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Halal Dark Chocolate Quality: Influence of Tempering Time and Temperature

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ABSTRACT
The quality of the raw cocoa mass used greatly affects the final quality of the chocolate product. Conching and tempering are also important processes in chocolate making to produce high-quality chocolate that customers like. The process includes mixing, cutting and aeration of the chocolate mass during heating at a certain temperature needed to achieve the desired quality characteristics of the chocolate product. This study was aimed to determine the effect and interaction of differences in tempering time and temperature on the characteristics of halal dark chocolate during tempering. This study used a completely randomized design (CRD) with 2 factors, the first factor was the length of tempering which were 15 minutes, 30 minutes and 45 minutes and the second factor was tempering temperature, which were 28 0C, 30 0C, and 32 0C respectively. Research design was carried with 9 treatment combinations and each treatment was repeated 2 times. The data obtained were analyzed using the analysis of variance (ANOVA) method and then proceeded with Duncan's new multiple range test at the 5% level. The results showed that the length of tempering time had a significant effect on antioxidant activity, L *, a * and b * color degrees, stability test and overall sensory acceptance while tempering temperature has a significant effect on antioxidant activity. The results showed that the length of time and tempering temperature had a significant effect on antioxidant activity, color degrees of L *, a * and b *, overall acceptance of sensory properties. The best treatment was the tempering time of 45 minutes and tempering temperature of 30 ˚C with antioxidant activity value of 61.715%, has a color degree value of L * 45.05, a * 8.45, b * 20.25, has good melting properties, no fat blooming has been found for the storage of 60 days and the overall sensory acceptance of the panelists is fairly similar

Keywords: *Cocoa, temperature, tempering, dark chocolate.*

1. INTRODUCTION

Cocoa (*Theobroma cacao* L.) is one of the plantation commodities that are commonly found in Indonesia. Jambi Province is one of the cocoa-producing regions in Indonesia. Cocoa plantations in Muaro Jambi Regency are scattered in almost all sub-districts. It was recorded that in 2015 cocoa production in Kumpeh District had the highest cocoa production, which was 223 tons [1].

According to P. Ide (2008) [2], dark chocolate is a chocolate bar made from cocoa powder with cocoa butter and mixtures of sugar, vanilla and lecithin. Dark chocolate which has a bitter taste has a low sugar content compared to milk and white chocolates. Dark chocolate contains not less than 30-35% cocoa solids, not less than 18% cocoa fat and not less than 2.5-14% cocoa solids without fat [3].

Dark chocolate has the characteristics of being susceptible to temperature, odor, external flavoring, air, light, humidity, and time. Chocolate storage for a long time can reduce the quality of chocolate characteristics such as texture, taste, aroma, and appearance [4]. Fat blooming is a common occurrence in chocolate products. This factor is a physical defect that appears during chocolate storage and is

characterized by the appearance of a whitish layer on the chocolate surface layer. Many factors can affect fat blooming which were inappropriate fat mixture, cooling, temperature, and storage time [4]. One way to improve the quality of chocolate is by managing the tempering factor which involves a series of stages of heating, cooling, and stirring at low speed [5]. Tempering greatly affects chocolate because if the tempering is not good it can cause the chocolate to stick to the mold, have an opaque color and form blooms because the shape of fat crystals in chocolate is not yet stable. In addition, tempering also serves to distribute fat crystals thoroughly in the mixture of materials [6]. According to Apri and Slamet (2013) [7], a good tempering temperature is in the range of 18ºC to 32ºC, because it will have a good melting point of chocolate, while chocolate that is not tempered will result in a poor melting point. The results of previous research by Eti *et al*., (2013) [4] showed milk chocolate bars that use cocoa butter without tempering, fat blooms are formed on the surface of milk chocolate bars. Meanwhile, in milk chocolate bars using cocoa fat from tempering fat blooming is not formed. Furthermore, the results of the study by Fakhmi *et al*., (2016) [8] regarding the analysis of fat blooming, it is known that the peanut butter chocolate filling with a 30 minute tempering treatment with a tempering temperature of 35ºC blooms formed almost all over the surface of the peanut butter chocolate filling which was marked by the appearance of white dots and the color is starting to turn dull. Meanwhile, peanut butter chocolate filling with a tempering duration of 10 minutes with a tempering temperature of 25ºC did not occur evenly on the surface of the chocolate, but only some white dots appeared on the surface and the surface color did not turn dull. Therefore, the aim of this research is to determine the effect of differences in tempering time and temperature on the characteristics of halal dark chocolate produced.

2. MATERIALS AND METHOD

2.1. Materials

The materials used in this study were *forastero* cultivars cocoa pods from Kumpeh Subdistrict, Muaro Jambi Regency, Jambi Province, Indonesia, pure cocoa powder, cocoa butter obtained from pressing cocoa liquor, virgin coconut oil from local supermarket, refined sugar, lecithin with premium brand soya lecithin (halal), instant vanilla and aluminum foil. While the chemicals used for analysis were 96% ethanol (analytical grade) and DPPH (sigma).

The equipment and instruments used in this study were analytical balances, special designed cocoa bean fermentation box, cocoa bean roaster, grinder, hydraulic press, chocolate tempering instrument, 60 mesh sieve, mixing bowl, digital thermometer, mold, refrigerator, incubator, UV-Vis spectrophotometer, color reader type CR-10 brand Konica Minolta.

2.2. Research Design

This study used a completely randomized design (CRD) with 2 factors which was factor 1 (A) the length of time and factor 2 (B) was temperature of tempering which obtained 9 treatment combinations and each treatment was repeated 2 times so that 18 experimental units were obtained. The treatment of tempering time and temperature as follows: A1B1 = time 15 min, temp. 28 ^{0}C; A1B2 = time 15 min, temp. 30 ^{0}C; A1B3 = time 15 min, temp. 32 ^{0}C; A2B1 = time 30 min, temp. 28 ^{0}C; A2B2 = time 30 min, temp. 30 ^{0}C; A2B3 = time 30 min, temp. 32 ^{0}C; A3B1 = time 45 min, temp. 28 ^{0}C; A3B2 = time 45 min, temp. 30 ^{0}C; A3B3 = time 45 min, temp. 32 ^{0}C respectively.

2.3. Research Design

2.3.1. Cocoa Powder Manufacture

The raw material used was *forastero* cultivars from Kumpeh District, Muaro Jambi Regency, Jambi Province which were ripe in yellowish color. The fruit was further broken down with a wooden block and the seeds are removed. After being separated from the placenta, the beans were weighed and put into a fermentation box measuring 28 cm long and 40 cm high (the box can accommodate ±5-6 kg of wet cocoa beans) after which the box was covered with banana leaves. In the fermentation process, the cocoa beans were turned every 48 hours, then the cocoa beans were fermented for 6 days dried. Drying by drying directly in the sun for ±7 days to reach a moisture content below 7.5%. Cocoa beans that have gone through the fermentation process were then dried by drying directly in the sun for ±7 days to reach a moisture content below 7.5%. Cocoa beans were then roasted at a temperature of around 120°C to 140°C for 30 minutes. Moreover, the cocoa beans were crushed using a grinder so that they become cocoa paste. The paste was then put into a filter cloth for the cocoa butter extraction process using the hydraulic press to extract the cocoa butter and separate the cocoa

powder. Furthermore, the cocoa powder was sieved with a 60 mesh sieve to form a fine cocoa powder that will be used in the further study.

2.3.2. Dark Chocolate Processing

The ingredients used in making dark chocolate were weighed according to the formulation, which were 8.5 g cocoa powder, 23 ml fat, 2.50 ml virgin coconut oil, 15 g sugar, 1 g vanilla and 0.15 ml halal lecithin. Cocoa powder, cocoa butter and virgin coconut oil were mixed until homogeneous in a separate container. Cocoa butter was previously heated at a temperature of 50 ^{0}C to produce liquid cocoa butter. Liquid cocoa butter was then mixed with virgin coconut oil and cocoa powder was then stirred until smooth. Furthermore, powdered sugar, lecithin and vanilla are mixed for further conching process at 40°C for 8 hours. The addition of halal lecithin in the process of making dark chocolate consists of 2 stages, stage 1 was one third was inserted at the beginning of the stirring and the remaining two thirds was about 1 hour before the stirring is complete. The dark chocolate dough after the conching process was completed, the tempering process was carried out according to the treatment, which were 15, 30 and 45 min and temperature of 28 °C, 30 °C and 32 °C respectively. The dark chocolate dough was then molded using the container provided. The dark chocolate that has been molded was cooled at 4°C for 24 hours in the refrigerator for further analysis.

2.4. Research Parameters

2.4.1. Antioxidant Activity Test

The dark chocolate sample weighed ±1.00 g using an analytical balance, moved into a 100 ml volumetric flask then ultrasonically for ±80 minutes at 60 °C, allowed to stand until room temperature was reached. After that, the sample was dissolved with 50 ml of 96% ethanol until dissolved, and ethanol was added to the mark and then homogenized. Then the solution was filtered using filter paper. The filtered solution was taken 0.2 ml, then put into a closed test tube which already contained 3.8 ml of DPPH solution. The solution mixture was 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 were used to determine the % inhibition. The DPPH ability of the extract was calculated using the following equation:

Total antioxidants (%) =

$$\frac{(Absirbance\ control - Absorbance\ sample)}{Absorbance\ control}\ x\ 100\% \quad (1)$$

2.4.2. Color Degree

Color testing was carried out using the Konica Minolta CR-10. The sample to be tested was first put in a transparent ziplock plastic, turn on the color reader, then attach the optical head to the ziplock plastic (sample) and press the measuring button, the results obtained include L* (lightness), a * (redness) and b* (yellowness). Furthermore, measurements of the values of L*, a*, and b* were carried out on the sample. The L*, a*, and b* values obtained from color capture by Color Reader are then searched for the color name (hue) using color-hex on www.colorhexa.com.

2.4.3. Stability Test

Stability test or melting properties were carried out by observing the dark chocolate form produced by changing its shape from solid to melted. The stability test was carried out in an incubator with a temperature of 37ºC for a certain time. It was observed that there was a change in the shape of the dark chocolate.

2.4.4. Fat Blooming Test

Fat blooming test was indicated by the presence of a white layer/spot on dark chocolate. This test was carried out by storing dark chocolate for 60 days at room temperature. Then observed every 15 days using the Konica Minolta CR-10 type Color Reader to see the whiteness index (WI) on the surface of the sample. The whiteness index is measured by the following equation:

$$WI = 100 - \sqrt{(100 - L)^2 + a^2 + b^2} \quad (2)$$

2.4.5. Organoleptic Test

Organoleptic testing of dark chocolate was tested on 20 trained panelists. Organoleptic testing was carried out using the hedonic test for overall acceptance. Hedonic test assessment score (Overall acceptance score overall receipt 5 very like 4 Like 3 fairly like 2 Do not like 1 Very not like.

2.5. Data Analysis

The data obtained from the observations were analyzed using ANOVA at the level of 5% and 1%. If the data obtained are significantly different, then

proceed with the Duncan's New Multiple Range Test (DNMRT) further test at the 5% level.

3. RESULTS AND DISCUSSION

3.1. Antioxidant Activity

The capacity of proteins to be hydrolyzed into amino acids by protease enzymes is known as soluble protein or protein digestibility (Pellet and Young, 1980) [8]. The Lowry analysis is used to identify soluble protein levels. Figure 1 shows observations of soluble protein in crocodile flathead, cardinal fish, java barb, and common barb.

Based on the results of the analysis of variance, it showed that the length of tempering time had a significant effect on the value of antioxidant activity, and the tempering temperature significantly affected the value of antioxidant activity, but there was no interaction between the two factors. The value of antioxidant activity can be seen in Table 1.

Table 1 The average value of dark chocolate antioxidant activity based on the interaction of tempering time and temperature expressed in % inhibition.

Tempering Temperature (B)	Tempering Time Length (A)		
	15 minutes	30 minutes	45 minutes
28 ˚C	67.12 ± 1.1 c B	64.69 ± 0,2 b B	62.86 ± 0.6 a B
30 ˚C	66.59 ± 0.5 c B	64.00 ± 0,5 b B	61.72 ± 0.5 a B
32 ˚C	65.22 ± 0.8 c A	62.47 ± 1.0 b A	60.96 ± 1.0 a A

Note: The numbers followed by the same letter are not significantly different at the 5% level according to the DNMRT test. Lowercase letters are read horizontally and uppercase letters are read vertically

Table 1 shows that the average antioxidant ranges from 61% to 67.12%. The lowest antioxidant activity value, i.e. 61%, was found at a temperature of 32 ºC and a time of 45 minutes and the highest value of antioxidant activity, i.e. 67.12%, was found at a treatment temperature of 28 ºC and a time of 15 minutes. The decrease in the value of antioxidant activity that occurs with increasing length of time and tempering can be caused because temperature and time affect the antioxidant content which is susceptible to temperature. Dark chocolate was also made through a series of other processes, such as conching for 8 hours at 40ºC and roasting cocoa beans for 30 minutes at a temperature of 120-140ºC. The similar results found with previous researchers [16], antioxidants will be lost or reduced along with the higher temperature and length of tempering time. This is because antioxidants have properties that are easily damaged when exposed to light, placed at high temperatures, and drying using high temperatures. This is also supported by Albertini *et al*., (2015) [17] which states that thermal processes involving temperature in cocoa processing can cause a decrease in the content of cocoa beans. polyphenols and antioxidant activity in cocoa beans and their processed products. The content of antioxidant activity in dark chocolate based on Oxygen radical absorbance capacity (KARO) ranges from a value of ±45-70% with a category that can be consumed [18]. The results of research by Lany *et al*., (2012) [11] show that dark chocolate has a fairly high antioxidant activity value, which was 59.19%.

3.2. Color Analysis

L*, a*, b* values and dark color description of dark chocolate can be seen in Table 2.

Table 2 The average value of dark chocolate colour value based on the interaction of tempering time and temperature.

Treatments	L*	a*	b*	Colour	Colour Description
15 min: 28 ˚C	45.5 ± 0.5 c A	8.4± 0.2 b A	20.5 ± 0.1 b A		*Very Dark Desaturated Orange*
15 min: 30 ˚C	45.4 ± 0.2 c A	8.5 ± 0.4 b A	20.3 ± 0.6 b A		*Very Dark Desaturated Orange*
15 min: 32 ˚C	45.1 ± 0.1 c A	8.3 ± 0.1 b A	20.01 ± 0.1 b A		*Very Dark Desaturated Orange*
30 min: 28 ˚C	44.9 ± 0 b A	8.0 ± b A	20.01 ± 0.1 b A		*Very Dark Desaturated Orange*
30 min: 30 ˚C	45.0 ± 0.1 b A	8.2 ± 0.5 b A	20.00 ± 0 b A		*Very Dark Desaturated Orange*
30 min: 32 ˚C	45.0 ± 0.1 b A	8.2 ± 0.0 b A	20.01 ± 0.1 b A		*Very Dark Desaturated Orange*
45 min: 28 ˚C	44.9 ± 0.2 a A	8.2 ± 0.4 a A	20.2 ± 0.2 a A		*Very Dark Desaturated Orange*
45 min: 30 ˚C	44.4 ± 0.1 a A	7.4 ± 0.1 a A	19.8 ± 0.1 a A		*Very Dark Desaturated Orange*
45 min: 32 ˚C	44.5 ± 0.0 a A	7.2 ± 0.1 a A	19.8 ± 0.1 a A		*Very Dark Desaturated Orange*

Note: The numbers followed by the same letter are not significantly different at the 5% level according to the DNMRT test. Lower case letters are read horizontally and uppercase letters are read vertically.

Based on the results of the variance, it showed that the tempering time had a significant effect on the values of L*, a* and b*, while the tempering temperature had no significant effect on the values of L*, a* and b* and there was no interaction between the two factors. Table 4 showed that the highest L* value was found in the tempering treatment with a time of 15 minutes and a temperature of 28˚C, which is 45.5, while the lowest L* value was found in the tempering treatment with a time of 45 minutes and a temperature of 30 ˚C, which is 44.4. The highest a* value was found in the tempering treatment with a time of 15 minutes and a temperature of 28˚C which was 8.5 while the lowest a* value was found in the tempering treatment with a time of 45 minutes and a temperature of 32˚C which was 7.2. The highest b* value was found in the tempering treatment with a time of 15 minutes and a temperature of 28˚C which is 20.5 while the lowest b* value was found in the tempering treatment with a time of 45 minutes and a temperature

of 32˚C which is 19.8. The difference in treatment time and tempering temperature on dark chocolate had the same color description, namely very dark desaturated orange. This was due to the long tempering time during the stirring process that accelerates the Maillard reaction which causes the dark chocolate color to get darker, which is indicated by the decreasing value of brightness L (lightness). According to Winarno (2002) [19], states that the Maillard reaction occurs in materials containing high sugar and protein which are heated, causing a dark brown color. In addition, the content of tannin compounds in chocolate also adds to the brownish color. This was reported by Prawoto *et al*., (2001) [20], dark chocolate generally has a dark brown color, because the basic color of cocoa beans was brown which dominates the color of the resulting product. Moreover, the addition of lecithin can also give a shiny impression to the chocolate. This was also stated by Fakhmi *et al*., (2016) [8], through the tempering process will produce chocolate products and have a glossy appearance. Ketaren (1986) [6] stated that tempering greatly affects chocolate because if the tempering is not good it can cause the chocolate to stick to the mold, have an opaque color and form blooming due to the unstable shape of fat crystals in chocolate.

3.3. Stability Test

Products like dark chocolate are said to be good if they don't melt easily at room temperature. The results of observations of changes in dark chocolate can be seen in Table 3

Table 3 The average value of dark chocolate stability test based on the interaction of tempering time and temperature.

Treatments	0 minute	5 minutes	10 minutes	15 minutes	20 minutes	25 minutes	30 minutes
15 min: 28 ˚C	5 ± 0 a A	5 ± 0 a A	4 ± 0 a A	3.5 ± 0.7 a A	2.5 ± 0.7 a A	1.5 ± 0.7 a A	0.5 ± 0.7 a A
15 min: 30 ˚C	5 ± 0 a A	5 ± 0 a A	5 ± 0 a A	4 ± 0 a A	4 ± 0 a A	3 ± 0 a A	2 ± 0 a A
15 min: 32 ˚C	5 ± 0 a A	5 ± 0 a A	5 ± 0 a A	4 ± 0 a A	3.5 ± 0.7 a A	3.5 ± 0.7 a A	2.5 ± 0.7 a A
30 min: 28 ˚C	5 ± 0 b A	5 ± 0 b A	5 ± 0 b A	4 ± 0 b A	4 ± 0 b A	3.5 ± 0.7	2.5 ± 0,7 b A
30 min: 30 ˚C	5 ± 0 b A	5 ± 0 b A	5 ± 0 b A	4 ± 0 b A	4 ± 0 b A	3,5 ± 0,7	2,5 ± 0,7 b A
30 min: 32 ˚C	5 ± 0 b A	5 ± 0 b A	5 ± 0 b A	4 ± 0 b A	4 ± 0 b A	4 ± 0 b A	4 ± 0 b A
45 min: 28 ˚C	5 ± 0 b A	5 ± 0 b A	5 ± 0 b A	4 ± 0 b A	4 ± 0 b A	4 ± 0 b A	4 ± 0 b A
45 min: 30 ˚C	5 ± 0 b A	5 ± 0 b A	5 ± 0 b A	4 ± 0 b A	4 ± 0 b A	4 ± 0 b A	4 ± 0 b A
45 min: 32 ˚C	5 ± 0 b A	5 ± 0 b A	5 ± 0 b A	4 ± 0 b A	4 ± 0 b A	4 ± 0 b A	4 ± 0 b A

Note: 5=very hard, 4=hard, 3=fairly hard, 2=Fairly melting, 1=Melting, 0= Totally melting; The numbers followed by the same letter are not significantly different at the 5% level according to the DNMRT test. Lowercase letters are read horizontally and uppercase letters are read vertically.

Based on the results of the variance, it showed that the length of tempering time had a significant effect on the stability value, while the tempering temperature had no significant effect on the stability value and there was no interaction between the two factors. It can be seen that the longer tempering time used in the dark chocolate manufacturing process can increase the stability of the dark chocolate texture. This was confirmed by another reseacher [21] which states that a good stability test was due to the stability of the fat crystals formed in the tempering process which was very stable so it was not easy to melt. The stability of dark chocolate products can also be caused by the addition of sugar, where the sugar and chocolate particles will bind to each other. The results showed that the tempering treatment for 15 minutes at a temperature of 28ºC began to experience shape instability within 10 minutes which was marked by a change in the texture of dark chocolate, until within 30 minutes the tempering treatment for 15 minutes at a temperature of 28ºC had changed. the texture becomes very runny. Unlike the case with tempering treatment for 45 minutes at a temperature of 32ºC which remains stable in texture from the initial time to 30 minutes, which has a hard texture. The hard texture referred to in this test was the texture of dark chocolate which still looks solid. While the melted texture that looks melted. The purpose of the tempering process was to obtain the best crystal form through a polymorphic transformation process. The fat crystal needed to form a stable fat structure is the form (V crystal). In addition, another researcher [22] also stated that tempering was carried out with the aim of giving a change in the crystal shape of the fat because if it is not tempered, the fat crystal form is unstable so that the resulting chocolate will easily melt.

3.4. Fat Blooming

Test Fat blooming test was carried out by storing dark chocolate for 60 days at room temperature. The results of observations for 60 days can be seen in Table 4.

Table 4 The average value of whiteness index (WI) based on the interaction of tempering time and temperature

Treatments	Whiteness Index (WI)			
	0-15 days	**15-30 days**	**30-45 days**	**45-60 days**
15 min: 28 ˚C	41.19	40.99	40.97	40.94
15 min: 30 ˚C	41.10	40.97	40.95	40.93
15 min: 32 ˚C	41.01	40.96	40.94	40.90
30 min: 28 ˚C	40.88	40.86	40.84	40.79
30 min: 30 ˚C	40.83	40.77	40.75	40.72
30 min: 32 ˚C	40.82	40.77	40.74	40.63
45 min: 28 ˚C	40.71	40.66	40.64	40.61
45 min: 30 ˚C	40.53	40.47	40.25	40.20
45 min: 32 ˚C	40.63	40.60	40.58	40.48

Fat blooming on dark chocolate is characterized by the presence of a white layer or white spots that are not visible to the eye on the surface of dark chocolate. According to Buscato *et al.*, (2018) [23] the whiteness index represents the brightness level of a food product which indicates discoloration during storage. Based on Table 6, it can be seen that the whiteness index of dark chocolate stored for 60 days had a value that decreases with the longer storage time. However, the decrease in value that occurred was not so far between treatments. It can be seen that the treatment time and temperature of tempering 45 minutes with a temperature of 30ºC was the best treatment because it had the lowest whiteness index value of 40.20 until the 60th day of storage which indicates dark chocolate with this treatment did not experience fat blooming. This was

agreed by the results of other research [8] regarding the analysis of fat blooming, it was known that in peanut butter chocolate filling with a tempering time of 30 minutes with a tempering temperature of 35ºC, blooming was formed almost all over the surface of the peanut butter chocolate filling which was marked by the appearance of white dots and colors will start to turn dull.

Another researcher [6] stated that tempering greatly affects chocolate because if the tempering is not good it can cause the chocolate to stick to the mold, have an opaque color and form blooming due to the unstable shape of fat crystals in chocolate. Tempering will form more stable brown crystals. The absence of fat blooming was also caused by the addition of lecithin which functions as an emulsifier. This was confirmed by previous research [22], lecithin emulsifiers were used to bind or store fat in chocolate so it did not cause flowers in chocolate. The purpose of the tempering process was to obtain the best crystal form through a polymorphic transformation process. The fat crystal needed to form a stable fat structure was the form (V crystal). The crystallization process that occurs quickly with optimal contraction will produce a shiny final product and be relatively more resistant to fat blooms.

According to Mulato (2002) [24] if the tempering is too fast (under tempering), where the expected number of crystal forms (V form) does not reach the optimal concentration, it has the potential to cause recrystallization which triggers fat blooming. The same thing also happens if there is over tempering. The concentration of V-shape crystals will be too high, so as not to be sufficient to produce mass contraction. As a result, it can also increase the risk of fat blooming.

3.5. Sensory preference

The overall acceptance parameter was used in the sensory preference test to determine the panelist's level of preference for quality attributes (color, taste, texture and aroma contained in the product as a whole for dark chocolate [25].

The average value of the organoleptic test of overall dark chocolate acceptance based on the tempering time and temperature can be seen in Table 5.

Table 5 The average value of overall sensory acceptance based on the interaction of tempering time and temperature.

Treatments	Overall Acceptance
15 min : 28 ˚C	3.15 ± 1.0a A
15 min: 30 ˚C	3.2 ± 0.6a A
15 min : 32 ˚C	3.25 ± 0.7a A
30 min : 28 ˚C	3.55 ± 0.8b A
30 min : 30 ˚C	3.65 ± 1.0b A
30 min : 32 ˚C	3.5 ± 0.8b A
45 min : 28 ˚C	3.45 ± 0.8b A
45 min: 30 ˚C	3.5 ± 0.9b A
45 min: 32 ˚C	3.25 ± 1.0b A

Note: Overall acceptance: 5=very like 4= Like 3= fairly like 2= not like 1= Very not like; The numbers followed by the same letter are not significantly different at the 5% level according to the DNMRT test. Lowercase letters are read horizontally and uppercase letters are read vertically.

The results of analysis of variance showed that the length of tempering time had a significant effect on the overall acceptance of dark chocolate, but the tempering temperature had no significant effect, and there was no significant difference between the interactions between each factor on the overall acceptance of dark chocolate. Based on the overall preference of dark chocolate, the longer the tempering time will increase the overall acceptance of dark chocolate according to the panelists' assessment. It was shown in Table 5 that the highest overall acceptance value of dark chocolate was found in the 45 minute tempering treatment with a tempering temperature of 30ºC, which was 3.65 (fairly like), while the lowest overall dark chocolate acceptance value was found in the 15 minute tempering treatment at a temperature of 15 minutes. tempering 28ºC which was 3.15 (fairly like).

Test Color Color is a very important component to determine the quality or degree of acceptance of a food or product in general depending on the color that appears [19]. According to Annisa (2016) [26], mixing and stirring for a long time can reduce the particle size of the material, especially in the ingredients in powder form such as cocoa powder, granulated sugar and other powdered materials. This was because the longer the

tempering time and temperature increase the taste of dark chocolate according to the panelists' assessment. Chocolate contains tannins which cause chocolate to have a bitter taste. According to Alex (2003) [27], the taste of chocolate was often confused and with astringent taste because people do not fully understand the nature and differences between the two tastes, especially the tannins and polyphenols in chocolate as the components that most influence the astringent and bitter taste. The longer the tempering time and temperature used will reduce the bitter taste in chocolate because it goes through the stirring and heating process which causes the tannin content to decrease. This similar resilts found by Annisa's statement (2016) [26] that the stirring and heating treatment in the chocolate-making process can reduce the bitter taste formed due to continuous mixing and stirring that will cause the oxidation process of tannins and the interaction of several ingredients, where sugar will caramelize and decomposition. Scent aroma was one of the organoleptic properties as well as determining the level of consumer acceptance contained in 10 food products [19].

The cause of the emergence of aroma from the conching process, can be caused by the addition of taste and aroma enhancing substances, such as cocoa powder with the addition of sugar which will further enhance the distinctive aroma of chocolate. The aroma of chocolate formed can be influenced by the roasting process of cocoa beans which is the raw material for making cocoa powder. During roasting, the flavor-forming compounds react with each other to produce volatile components and have a distinctive chocolate aroma [28].

4. CONCLUSION

Based on the results of this research it can be concluded that the length of tempering time in dark chocolate had a significant effect on antioxidant activity, L*, a* and b* color degrees, dark chocolate stability, organoleptic texture and overall acceptability. The tempering temperature in the manufacture of dark chocolate had a significant effect on the antioxidant activity of dark chocolate. The interaction of differences in tempering time and temperature significantly affected the organoleptic response of the color and taste of dark chocolate produced. The best treatment in making dark chocolate was the treatment with the lengt of tempering time of 45 minutes with a tempering temperature of 30ºC which contains antioxidant activity of 61.715%, had the color degree value of L* was 44.4, a* 7.4, b* 19.8 respectively, good melting properties (stability), no fat blooming for 60 days, the overall acceptance of the panelists fairly like (3.65).

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