The Effect Of Adding Hydrogenated Coconut Oil And The Time Of Adding Cocoa Powder On The Physical And Organoleptic Chocolate Bar

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Abstract. Chocolate bars are one of the processed cocoa products that are much loved by Indonesians. The main ingredient used to manufacture chocolate bars is cocoa butter. However, the relatively high price of cocoa butter causes chocolate bar production costs to be high. Hydrogenated coconut oil as an alternative to reduce the use of cocoa butter was investigated to reduce production costs. On the other hand, aroma can be reduced due to the conching process where during the conching process some volatile compounds evaporate. Therefore, it will be compared between the addition of cocoa powder at the beginning and at the end of the conching process which can give the sharpest aroma to the final chocolate bar product. The result showed that the addition of hydrogenated coconut oil at the level of 50% of the total use of cocoa butter gave the best physical properties of chocolate bar which resulted in a higher melting point with less fat blooming. The organoleptic results showed a significant difference between the controls, the time of adding cocoa powder at the beginning and at the end, where adding cocoa powder at the beginning gave a higher value for the parameters of taste and texture, but less value for the parameters of color and aroma.

1 Introduction

1.1 Background

Chocolate is a food that is much loved by Indonesian people of all ages. One of the most popular processed chocolate products in Indonesia is chocolate bars or also commonly known as chocolate bars [1]. Chocolate is very preferred because it has distinctive properties, namely being solid at room temperature (27-30oC) and has a melting point of 33-34oC. Thus, the chocolate will melt in the oral cavity which has a

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temperature of around 37oC [2]. The main raw material for making chocolate that gives these characteristics is cocoa butter. Cocoa butter is a vegetable fat derived from processing cocoa nibs which has a high melting point. The melting point of fat is determined by the density of triacylglycerol (TAG) which makes up the fat. Fatty acids have different melting properties according to the length of the carbon chain and the level of saturation [3]. Cocoa butter has the main components of fatty acids, namely 34% stearic acid, 34% oleic acid, 25% palmitic acid, and 2% linoleic acid [4]. The number and position of the three main fatty acids have an influence on the melting characteristics of cocoa butter [5] Even though cocoa butter is the main ingredient in chocolate making, the use of 100% cocoa butter has drawbacks, namely high production costs because the price of cocoa butter is relatively expensive [6]. Cocoa butter is not suitable for use in hot climates. Using 100% cocoa butter will tend to experience fat blooming even though it has gone through the tempering phase [7].

Several studies have been conducted to replace the role of cocoa fat in the manufacture of processed chocolate. The use of other vegetable fats in the manufacture of chocolate has been widely carried out with the aim of reducing chocolate production costs and improving the properties of the chocolate produced [6,8]. One of the most widely used vegetable oils is coconut oil. Coconut oil is one of the most widely produced coconut derivative products in Indonesia. Coconut oil is a vegetable oil consisting of 90-95% saturated fatty acids. Most of the fatty acids contained in coconut oil are lauric acid [9]. Cocoa butter and coconut oil have different melting points. This can be seen clearly from the shape at room temperature where the cocoa butter is solid while the coconut oil is liquid. This difference is based on differences in the fatty acids that make up the two [3]. Cocoa butter has a high content of palmitic acid while coconut oil has a high content of lauric acid [10]. Palmitic acid is a type of stearin which has a high density resulting in a high melting point. This is different from lauric acid which has shorter carbon chains so that the density is lower and the melting point is lower [3]. Thus, the manufacture of chocolate with coconut oil should be treated first to achieve the desired melting point, which is 33-34oC as well as the melting point of cocoa butter. One of the treatments that can be given to increase the melting point of coconut oil is hydrogenation. Hydrogenation is the addition of the element hydrogen to coconut oil which causes a change in the double bond thus allowing the change of state from liquid oil to solid thus, the addition of hydrogenated coconut oil has properties similar to cocoa butter, that is, it has a high melting point.

Apart from a high melting point, organoleptic quality is also equally important in chocolate products. Coconut oil can give a bad aroma to the final chocolate product, besides that, on the other hand, the conching process can also reduce the aroma of cocoa butter. Conching is the process of mixing ingredients while the dough is heated. The conching process should be a big concern in chocolate making. This is because during the conching process, the volatile acids and water content in the chocolate are reduced so that the quality of the chocolate will be good. In this process, the particle size is also reduced, resulting in a soft final product [11]. However, conching can also reduce the aroma of the resulting chocolate. Therefore, treatment needs to be carried out in the conching process so that the chocolate produced is as desired, namely having a high melting point and a good chocolate aroma. In this study, the addition of hydrogenated coconut oil and variations in the time of adding cocoa powder were given, namely at the beginning and at the end of the

conching process to see the effect on the organoleptic of the resulting chocolate. Based on the description above, it is important to conduct this research to find out how variations in the addition of hydrogenated coconut oil and the time of adding cocoa powder affect the physical and organoleptic properties of chocolate bars.

1.2 Problem Formulation

Cocoa butter as the main component in the manufacture of chocolate has an expensive price and limited availability. Whereas in the mass production of chocolate, producers of course want low production costs with the same quality. It is necessary to add other vegetable fats that are more affordable but have similar properties to cocoa butter, such as adding hydrogenated coconut oil. However, during processing, the quality of the chocolate will decrease as a result of the conching process being carried out, so it is treated with the addition of cocoa powder at the end of the conching process to obtain a good quality aroma of chocolate products.

1.3 Research objectives and benefit

The objectives of this research are:

1) To determine the effect of adding hydrogenated coconut oil on the physical properties of the resulting chocolate,
2) To determine the effect of adding cocoa powder during the *conching* process to the resulting chocolate,
3) To obtain the best formulation from chocolate with the addition of hydrogenated coconut oil and when the best time is the addition of powdered cocoa.

The benefits that can be obtained from the research are that it is hoped that the addition of hydrogenated coconut oil and the variation when adding cocoa powder can provide benefits to producers to reduce production costs while still obtaining the final quality of the chocolate product as desired.

2 Research methods

2.1 Time and place of research

This research was conducted in December - April 2023, taking place at SMK SMTI Makassar and the Food Microbiology Laboratory, Department of Agricultural Technology, Faculty of Agriculture, Hasanuddin University.

2.2 Tools and materials

The tools used in this research consisted of analytical scales, containers, 100 mesh sieve, mixer, ball mill, tempering equipment, chocolate printers, and refrigerators. The tool for analysis is the incubator.

The materials used in this research for processing include the main ingredients of cocoa butter originating from the Kolaka area, Southeast Sulawesi, Tulip brand cocoa powder,

Mamaco brand hydrogenated coconut oil, Gulus refined sugar, Anchor skimmed milk powder, Koepoe-Koepoe brand vanilla, soy lecithin, and other supporting materials (aluminum foil and labels).

2.3 Research design

The design of this study used a completely randomized design method and the data processing method of analysis of variance and Duncan's further testing. This research consists of 2 phases, namely:

a. Phase I : Addition of hydrogenated coconut oil

This phase aims to determine the physical properties of chocolate bars with variations in the addition of hydrogenated coconut oil with variations in 3 levels of addition of hydrogenated coconut oil, namely:

A1 : 100% Cocoa butter
A2 : 50% Cocoa butter : 50% Hydrogenated coconut oil
A3 : 100% Hydrogenated coconut oil

The formulation for making chocolate bars can be seen in Table 1.

Table 1. Formulation of Chocolate Bar

Ingredient	Variations in treatment (gram)		
	A_1	A_2	A_3
Main Ingredient			
Cocoa Butter* (30%)	600	300	-
Hydrogenated Coconut Oil* (30%)	-	300	600
Refined Sugar (37,5%)	750	750	750
Skim Milk Powder (22,1%)	442	442	442
Additives:			
Cacao Powder (10%)	200	200	200
Vanilla (0,1%)	2	2	2
Soy Lechitin (0,3%)	6	6	6
Total	2000	2000	2000

Description *) Treatment CB Cocoa butter, HCO Hydrogenated Coconut Oil

b. Phase II: Time of adding cocoa powder

Phase II of this study aims to examine the effect of adding cocoa powder on the taste of the final chocolate product. Phase II activities were carried out after the best chocolate stability was obtained from the physical analysis in phase I. The best formulation was then carried out by treatment B, namely variations in the time of adding cocoa powder. The treatment for adding cocoa powder uses 2 variations, namely adding cocoa powder at the beginning of the process and at the end (adding cocoa powder in the last 30 minutes of the conching process). The control in phase I is still used as a quality comparison in phase II, so the control here has a code (B1) while the treatment for phase II in this study is the best formulation from phase I with the addition of cocoa powder at the beginning (B2) and the best formulation from phase I with time to add cocoa powder at the end (B3). After that, sensory analysis was carried out for the final chocolate product so that the best formulation and treatment for making chocolate were obtained, namely chocolate with good stability and a sharp aroma.

2.4 Research procedur

2.4.1 Chocolate bar making procedur phase I [12]

For making chocolate bars, cocoa butter / solid fraction of coconut oil, cocoa powder, powdered sugar, powdered skim milk are used, the ingredients are mixed and stirred except for vegetable lecithin using a mixer for 15 minutes, then conching for 4 hours at a temperature of 50oC. Lecithin is introduced at 2 hours before the end of the conching process. After conching, the dough is subjected to the final tempering process. The tempering process is carried out at a temperature of 26-33oC. The process of making chocolate is adjusted to a predetermined treatment..

2.4.2 Chocolate bar making procedur phase II [12, 13]

2.4.2.1 Adding cocoa powder at the beginning of conching process

The manufacture of chocolate bars uses cocoa butter and hydrogenated coconut oil, cocoa powder, powdered sugar, skimmed milk powder, the ingredients are mixed and stirred with a mixer for 15 minutes, then conched for 6 hours at a temperature of 50ºC. Lecithin was added 2 hours before the conching process ended. After the conching process ends, the tempering process is carried out. The tempering process is carried out at a temperature of 26-38ºC.

2.4.2.1 Adding cocoa powder at the ending of conching process

The manufacture of chocolate bars uses cocoa butter and hydrogenated coconut oil, refined sugar, powdered skim milk, the ingredients are mixed and stirred with a mixer for 15 minutes, then conched for 6 hours at a temperature of 50ºC. Lecithin was added 2 hours before the conching process ended. Cocoa powder was added 30 minutes before the

conching process ended. After the conching process ends, the tempering process is carried out. The tempering process is carried out at a temperature of 26-38ºC.

2.4.3 Physical analysis

2.4.3.1 Stability

The chocolate bars are molded with the same size and weight. After that, the incubator was prepared at 37ºC. After the incubator temperature has stabilized, all samples are put into the incubator at the same time. The shape stability test of the chocolate product is carried out by looking at the changes in the shape of the chocolate when it is in the incubator.

2.4.3.2 Fat blooming

The fat blooming test is carried out to see if there are white spots that appear on the surface of the chocolate product. The fat blooming test is carried out by storing the chocolate product at room temperature, namely 30oC and putting it in the refrigerator simultaneously for 15 minutes to see white spots on the chocolate product. This was done 3 times.

2.4.4 Organoleptic test

The organoleptic test used is the hedonic scale test. Sensory tests were carried out using 15 semi-trained panelists. The parameters tested are color, aroma, taste and texture. The hedonic scale used is a numerical scale between 1-5 where: (1) don't like it very much, (2) don't like it, (3) neutral, (4) like it, (5) like it a lot. Panelists gave special assessments of color, aroma, taste and texture.

2.4.5 Data Analysis

The data obtained from the research results were processed using analysis of variance (ANOVA) with three repetitions. The software used for data processing is Microsoft Excel 2010 and IBM SPSS Statistics 16. If the results have a real effect then proceed with the Duncan Multiple Range Test (DMRT).

3 Results and discussion

3.1 Physical analysis

3.1.1 Stability

The melting properties of chocolate are one of the main characteristics of chocolate. Good chocolate is chocolate that does not melt at room temperature and melts in the mouth.

The quality of chocolate can also be seen from how long it takes to melt. The results of the study were obtained after three levels of chocolate with different treatments were placed in an incubator for 4 hours found that the three chocolates experienced a softening of the texture and the density of the chocolate decreased.

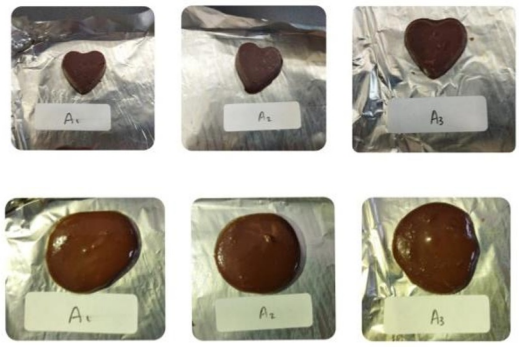

Fig 1. Stability Test Results

Observations were made on chocolate in an incubator for a total of 4 hours and the results showed that softening occurred in the chocolate bar product, the greatest softening occurred in the 100% cocoa butter treatment, then 50% cocoa butter: 50% hydrogenated coconut oil and finally in the 100% cocoa butter treatment. % hydrogenated coconut oil. This shows that chocolate bars treated with 100% cocoa butter have the most similar stability to those treated with 50% cocoa butter: 50% hydrogenated coconut oil. This shows that the use of hydrogenated coconut oil as a cocoa butter substitute can improve the stability of chocolate bar products, namely by increasing the melting point of chocolate bars. These results are in line with [14] who stated that cocoa butter has a relatively lower melting point than cocoa butter substitutes. Apart from that, the results of the observations made also show that the use of hydrogenated coconut oil to a certain extent can improve the melting point of chocolate products but is not intended to replace the presence of cocoa butter as the main ingredient in making chocolate.

The research results obtained from observing the stability of chocolate bars after 4 hours were that the more hydrogenated coconut oil added, the more stable the chocolate bar would be. This means that hydrogenated coconut oil can be used as a cocoa butter substitute in making chocolate bars and can improve the melting point of the final chocolate bar product. Cocoa butter substitute (CBS) has a melting point in the temperature range of 32-40oC, while commercial chocolate bar products have a melting point of around 37-40oC. This shows that the chocolate bars produced have a level of stability similar to commercial products on the market. However, observations in the 100% hydrogenated coconut oil treatment showed that there was oil separated from the chocolate bar, whereas this was not visible in observations of other treatment chocolate bars. This is in line with [6] who state that cocoa butter substitute can only replace part of the cocoa butter, not the whole. Supported by [15], who state that this is thought to be because cocoa butter has a role as a good dispersing agent for other ingredients, causing chocolate bars that use cocoa butter to not separate.

3.1.2 Fat Blooming

Fat blooming or the appearance of white spots on the surface of chocolate is an indication of a decline in the quality of chocolate where fat blooming causes the color of the chocolate to become dull, which causes the level of acceptance of chocolate to also decrease. According to [16], fat blooming usually occurs after a storage period of 10–14 days. Fat blooming does not mean the chocolate is damaged, but the occurrence of fat blooming is undesirable for chocolate producers. Therefore, testing was carried out on the chocolate fat blooming that occurred based on the composition of the chocolate that had been made. The fat blooming test is carried out by storing the chocolate product at room temperature, which is around 32oC and placing it in the refrigerator simultaneously for 15 minutes to see the white spots that appear on the chocolate product. This was done 3 times. The fat blooming test is carried out by storing chocolate bars at different storage temperatures to see whether the fat crystals formed during processing are as expected. The results of the fat blooming test with 3 observations can be seen in the table below.

Tabel 2. Moturation result fat blooming

Treatment	First Observation	Observation 1	Observation 2	Observation 3
A_1	No fat blooming	No fat blooming	No fat blooming	No fat blooming
A_2	No fat blooming	No fat blooming	A little fat blooming	A little fat blooming
A_3	No fat blooming	No fat blooming	A little fat blooming	A little fat blooming

Testing for fat blooming on chocolate products, after being stored for several days, white spots began to appear on the surface of the product treated with 50% cocoa butter: 50% hydrogenated coconut oil and 100% hydrogenated coconut oil treatment. The fat blooming that occurred in both treatments was thought to be due to the mixing of fat and incompatible additives. The use of cocoa butter substitutes in chocolate can cause the fat crystals formed between cocoa butter and cocoa butter substitutes to be less stable so that after storage for some time, fat blooming can occur in chocolate products. This is due to the difference in the fatty acids that make up cocoa butter and hydrogenated coconut oil which causes changes in the composition of the fatty acids in chocolate. Cocoa butter has a unique fatty acid composition where there are saturated – unsaturated – saturated fatty acid bonds which can form β fat crystals which have a small and stable structure during the tempering process. That changes in triacylglycerides (TAG) in chocolate bars result in empty spaces between fat crystals making chocolate products become grainy and greyish in color.

As for fat blooming in the treatment of 50% cocoa butter: 50% hydrogenated coconut oil, it is less than in the treatment of 100% hydrogenated coconut oil, this is thought to be due to the use of cocoa butter substitutes in the treatment of 50% cocoa butter: 50% hydrogenated coconut oil, which only partially replaces the presence of fat. cocoa as the main ingredient is not the whole. It is suspected that the formation of fat crystals is better and more stable than without the use of cocoa butter as the main ingredient. This is in

accordance with [17] that the melting of chocolate is influenced by the fatty acid components that make up it. Fat crystals themselves are formed during the tempering process in processing chocolate bars. The tempering process is a series of processes consisting of heating, cooling and stirring at low speed in making chocolate. The tempering process aims to improve the final quality of the chocolate product. When the tempering process takes place, the heating carried out will melt all the fat crystals inside, then followed by a cooling process which is expected to form β crystals which have a high and stable melting point. After that, it is reheated to melt the other crystals so that the final chocolate bar product contains uniform fat crystals. This is in accordance with the statement of [4], which states that fat crystals will be converted into β form which has a high melting point and is stable.

3.2 Organoleptic test

Organoleptic test is an assessment of a food product using the human senses based on the panelist's level of preference based on parameters of color, aroma, taste and texture. In principle, the preference test is a test for panelists to express their responses in the form of likes or dislikes towards the properties or formulations of the several material treatments presented [18]. The organoleptic test used in this test is the hedonic test which uses semi-trained panelists of 15 people. The chocolate bars served to the panelists were cut into small pieces. Panelists provide ratings in the form of numbers on the level of preference. The hedonic scale used in this study is a scale of 5: (1) really dislike, (2) don't like, (3) rather like, (4) like, (5) really like. Panelists gave a special assessment of the color, aroma, taste and elasticity of the chocolate bar product.

3.2.1 Color

Organoleptic color testing is one of the important tests to carry out because color is a parameter that can be seen with the eye and a good product color appearance can make consumers interested in trying the product [18]. The results of color organoleptic testing can be seen in the image below.

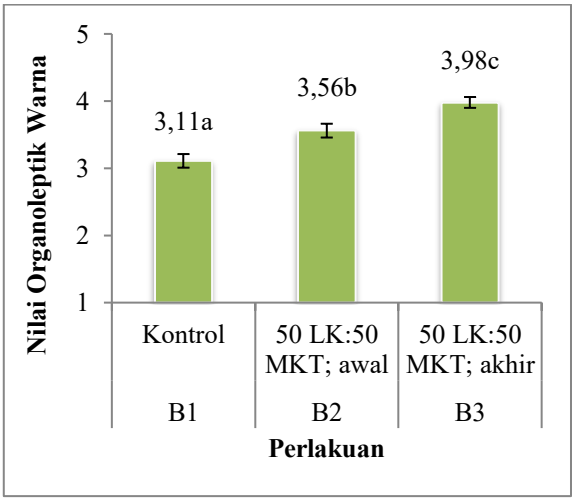

Fig 2. Color Organoleptic Test Results

The color organoleptic test results ranged from 3.11 to 3.98, which means that the panelists' assessment was somewhat like to like for the three samples tested. Figure 8 shows that the final result of the chocolate bar in the control has a value of 3.11 which means quite like it, the treatment of 50% cocoa butter: 50% hydrogenated coconut oil and the time of adding cocoa powder at the beginning has a value of 3.56 meaning it likes it and the treatment of 50% cocoa butter : 50% hydrogenated coconut oil and adding cocoa powder at the end has a value of 3.98 which also means you like it. These results were then analyzed using the 5% level ANOVA method and there was a real effect on the treatment given. After that, the results were then continued with Duncan's further test and the results were that each treatment carried out provided significant differences from each other. The final result of the control product is significantly different from the treatment of 50% cocoa butter : 50% hydrogenated coconut oil and the time of adding cocoa powder at the beginning of the conching process and also significantly different from the treatment of 50% cocoa butter : 50% hydrogenated coconut oil and the time of adding cocoa powder at the end of the conching process .

The real difference between the control and the 50% cocoa butter: 50% hydrogenated coconut oil treatment and the addition of cocoa powder at the beginning of the conching process is thought to be due to differences in the constituent fatty acids between cocoa butter and cocoa powder, which creates a different appearance in the final product. Mixing different fats in making chocolate can affect the color of the chocolate [6]. The use of hydrogenated coconut oil as a cocoa butter substitute makes the final chocolate bar product shinier compared to the control which only uses cocoa butter. According to [9] that the lauric acid in coconut oil can combine stably with cocoa butter and produce a shiny

appearance. As for the results of the research carried out, the panelists assessed that the use of 50% hydrogenated coconut oil had better final results as seen from the value of products with the use of hydrogenated coconut oil which were higher than those without the use of hydrogenated coconut oil. This is also found in [6] where the use of coconut oil in a ratio of 50:50 is the result of the brown appearance most preferred by the panelists.

There are also real differences in the treatment of 50% cocoa butter: 50% hydrogenated coconut oil and the time of adding cocoa powder at the end of the conching process where this treatment has the highest value compared to other treatments. Based on the value of the level of liking, both treatments are at the level of liking but statistically it turns out that the values are significantly different. The difference between the treatment of 50% cocoa butter: 50% hydrogenated coconut oil and the time for adding cocoa powder at the beginning of the conching process and the treatment of 50% cocoa butter: 50% hydrogenated coconut oil and the time for adding cocoa powder at the end of the conching process is the final result is a chocolate product with a darker color. . This is because the conching process can affect the color of the final chocolate product. The addition of cocoa powder at the end of the conching process means that the conching process is shorter, namely only around 30 minutes and causes the dark brown color of the cocoa powder to still be very attached to the final product. This is in accordance with [19] that the chocolate conching process affects the color of the final product, where the longer the conching process, the brighter the color of the product produced.

3.2.2 Aroma

Aroma organoleptic testing is a test carried out to see the subjective sensations obtained by the panelists from the sense of smell [20]. Organoleptic aroma testing in this research is one of the objectives which is expected to have good results in the treatment carried out. The results of the aroma organoleptic test can be seen in the image below.

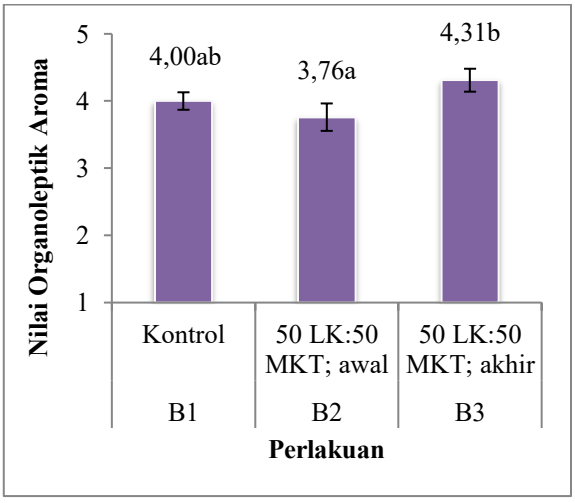

Fig 3. Aroma organoleptic test results

The aroma organoleptic test results ranged from 3.76 to 4.31, which means that the panelists gave a favorable score to the three samples tested. Figure 9 shows that the final

result of the control chocolate bar has a value of 4.00 which means like it, the 50% cocoa fat treatment: 50% hydrogenated coconut oil and the time of adding cocoa powder at the beginning of the conching process has a value of 3.76 which means like it and the 50% fat treatment. cocoa: 50% hydrogenated coconut oil and the time to add cocoa powder at the end of the conching process has a value of 4.31 which means like it. Even though the three treatments were all at the liking level, after being analyzed using the ANOVA method at the 5% level, there was a real influence on the treatments given. After that, the results were then continued with Duncan's further test and the results were that each treatment carried out provided significant differences from each other. The final results of the control product were not significantly different from the treatment of 50% cocoa butter : 50% hydrogenated coconut oil and the time of adding cocoa powder at the beginning of the conching process and were also not significantly different from the treatment of 50% cocoa butter : 50% hydrogenated coconut oil and the time of adding cocoa powder at the end conching process. The real difference was in the treatment of 50% cocoa butter: 50% hydrogenated coconut oil and the time to add cocoa powder at the beginning of the conching process and 50% cocoa butter: 50% hydrogenated coconut oil and the time to add cocoa powder at the beginning of the conching process.

The assessment between control and treatment using 50% hydrogenated coconut oil and adding cocoa powder at the beginning of the conching process was reduced, which is thought to be due to the use of hydrogenated coconut oil as a cocoa butter substitute. This reduction in value occurs due to the reduced use of cocoa butter which gives the final product a distinctive chocolate aroma. This is in line with [21] that cocoa butter has a cocoa flavor. There was no significant difference in the control treatment and the treatment of 50% cocoa butter : 50% hydrogenated coconut oil and the time of adding cocoa powder at the beginning of the conching process and the treatment of 50% cocoa butter : 50% hydrogenated coconut oil and the time of adding cocoa powder at the end of the conching process. Both the addition of hydrogenated coconut oil and the variation in time for adding cocoa powder were the same as without any treatment. This is in line with research conducted by [6] that the addition of hydrogenated coconut oil in a ratio of 50:50 had no real effect on aroma parameters.

There is a real difference in the treatment of 50% cocoa butter: 50% hydrogenated coconut oil and the time of adding cocoa powder at the beginning of the conching process compared to the treatment of 50% cocoa butter: 50% hydrogenated coconut oil and the time of adding cocoa powder at the end of the conching process. This real difference is thought to be due to imperfect mixing during the conching process when the cocoa powder was added at the end of the conching process. The conching process, which includes heating and stirring, makes the volatile compounds found in cocoa powder and other additives reduce the sour taste of the ingredients, but it also reduces the aroma of the chocolate. According to [22], there is a release of moisture and volatile compounds during the conching process. The ingredient that gives aroma to chocolate bars is cocoa powder. This is in accordance with [23], that cocoa powder is an additional ingredient that functions to provide a strong aroma to chocolate products. The addition of cocoa powder at the end of the conching process, which is shorter than the control treatment and the time for adding cocoa powder at the beginning of the conching process, is thought to mean that there are still many volatile compounds remaining in the final product which makes the final result

obtained is a chocolate bar with a strong aroma. This is also found in [22], who state that when the conching process lasts for around 420 minutes, the ingredients are mixed and the release of volatile compounds occurs.

3.2.3 Taste

Organoleptic taste testing is a test that uses the five senses in its assessment, like taste, smell, touch, sight and hearing [24]. The results of the organoleptic taste test can be seen in the image below.

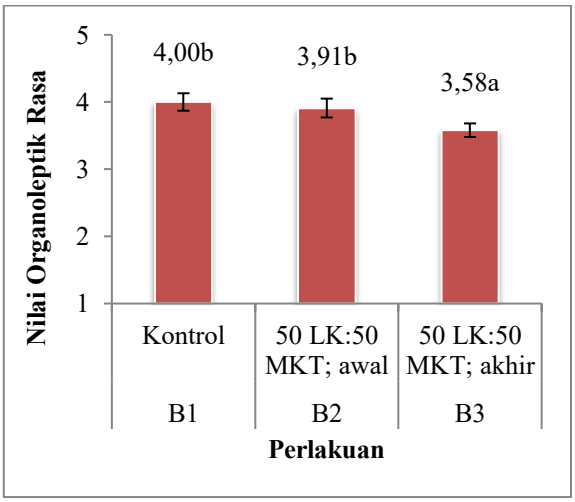

Fig 4. Taste organoleptic test results

The organoleptic taste test results ranged from 3.58 to 4.00, which means the panelists liked the three samples tested. Figure 10 shows that the final result of the chocolate bar in the control has a value of 4.00 which means like it, the 50% cocoa fat treatment: 50% hydrogenated coconut oil and the time of adding cocoa powder at the beginning of the conching process has a value of 3.91 which means like it and the 50% fat treatment cocoa: 50% hydrogenated coconut oil and the time to add cocoa powder at the end of the conching process has a value of 3.58 which means like it. The three treatments were at the liking level, but after being analyzed using the 5% level ANOVA method, there was a real influence on the treatment given. After that, these results were then continued with Duncan's further test and the results showed that the control was not significantly different from the treatment of 50% cocoa butter : 50% hydrogenated coconut oil but there was a real difference between the control and the treatment of 50% cocoa butter : 50% hydrogenated coconut oil and the time to add cocoa powder at the beginning of the conching process with treatment of 50% cocoa butter: 50% hydrogenated coconut oil and the time to add cocoa powder at the end of the conching process.

The results obtained showed that there was no real difference between the control and the treatment of 50% cocoa butter: 50% hydrogenated coconut oil and the addition of cocoa powder at the beginning of the conching process, meaning that the use of 50% hydrogenated coconut oil as a cocoa butter substitute was still acceptable to the panelists in terms of taste of the final product. This is in accordance with [6] who conducted research

on the addition of cocoa butter substitute to coconut oil and found that there was no significant difference in results at the 50:50 level. The results were significantly different in the treatment of 50% cocoa butter: 50% hydrogenated coconut oil and the addition of cocoa powder at the end of the conching process, allegedly because cocoa powder has a bitter taste. Research conducted by [23] shows that the same cocoa powder used in this study has a bitter taste and leaves a bitter impression afterwards. In line with this, [25] stated that cocoa powder processed without fermentation has the highest level of bitter taste. The addition of cocoa powder at the end of the conching process causes the process to not be optimal so that the cocoa powder is not completely mixed with the other ingredients, resulting in a predominantly bitter taste of cocoa powder, which the panelists don't like. The conching process can provide better taste quality due to the reduction of powder material particles by heating [26].

3.2.4 Texture

Organoleptic texture testing aims to see the level of panelists' acceptance of the final product texture where the assessment of this parameter is a response to physical stimulation of food when it is in the oral cavity [27]. The results of the texture organoleptic test can be seen in the image below.

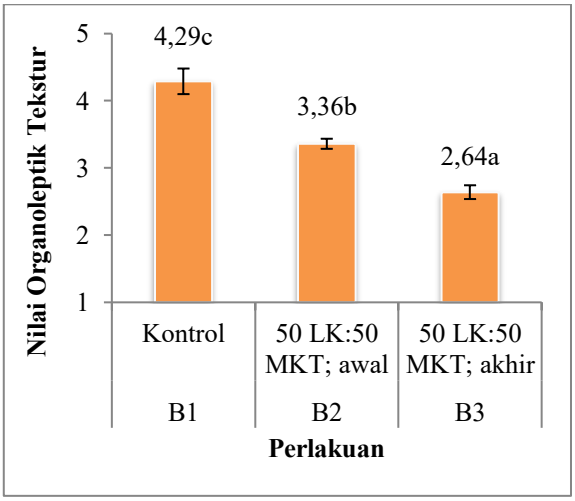

Fig 5. Texture organoleptic test results

The results of the organoleptic texture test ranged from 2.64 to 4.29, which means that the panelists' assessment was somewhat like to like for the three samples tested. Figure 11 shows that the final result of the chocolate bar in the control has a value of 4.29 which means like it, the 50% cocoa butter treatment: 50% hydrogenated coconut oil and the time of adding cocoa powder at the beginning has a value of 3.36 which means it likes it somewhat and the 50% cocoa butter treatment : 50% hydrogenated coconut oil and adding cocoa powder at the end has a value of 2.64, which means I like it a little. These results were then analyzed using the 5% level ANOVA method and there was a real effect on the treatment given. After that, the results were then continued with Duncan's further test and the results were that each treatment carried out provided significant differences from each

other. The final result of the control product is significantly different from the treatment of 50% cocoa butter : 50% hydrogenated coconut oil and the time of adding cocoa powder at the beginning of the conching process and also significantly different from the treatment of 50% cocoa butter : 50% hydrogenated coconut oil and the time of adding cocoa powder at the end of the conching process .

The significant difference in texture between the control and the 50% cocoa butter: 50% hydrogenated coconut oil treatment and the addition of cocoa powder at the beginning of the conching process is thought to be because hydrogenated coconut oil gives the final chocolate bar a harder texture than chocolate bars that use cocoa butter. This is thought to be due to differences in the fatty acids that make up the two main ingredients. Hydrogenated coconut oil has high melting properties so that when added to chocolate products the resulting chocolate product also has high melting properties and thus the texture is denser than without the addition of hydrogenated coconut oil [14]. There is a significant difference in the treatment of 50% cocoa butter: 50% hydrogenated coconut oil and the time for adding cocoa powder at the beginning of the conching process and the treatment of 50% cocoa butter: 50% hydrogenated coconut oil and the time for adding cocoa powder at the end of the conching process, which is thought to be due to the shorter conching process. causes the mixing of cocoa powder with other ingredients to be imperfect. The conching process is one of the main processing processes in making chocolate, where the conching process is carried out by stirring and heating so that powdered ingredients such as sugar and cocoa powder are converted into smaller particles and coated with fat so that the resulting chocolate product is softer [27]. Based on this, it can be seen that the cause of the reduced texture value during the treatment when adding cocoa powder at the end of the conching process was because the cocoa powder was not broken down into smaller particles properly so that the resulting texture was a final product with a sandy texture which was not liked by the panelists. This is also in line with [19], who stated that the conching process greatly influences the final quality of chocolate, especially sensory factors such as texture, melting properties, color and taste.

4 CONCLUSIONS

The conclusions from the results of this study are as follows:

1. Hydrogenated coconut oil as cocoa butter substitutes has an influence on the manufacture of chocolate bars and the results of physical analysis at a 50% variation level with the addition of hydrogenated coconut oil.
2. Variations in the timing of adding cocoa powder have a significant effect on the organoleptic quality assessment of chocolate bars with the parameters of color, aroma, taste and texture.
3. The best formulation for adding hydrogenated coconut oil is a level of 50% of the total use of cocoa butter with the results of physical analysis namely the melting point is the most similar to the control and the fat blooming is the least and variations in the time of adding cocoa powder at the end of the conching process can improve the aroma quality of the final chocolate bar product but not in its entirety.

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