASSESSMENT SCORES

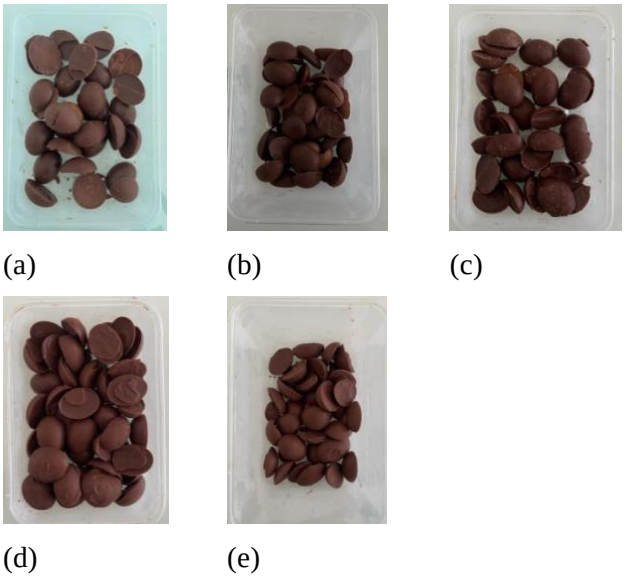
Score	Overall acceptance
9	like extremely *(like extremely)*
8	very *much*
7	Like *(like moderately)*
6	Somewhat like *(like slightly)*
5	Neutral *(neither like or dislike)*
4	Dislike *slightly (dislike slightly)*
3	Dislike *(dislike moderately)*
2	Dislike very much *(dislike very much)*
1	Dislike extremely *(dislike extremely)*

Data Analysis
ANOVA was applied to obtain the effect of the treatment. The ANOVA tests were followed by DnMRT post test if the significant difference was presented at $p<5\%$.

III. RESULT AND DISCUSSION

A. Dark Chocolate

Chocolate that can be declared high quality must contain a minimum of 60% chocolate paste. When compared with other types of chocolate, high-quality dark chocolate usually has a more dominant taste, namely more bitter and intense because it contains very little sugar [3].



(a) (b) (c)

(d) (e)

Figure 1. *Dark chocolate* (a) Without CPO lecithin, (b) Lecithin 0.1%, (c) Lecithin 0.2%, (d) Lecithin 0.3%, (e) Lecithin 0.4%

Dark chocolate with P0 treatment does not have CPO lecithin added to it, so the resulting chocolate has a color that tends to be brighter compared to the other four chocolate samples. Without the addition of CPO lecithin, the resulting chocolate texture melts quickly at room temperature and is more fragile. This is in direct contrast to the chocolate products produced when treated with the addition of CPO lecithin.

B. CPO Lecithin analysis

The CPO lecithin produced in this study was through an acid degumming process with the addition of phosphoric acid. There are two types of phosphatides in CPO, namely hydratable phosphatides (HPL) and non-hydratable phosphatides (NHPL). Hydratable phosphatides are easily separated by adding water at a low temperature of around 40°C, while non-hydratable phosphatides must first be converted to hydratable phosphatides by adding an acid solution and carrying out a neutralization process to remove the FFA (Free Fatty Acid) levels [11].There are 4 test parameters carried out on CPO lessitin including the water content test, the insoluble acetone test (AI), toluene insoluble (TI) test and acid number test. The AI value on the lecithin quality standard is >60%, the TI value 0.3%, and the acid number value is 35 mgKOH/g- 6 mgKOH/g (EFEMA, 2018). The quality characteristics of the CPO lecithin used in this study can be seen in Table 3.

TABLE 3
CPO (*CRUDE PALM OIL*) LECITHIN TEST VALUE

CPO Lecithin Test Parameters	Mark
Water content	0.12%
Toluene Insolube (TI)	0.2%
Acetone Insoluble (AI)	56.33%
Acid Number	5.36 gKOH/g

C.Color Degrees

Hunter method color degree analysis is carried out using *a color reader* . *Color reader* is a tool for measuring L*, a* and b* values. Where the L* value determines the brightness level of a sample. The a* value determines the level of red or green and the b* value determines the yellow or blue color. To read color (° *hue*) use *the website color-hex.* The results of analysis of variance showed that the addition of lecithin from CPO (*Crude Palm Oil*) had no significant effect on the L* and a* values, and had a significant effect on b* in *dark chocolate* . The L*, a*, b* values and description of the *dark chocolate color* can be seen in **Table 4.**

TABLE 4
DARK CHOCOLATE COLOR DEGREE VALUES

Addition CPO Lecithin (%)	L* ± SD	a* ± SD	b* ± SD	Color	Color Description
0	28.25 ± 0.42	13.42 ± 0.17	22.25 ± 0.32 [a]		*Very Dark Orange (Brown Tone)*
0.1	28.42 ± 0.50	13.50 ± 0.19	22.33 ± 0.27 [ab]		*Very Dark Orange (Brown Tone)*
0.2	28.50 ± 0.33	13.58 ± 0.17	22.42 ± 0.17 [abc]		*Very Dark Orange (Brown Tone)*
0.3	28.58 ± 0.17	13.67 ± 0.00	22.67 ± 0.27 [bc]		*Very Dark Orange (Brown Tone)*
0.4	28.67 ± 0.38	13.75 ± 0.17	22.75 ± 0.17 [c]		*Very Dark Orange (Brown Tone)*

Note: Numbers followed by different lowercase letters in the same column are significantly different at the 5% level according to the DNMRT test.

The color analysis data obtained showed that the L* value produced in dark chocolate ranged from 28.25–28.67 with the highest L* value obtained in the addition of 0.4% CPO lecithin,

namely 28.67, while the lowest L* value was obtained in the addition of CPO lecithin 0% is 28.25. From all treatments, the L* value was found to be very far from 100 and close to 0, which means that it is almost close to black. The a* value produced in dark chocolate ranges from 13.42–13.75, where this value shows a red color. The highest a* value was obtained by adding 0.4% CPO lecithin, namely 13.75, and the lowest a* value was obtained by adding 0% CPO lecithin, namely 13.42. While the b* values obtained range from 22.25–22.75 where this number leads to a yellow color. The highest b* value was found in the addition of 0.4% CPO lecithin which was 22.75 and the lowest b* value was found in the addition of 0% CPO lecithin which was 22.25. These values are then entered into the Photoshop CS6 application to obtain code # which is then entered into the color-hexa website to determine the color description, so that the product color description for dark chocolate obtained is very dark orange (brown tone).

The results of the analysis data show that the value of each treatment is increasing with the addition of lecithin. This shows an increase in the color brightness value of the resulting dark chocolate. One reason for this to happen is the yellow color of CPO lecithin added to dark chocolate. Before being processed into CPO, the maturity level of oil palm fruit is generally determined based on the amount of loose fruit and color [12]. The color of the oil palm fruit is due to the presence of anthocyanin compounds, with increasing maturity the anthocyanin compounds will tend to decrease. This is also reinforced by the statement [13] that the heating that occurs during the manufacture of lecithin from CPO will affect the resulting color. The higher the temperature, the color of the lecithin obtained will tend to be dark in color so that at low temperatures the color of the lecithin obtained tends to be yellowish brown. Based on the results of the analysis of variance, it showed that the addition of CPO (Crude Palm Oil) lecithin had no significant effect on the ˚Hue value of the resulting dark chocolate. ˚Hue values can be seen in **Table 5**.

TABLE 5.
DARK CHOCOLATE HUE VALUES

Addition of CPO Lecithin (%)	˚Hue ± SD value	Color Brightness
0	58.50 ± 0.69	*Yellow Red*
0.1	58.50 ± 0.69	*Yellow Red*
0.2	58.58 ± 0.32	*Yellow Red*
0.3	58.75 ± 0.42	*Yellow Red*
0.4	58.92 ± 0.42	*Yellow Red*

The value of ˚Hue produced in dark chocolate with the addition of CPO lecithin ranged rom 58.50-58.92 which describes the dominant color of yellow red. The color produced from dark chocolate products comes from lecithin and cocoa powder which are added during the
processing process

D. Antioxidant activity

Analysis of antioxidant activity was carried out by testing dark chocolate's ability to reduce free radical activity originating from DPPH. Compound 1,1-diphenyl-2-picrylhydrazyl (DPPH) is a stable free radical compound that changes color from purple to yellow because antioxidants donate electrons to DPPH. Antioxidant activity with the DPPH method is expressed in units of % inhibition. This inhibition shows the magnitude of the percentage of barriers to free radical compounds. Based on the analysis of the variety of addition of lecithin from CPO (Crude Palm Oil) it has a significant effect on the value of antioxidant activity in dark chocolate. The antioxidant activity value of dark chocolate can be seen in **Table 6**.

TABLE 6.
ANTIOXIDANT ACTIVITY VALUES *OF DARK CHOCOLATE*

Addition CPO Lecithin (%)	Antioxidant Activity ± SD
0	70.94 ± 0.85 ^{c}
0.1	68.79 ± 0.69 ^{b}
0.2	68.01 ± 0.83 ^{b}
0.3	66.76 ± 0.49 ^{a}
0.4	66.25 ± 0.30 ^{a}

Description: Numbers followed by different lowercase letters the same column, significantly different at the 5% level according to the DNMRT test.

According to **Table 6.** The addition of 0% CPO lecithin resulted in the highest antioxidant activity, 70.94%, and the addition of 0.4% CPO lecithin resulted in the lowest antioxidant activity, 66.25%. The antioxidant content of dark chocolate per 100g is 13,120 units based on the Oxygen Radical Absorbant Capacity (KARO). While dark chocolate has a high antioxidant activity value of 59.19%. This demonstrates that the antioxidant content of chocolate is just as important as the antioxidant content of ascorbic acid. This figure is still significantly lower than the figure obtained from the total percentage of antioxidant activity of dark chocolate in the treatment of adding 0% CPO lecithin, which is 70.94%. Analysis of antioxidant activity showed a decrease in antioxidant activity. The higher the concentration of the addition of CPO lecithin, the lower the antioxidant activity in dark chocolate. This happened because the DPPH solution and the dark chocolate sample which had been dissolved in 96% ethanol interacted antagonistically so that the antioxidant activity rate was low. This is reinforced by the statement of [14] Choe and Min (2009), which stated that he decrease in the value of antioxidant activity in a product is possible due to the stronger intermolecular forces between secondary metabolites and solvents at certain concentrations. This makes it difficult for secondary metabolites to reduce free radicals from DPPH. According to [15], antagonistic interactions can occur in plants other than the active substance as the main component which is the most influential, because there are still other side compounds that might affect the expected response. In

Sambodo's [16], red seaweed and lemon peel were extracted using the maceration method using methanol. Testing the antioxidant activity using the DPPH method with the color dimming parameters DPPH and IC50 showed that the antioxidant activity has a synergistic effect with a ratio of 1:1, 1:2 and a moderate antagonistic effect with a ratio of 2:1. This was allegedly due to the interaction between the chemical compounds contained in each extract.

E. Fat Blooming

Fat blooming is a physical defect that appears during storage of *dark chocolate* . The physical defects that occur are characterized by the appearance of white spots on the brown surface. The occurrence of *fat blooming* is caused by the presence of unstable fat so that the fat rises to the surface of *the dark chocolate* during storage at room temperature. Fat that is unstable at extreme temperatures will slowly distribute over the surface and when the fat solidifies again there will be white spots on the brown surface. These spots ultimately make the appearance of *dark chocolate* less attractive in terms of color [17].

The formation of *fat blooming* only changes the physical properties of the chocolate, but does not change the taste, aroma and texture characteristics. *Fat blooming* analysis was carried out by storing *dark chocolate samples* at room temperature for 21 days, every 3 days observing the changes that occurred using a color detection tool, namely a *color reader* . To determine whether or not *fat blooming occurs* in *dark chocolate* , you can determine the value of the whiteness index (WI). The WI value of *dark chocolate* can be seen in **Table 7** and **Figure 2.**

TABLE 7.
FAT BLOOMING VALUE DURING STORAGE

Addition CPO Lecithin (%)	Whiteness Index (WI)							
	0	3	6	9	12	15	18	21
0	23.90	23.88	23.75	23.70	23.60	23.54	23.50	23.45
0.1	24.09	23.82	23.79	23.73	23.68	23.60	23.55	23.49
0.2	24.15	23.98	23.88	23.80	23.79	23.73	23.80	23.58
0.3	24.24	24.18	24.12	24.09	24.00	23.92	23.86	23.63
0.4	24.35	24.30	24.29	24.15	24.02	23.98	23.90	23.70

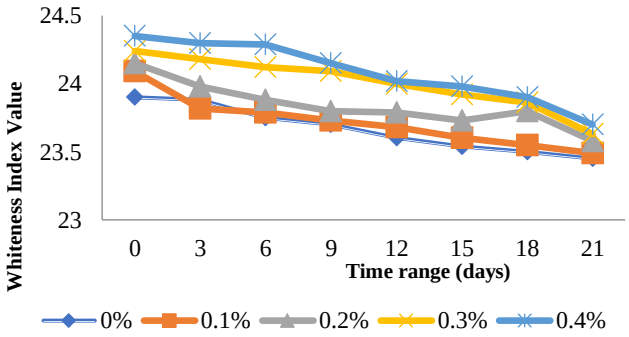


Figure 2. Diagram of Observation Results of *Dark Chocolate* During Storage

Based on **Table 7** and **Figure 2**, the results of observations of *dark chocolate* during 21 days of storage showed that the whiteness index value decreased with increasing storage time, although the decrease in the whiteness index value was not too different. The treatment with the addition of 0.4% CPO lecithin had the highest WI value, namely 23.70 on the 21st day and the treatment with the addition of 0% CPO lecithin had the lowest WI value, namely 23.45 on the 21st day. However, the value obtained is still far from the value of *fat blooming* . According to [8] (Buscato *et al.*, 2018), it is stated that with each storage phase carried out, the whiteness index value will decrease. The higher the whiteness index value, the more white spots will form on the surface *of the dark chocolate* .

Based on the results of the research carried out, it can be seen that during storage for 21 days there was no occurrence of *fat blooming* or white spots visible on the surface *of the dark chocolate* . This is due to the addition of CPO (*Crude Palm Oil*) lecithin as an *emulsifier* to bind the fat contained in *dark chocolate* . According to Indarti *et al.*, (2013), lecithin also functions as a good binder between cocoa butter and oil and several other components, so that fat clumping or *fat blooming does not occur* . This is also reinforced [18] , which states that *fat blooming* can be prevented by carrying out a good tempering process and adding *emulsifiers* to chocolate products, because *emulsifiers* in the form of lecithin can be used to bind or store

fat in chocolate so that it does not cause fat spots . *blooming*). The *tempering* process can also affect *fat blooming* in chocolate products

F. Stabiity test

Stability analysis is carried out to determine the level of melting of a product by directly observing the changes that occur. This stability analysis was carried out using an incubator at a temperature of 37℃ for 30 minutes. Analysis of the stability of the shape of *dark chocolate* is characterized by a change in shape from solid to melted. Observations were made every 5 minutes visually. Based on the results of analysis of variance, it shows that the addition of CPO lecithin has a significant effect on the stability of *dark chocolate* . The results of *the dark chocolate* stability analysis can be seen in **Table 8.**

TABLE 8.
STABILITY VALUES *OF DARK CHOCOLATE*

Addition of CPO Lecithin (%)	Stability Level ± SD
0	3.07 ± 1.30 [a]
0.1	3.28 ± 1.22 [ab]
0.2	3.64 ± 0.95 [bc]
0.3	4.14 ± 0.84 [cd]
0.4	4.64 ± 0.50 [d]

Description: Numbers followed by different lowercase letters the same column, significantly different at the 5% level according to the DNMRT test.

The results of the stability analysis *of dark chocolate* were observed every 5 minutes. Based on the results shows on the **Table 8**. The stability level of *dark chocolate* with added lecithin from CPO ranges from 3.07 (rather hard) – 4.64 (very hard). In the data above, it can be seen that the highest level of stability was found in the treatment with the addition of 0.4% CPO lecithin, namely 4.64 and the lowest level of stability was found in the treatment with the addition of 0% CPO lecithin, namely 3.07. From the results of the stability analysis, it can be seen that the addition of 0.4% CPO lecithin has the best level of stability, because it is able to maintain the level of stability in the incubator up to 30 minutes while remaining hard. Compared with the addition of 0% CPO lecithin which experienced a decrease in the level of stability starting from the 15th minute to the 30th minute, so it had the lowest level of stability.

In the 0% CPO lecithin treatment, the texture changed from solid/hard to melted due to the absence of added lecithin. In accordance with [19], that adding lecithin to chocolate will increase the stability of chocolate, increasing the melting point causes an increase in the stability of chocolate so that it is resistant to melting.

The addition of lecithin *emulsifier* causes the water content to decrease. This is because lecithin has a higher hydrophilic group compared to the hydrophobic group. The higher the concentration of lecithin e- *emulsifier* added, the higher the hydrophilic group will be. It is this hydrophilic group that binds water so that the water which was originally free water can no longer move freely because it has been bound by the hydrophilic group of the lecithin *emulsifier* . The higher the bound water, the lower the evaporation which is calculated as the water content of the product so that as the concentration of the lecithin *emulsifier* increases, the water content of the product will decrease further

G. Sensory test

The quality of food ingredients generally depends on several factors, including taste, color, texture, aroma and nutritional value. The hedonic (liking) test method and hedonic quality test for color, aroma, taste and texture were carried out by 25 panelists. Sensory assessment was determined by scores and based on the results of analysis of variance showing that the addition of CPO lecithin had a real effect on the sensory color, aroma, texture and overall acceptability of *dark chocolate* and had no real effect on the sensory taste. The results of the *dark chocolate* sensory test analysis can be seen in **Table 9.**

TABLE 9.
DARK CHOCOLATE SENSORY TEST VALUES

Addition of CPO Lecithin (%)	Color ± SD	Aroma ± SD	Taste ± SD	Texture ± SD	Overall Acceptance ± SD
0	2.44 ± 0.52 [a]	2.20 ± 0.41 [a]	2.36 ± 0.49	1.60 ± 0.50 [a]	5.64 ± 0.64 [a]
0.1	2.84 ± 0.42 [b]	2.56 ± 0.51 [b]	2.44 ± 0.51	1.84 ± 0.55 [a]	6.28 ± 0.54 [a]
0.2	3.36 ± 0.63 [c]	3.40 ± 0.50 [c]	2.56 ± 0.51	2.44 ± 0.51 [bc]	7.20 ± 0.58 [c]
0.3	4.20 ± 0.32 [d]	4.44 ± 0.51 [d]	2.68 ± 0.48	3.36 ± 0.49 [c]	8.16 ± 0.62 [d]
0.4	4.64 ± 0.53 [e]	4.36 ± 0.49 [d]	2.60 ± 0.50	3.32 ± 0.48 [c]	6.12 ± 0.83 [b]

Note: Numbers followed by different lowercase letters in the same column are significantly different at the 5% level according to the DNMRT test.

- Overall Score:
  Like Extremely , 8 Like Very Much , 7 *Like Moderately* , 6 *Like Slightly* , 5 Neutral (*Neither Like or Dislike*), 4 Dislike *slightly*), 3 Dislike (*Dislike Extremely*), 2 Dislike very much (*dislike very much*), 1 Dislike very much (*dislike extremely*).

Color

Color is a physical form that can influence the quality or degree of acceptance of a product, which generally gives the first impression to consumers who see a product. Therefore, attractive colors will make consumers respond and give the impression that they want to taste a product or even just like it. Based on the results of analysis of variance, it shows that the

addition of lecithin from CPO (*Crude Palm Oil*) has a significant effect on the color of *the dark chocolate* produced.
Based on the results shows on the **Table 9**. The results of the *dark chocolate* color sensory test showed the highest average, namely the treatment with the addition of 0.4% CPO lecithin with a value of 4.64, the color criterion was very very brown. Meanwhile, the lowest average was the treatment with the addition of 0% CPO lecithin with a value of 2.44, slightly brown color criteria. From the color sensory test results of *dark chocolate products* , it can be seen that the researcher prefers *dark chocolate* with a very brown color. According to [22], *dark chocolate* generally has a dominant dark brown and shiny color. This is caused by the use of ingredients in it which affects the color of the product produced. Where the lecithin added in the chocolate processing process makes the color of *dark chocolate* dark and gives a shiny impression [20]. This is in accordance with the research results obtained that the color of *dark chocolate* looks dark and there is a shine on the surface. The amine group of CPO lecithin in the chocolate heating process allows the *Maillard reaction to occur* , where the color produced by the product becomes dark. The yellow color of the added CPO lecithin affects the color of the chocolate.

Aroma
The characteristics of food ingredients that have an impact on the respiratory system and are perceived by the sense of smell are the definition of smell or aroma. Based on the results of analysis of variance, it shows that the addition of lecithin from CPO (*Crude Palm Oil*) has a significant effect on the color of *the dark chocolate* produced.
Based on **Table 9**, the results of the sensory test for the aroma of *dark chocolate* showed that the panelists accepted the aroma with the highest average value, namely in the treatment with the addition of 0.3% CPO lecithin which was added with lecithin with a value of 4.44, criteria for a very typical chocolate aroma. Meanwhile, the lowest average value was the *dark chocolate aroma* treated with the addition of 0% CPO lecithin with a value of 2.20, the criteria for a slightly typical chocolate aroma. The results of the sensory test showed that the observations of the aroma were significantly different at the 5% level with the average value not being very significant. It can be concluded that the panelists prefer *dark chocolate products* which have a very distinctive chocolate aroma. The CPO lecithin added to each treatment is in the form of a powder with a yellow color, odorless and tasteless so it does not provide much different values in the product aroma sensory test results.
According to Hartomo (1993) [21], lecithin has soluble properties so that the actual aroma does not appear because it has been mixed with other ingredients in making *dark chocolate* . This is also confirmed by Nathania's statement (2016), which states that the addition of lecithin to this chocolate product does not have much effect on the aroma of the chocolate produced. This is because the main factor that influences the aroma of *dark chocolate* is the *conching process* . The *conching* process aims to enhance the distinctive aroma of chocolate and also eliminate unwanted odors.

Flavor
The sense of taste or tongue, is used to evaluate food products. There are papillae on the surface of the tongue that detect stimuli and products that will dissolve in saliva [22]. Based on analysis of variance, it shows that the addition of CPO (*Crude Palm Oil)* lecithin has no real effect on the taste of *the dark chocolate* produced.
Based on **Table 9**, the results of the *dark chocolate* taste sensory test showed the panelists' acceptance of the *dark chocolate taste* with the highest average value, namely in the treatment with the addition of 0.3% CPO lecithin with a value of 2.68 for bitter criteria. Meanwhile, the lowest average value was in the treatment with the addition of 0% CPO lecithin with a value of 2.36, slightly bitter criteria. In this test, *dark chocolate was obtained* with the criteria of being slightly bitter to bitter, this is because *dark chocolate* has a distinctive bitter taste originating from alkaloid components such as *theobromine, caffeine* , phenolic components, *pyrazines* , several peptides and free amino acids in cocoa beans. [23].
There are two compounds that play the most role in giving chocolate a bitter taste (*after taste), namely theobromine* and *caffeine* . The *theobromine* compound content in cocoa beans is much greater (2%) than the caffeine compound content (<1%) so that *theobromine compounds* have a greater role in providing a bitter taste [24], who stated that the characteristic natural bitter taste of chocolate comes from alkaloid components such as *theobromine* . The typical taste of chocolate is a bitter taste that is felt and quickly disappears on the surface of the tongue. The bitter taste can be felt throughout the oral cavity, while the bitter taste that comes from *the theobromine component* is only felt at the base of the tongue. The results of the sensory test on this taste parameter showed that the panelists preferred *dark chocolate* which has a bitter taste. This is because the CPO lecithin added to *dark chocolate* does not dominate the taste of the resulting chocolate when compared to cocoa powder *and* cocoa butter which have a distinctive taste and are more dominant in use.

Texture
In this research, texture observations were carried out when the *dark chocolate product* was eaten, bitten and chewed by the panelists. Based on analysis of variance, it shows that the addition of CPO (*Crude Palm Oil)* lecithin has a significant effect on the texture of *the dark chocolate* produced.
Based on **Table 9**, the results of the sensory test for the texture of *dark chocolate* showed the panelists' acceptance of the texture with the highest average value, namely the treatment with the addition of 0.3% CPO lecithin with a value of 3.36 for the fine texture criteria. Meanwhile, the lowest average value was the treatment with the addition of 0% CPO lecithin with a value of 1.60, a rather smooth criterion.

The results of sensory testing *of dark chocolate* texture parameters show that panelists prefer *dark chocolate* which has a smooth texture. The smooth texture is obtained due to the addition of additional ingredients mixed into it. In the *dark chocolate* made in this research, lecithin from CPO (*Crude Palm Oil*) was added according to the treatment. The added CPO lecithin is intended as *an emulsifier* . According to [25], the addition of lecithin can help smooth the texture of food and function as an emulsifying agent in chocolate, where lecithin as an *emulsifier* provides the ability to maintain texture. This is also confirmed by the statement of [26], that lecithin provides the ability to maintain the texture from melting as a result of the dispersion of fat with an air cell structure which produces a hard and dry texture character.

Overall Acceptance

This assessment aims to determine the researcher's level of acceptance of *dark chocolate products* with the addition of lecithin from CPO. The results of the analysis of variance showed that the differences in treatment had a very significant effect on the overall acceptance *of dark chocolate* [27] [28].

Based on **Table 9,** rating of overall preference for *dark chocolate* , the average value ranges from 5.64 (somewhat like) to 8.16 (like very much). The highest overall acceptance value for *dark chocolate* was found in the treatment with the addition of 0.3% CPO lecithin, namely 8.16 (very like), while the lowest overall acceptance value for *dark chocolate* was found in the treatment with the addition of 0% CPO lecithin, namely 5.64 (somewhat liked). The addition of CPO lecithin to chocolate influences the level of panelists' overall preference for *dark chocolate* . This is because different lecithin concentrations can affect color, texture, taste and aroma. It can be seen that from the hedonic quality sensory test on the parameters of color, texture, taste and aroma, the treatment with the addition of 0.3% CPO lecithin has a very brown color, smooth texture, bitter taste and a very typical chocolate aroma. The results obtained were quite different from the average value in the treatment with the addition of 0% CPO lecithin or without the addition of lecithin which had a slightly brown color, a slightly smooth texture, a slightly bitter taste and a slightly chocolatey aroma

III. Conclusion

Based on the results of the research that has been carried out, it can be concluded that the addition of CPO lecithin to *dark chocolate* affects the resulting physicochemical and sensory characteristics regarding the degree of color b*, antioxidant activity, stability level, *fat blooming* , sensory test of texture, color, aroma and overall acceptability, however has no real effect on the degree of color L*, a*, hue and sensory taste. The best addition of CPO lecithin in making *dark chocolate* was obtained in the 0.3% treatment which contained 66.76% antioxidant activity, had a color degree value of L*28.58, a* 13.67, b* 22.67, hue 58.75 , good stability (melting properties) (4.14), able to prevent *fat blooming* , has a very brown color (4.20), very typical chocolate aroma (4.44), bitter taste (2.68), texture smooth (3.36) and overall acceptance that panelists really like (8.16) for *dark chocolate*.

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