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Sensory Attributes and Preliminary Characterization of Milk Chocolate Bar Enriched with Cinnamon Essential Oil

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Abstract. Cocoa (*Theobroma cacao*) is one of Indonesia's main commodities with annually increasing production. Chocolates are semi-solid suspensions of fine solid particles in a continuous fat phase. Primary chocolate categories are dark, milk, and white that differs in content of cocoa solid, milk fat, and cocoa butter. Milk chocolate bar is one of the most popular processed cocoa products in Indonesia. Widely cultivated in Indonesia, cinnamon is potential to be developed and is expected to add flavor and taste as well as enhance functional properties of milk chocolate, since it is well-known of its high antioxidant properties. The aim of this study was to determine the effect of cinnamon essential oil addition on the sensory attributes and physicochemical properties of milk chocolate bar. Three formulas of milk chocolate bar with an addition of cinnamon essential oil (0.1%, 0.3%, and 0.5%) were evaluated in this study. Panelists acceptance level decreased with increasing concentrations of cinnamon essential oil added, while moisture content and color analysis results did not show any significantly different for each formula, suggesting that milk chocolate bar with the addition of 0.1% of cinnamon essential oil had the highest level of acceptance and preferences for some of properties evaluated.

1. Introduction

As the third largest producer of cocoa (*Theobroma cacao* L.) in the world, the production of Indonesian cocoa continuously increases which were 740.513 tonnes, 777.539 tonnes, 817.322 tonnes in 2012, 2013, and 2014, respectively, based on the data of Directorate General of Estate Crops on 2014. Cocoa beans production increased annually, in 2012 recorded 53.300 ton cocoa beans was produced, in 2013 55.500 ton and in 2014 57.800 ton [1], suggesting that Indonesia has a great opportunity to be the centre of cocoa agroindustry in the world.

Milk chocolate is one of confectionary products that consist of cocoa mass, cocoa butter, sugar, and milk powder with or without the addition of other food ingredients and food additives such as lecithin [2]. Although the market of milk chocolate has been well established, some studies are still required to improve the quality and functionality of the chocolate. In the last decade, studies about processing and manufacturing chocolate products are linked to the biological active compound contained in cocoa, such as source of antioxidants, vitamins, minerals, and to the prevention of diseases [4]. In order to improve potential health benefit of chocolate, some studies have been conducted to enrich the chocolate by using functional material derived from other plant substrate. For an instance, the addition of dried fruits, including prunes, papaya, apricots, raisins, and cranberries have been reported to be able to improve sensory characteristics and bioactive compounds in dark and milk chocolates [5].

Widely cultivated in Indonesia, *Cinnamomum burmannii*, one of cinnamon species, has an excessive potency as an antioxidant and flavoring agent. They can be further processed by changing the crust into a powder, or by performing an extraction process to obtain cinnamon extract or cinnamon essential oil. Indonesia is one of the largest cinnamon producers in the world, in which approximately 89.500 tonnes per year [1]. The term of essential oils is understood to mean blends of secondary metabolites obtained from plant volatile fraction by distillation. Essential oil is widely used as a flavor agent because of its volatile compound [6]. Cinnamon essential oil is potential to improve flavor characteristic and to enhance functional properties of milk chocolate, due of its high antioxidant activity. The addition of cinnamon essential oil (5%) has been reported to increase antioxidant activity on salted egg [7]. Thus, this study aimed at determining the effect of cinnamon essential oil addition on the sensory attributes and physicochemical properties of milk chocolate bar.

2. Experimental

Cocoa liquor and cocoa butter derived from Forastero beans were used in this study. The beans were harvested from Kaliwining Jember (fermented for 2x48 hours). Full cream milk powder (Indomilk), sugar, lecithin were provided by the Indonesia Coffee and Cocoa Research Institute (ICCRI), Jember, Indonesia. Cinnamon essential oil (*Cinnamomum burmannii*) was obtained from CV. Anugrah Alam Abadi, West Sumatra.

The chocolate was produced by mixing of 496.5 g/500 g (consisting of 125 g/500 g of cocoa liquor, 137.5 g/500 g of cocoa butter, 112.5 g/500 g of milk powder and 121.5 g/500 g of sugar), and the additional ingredients of 3.5 g/500 g (consisting of 1.5 g/ 500 g lecithin, 1.5 g/500 g of soda, and 0.5 g/ 500 g of vanilla). Cinnamon essential oil at the concentration of 0.1%, 0.3% and 0.5% were chosen according to some previous experiment trials.

Cocoa liquor, cocoa fat, milk powder, sugar, soda, vanilla, were mixed first in a mixer, then 0.3% lecithin was added. The mixture was then refined in ball miller refiner to gain particle size up to 40-50 μm (50°C, 80 rpm, 20 hours). Conching was done to improve and enhance the flavor and viscosity of the end of the milk chocolate paste. Conching process was done using conche rotations at 60°C for 16 hours. The second refining step was conducted to mix 500 grams of milk chocolate with cinnamon essential oil in which F1 with 0.1% addition of cinnamon essential oil, F2 with 0.3% addition of cinnamon essential oil, and F3 with 0.5% addition of cinnamon essential oil. This step was conducted in 10 minutes by using ball miller with a rotary speed of 80 rpm at 50°C. Tempering process was done by melt down milk chocolate bar with a temperature less than 45°C. 2/3 part of the melted milk chocolate then stirred and sliding on marble table for 10-15 minutes until the temperature stabilized at 25°C. When the stable temperature was reached, 2/3 part of tempering results poured back into the bowl containing 1/3 part of untempered milk chocolate, then stirred for a few minutes until the temperature stable at ± 30°C, and then followed by moulding into chocolate plastic moulds. After 20 minutes, the moulded chocolates were de-moulding and were wrapped in the aluminium foil and stored at refrigerator temperature until used for further analysis.

Cinnamon milk chocolates were then evaluated using Hedonic methods [8]. The experimental chocolates were subjected to sensory evaluation by a group of panelists, comprising 30 random panelist members varying in age between 18-22 years. Five attributes (color, aroma, taste, appearance, overall acceptabillity) were evaluated. Three samples of chocolate with different codes were presented in a single serving plate with crackers and mineral water for rinsing between samples. Panelists were asked for not comparing the samples with other samples. The sensory properties were presented on a five point scoring scale 1) Dislike, 2) Dislike moderately, 3) Neither like nor dislike, 4) Like moderately, 5) Like very much).

Color measurement of milk chocolate bar was conducted using Konica Minolta Sensing Chromameter inc. Results obtained expressed in L^* (lightness, $L^* = 0$, black; $L^* = 100$, white), a^* ($a^* = 0$-100, red; $a^* = 0$ - (- 80), green), b^* ($b^* = 0$-70, yellow; $b^* = 0$ - (- 70), blue) [9]. While the value of °Hue represented the dominant wavelength that will determine whether the colors of red, green, or yellow

[10]. °Hue value calculated based on the value of a* and b* obtained by the formula: °Hue = $\tan^{-1}$ (b^*/a^*) [4].

Moisture content of chocolate was determined using Moisture Meter CA-200 Mitsubishi Chemical Analytech by Karl Fischer titration method. In the automatic system a pre-weighed amount of chocolate is dispersed in a mixture of formamide, chloroform, and methanol in the reaction vessel. This vessel is then sealed to prevent further moisture coming in from the surrounding air. The mixture was then continuously monitored by two platinum electrodes that are placed in it. If any free iodine is present, this will depolarise the cathode and so the current will stop flowing. The potential difference across the electrodes is therefore used to control the titration. Initially the Karl Fischer reagent (which includes pyridine) is added slowly via a peristaltic pump, which is able to record accurately the amount that passes through it. When the reaction is complete and no moisture remains, the current will stop flowing. The instrument can then calculate the percentage of water present, based on the sample weight and the amount of reagent used [11].

Completely Randomized Design (CRD) with one factor was used in this study. Data from the analysis were statistically analyzed using One-Way ANOVA. If there was a difference, Duncan's Multiple Range Test (DMRT) with a significance level of $\alpha = 5\%$ was conducted. From the sensory test results, the best formula will be obtained.

3. Results and Discussion

3.1. Sensory attributes

Sensory analysis is a process of identification, scientific measurement, analysis and interpretation of product attributes through the five human senses. Sensory analysis also involves a measurement that can be quantitative or qualitative. The sensorial quality of food products play an important role in the choice of food. Preference test or hedonic test aims to identify the level of preference and acceptance of a product [12]. The preference test result with a scoring method on milk chocolate bar with the addition of cinnamon essential oil shown in Table 1

Table 1. Level of panelists acceptance of milk chocolate with cinnamon essential oil addition

The addition of cinnamon essential oil	Attributes				
	Color	Aroma	Taste	Appearance	Overall
0.1% (F1)	4.63^{a} ±0.56	4.13^{b}±0.90	4.43^{c}±0.77	4.60^{b}±0.56	4.57^{c}±0.57
0.3% (F2)	4.43^{a} ±0.82	3.77^{ab}±1.00	3.87^{b}±1.00	4.23^{b}±0.93	4.00^{b}±1.02
0.5% (F3)	4.27^{a} ±0.78	3.50^{a}±0.97	3.03^{a}±1.33	3.77^{a}±1.07	3.20^{a}±0.92

[a]Within a row, means with the same superscript letters are not significantly different from one another ($\alpha > 0.05$)
ANOVA, analysis of variance (One-way)

3.1.1. Color attributes

Determining quality of food in general depends on several factors, including taste, color, texture and nutritional value [10]. Change in color on chocolate is due to reactions based on a class of chemicals found in cocoa called tannins (polyhydroxyphenols). These are made up of epicatechin molecules, which during the different fermenting, drying, and roasting stages may join together, oxidise or react with other chemicals within the cocoa. This increases the number of color-giving molecules and makes the cocoa much darker [11]. In general, milk chocolate bar has a lighter color than dark chocolate bar due to the presence of milk. Table 1 showed that that F1, F2, and F3 have the same letter notation. This means that the variation of the addition of cinnamon essential oil into milk chocolate was not significantly different to the colour of the three samples. Cinnamon essential oil has a light yellow color [13]. Milk chocolate bar with the addition of cinnamon essential oils up to 0.5% did not significantly affect the panelists' acceptance in the parameter of color.

3.1.2. Aroma attributes

The results showed that milk chocolate with 0.1% cinnamon essential oil is the most preferred product. Aroma of chocolate can be affected by several factors. Free amino acid is one of the essential components of the chocolate aroma precursors [11]. The characteristic smell of chocolate can also be produced by the reaction of amino acids such as leucine, threonine and glutamine with glucose, when heated until 100°C. Higher temperatures will produce a much more penetrating/pungent smell. Best chocolate aroma is usually produced from the seeds of high levels of free amino acids [14]. In addition, roasting cocoa beans also affects the aroma of chocolate. High temperature caused unpleasant aroma. The main components of cinnamon essential oil are cinnamaldehyde, eugenol, acetogenin and other aldehydes in small quantities. Cinnamon essential oil also contains methyl-n-amyl ketone [15]. The cinnamaldehyde has a spicy perception. Therefore, it can be expected that enriching 0.3% and 0.5% of cinnamon essential oils resulted in too much spicy taste, and then decreased consumer acceptance to the product.

3.1.3. Taste attributes

In chocolate, fermenting and roasting the cocoa beans has a significant impact on the formation of the chocolate flavor. Over fermented cocoa beans will cause a sour taste in chocolate. Similarly, if the roasting process is carried out at temperatures that are too high and too long will caused the chocolate has a bitter taste. Adding flavor agent is an alternative way to improve the taste attribute of chocolate. Due to its potency as flavor agent, cinnamon essential oils may be able to improve the taste of chocolate. Based on Table 1, three samples of milk chocolate with the addition of 0.1%, 0.3% and 0.5% of cinnamon essential oil have a different notation. Essential oil has a bitter taste, sometimes sharp, biting, gives the impression of warmth depending on the type of their components [16]. Therefore, panelists' acceptance will decrease with increasing concentration of cinnamon essential oil. The most preferred formula by panelists was milk chocolate with 0.1% addition of cinnamon essential oil.

3.1.4. Appearance attributes

Tempering is important for glossiness, a key quality attribute in chocolate. In under-tempered chocolates light scattering is caused by reductions in surface regularity. Over-tempering causes significant increase in product hardness, stickiness with reduced gloss and darkening of product surfaces. Under-tempering induced fat bloom in products with consequential quality defects on texture, color and surface gloss [17]. The results of sensory analysis showed a 0.1% addition of cinnamon essential oil was not significantly different with the addition of 0.3% cinnamon essential oil, while the addition of 0.5% cinnamon essential oil significantly different than the other formulas.

3.1.5. Overall attributes.

Consumers' assessment of a food product is not only influenced by one factor, but also a combination of several factors considered in their entirety. In this case, panelists rate the overall of milk chocolate bar in terms of color, aroma, taste, and appearance. Table 1 showed that the overall level of acceptance in the milk chocolate bar between samples with the addition of 0.1% of cinnamon essential oil, 0.3% of cinnamon essential oil and 0.5% of cinnamon essential oil were significantly different. Milk chocolate bar with 0.1% addition of cinnamon essential oil is the most preferred by panelists. Therefore, it can be concluded that in overall attributes, milk chocolate bar with the addition 0.1% cinnamon essential oil has the highest level of acceptance from panelists. The aroma and taste parameter are the main factor of the cinnamon enriched-chocolate acceptability.

3.2. Color measurement

According to Table 2, milk chocolate bar with addition 0.1% and 0.3% of cinnamon essential oil were in range of red color. While the milk chocolate bar with the addition of 0.5% cinnamon essential oil was in range of red-yellow color.The color of chocolate bar is in range of red and red-yellow color [4]. It was shown that the color of milk chocolate bar was getting brighter with increasing concentration

of cinnamon essential oil. The color of cinnamon essential oil is light yellow [13]. It is explaining that with the addition of essential oil of cinnamon will cause the color of milk chocolate bar into red-yellow range.

Table 2. Color attribute of cinnamon essential oil-enriched milk chocolate bar

The addition of cinnamon essential oil	L	a^*	b^*	°Hue
0.1 % (F1)	35.10^{a}±0.14	9.68^{b}±0.11	11.45^{a}±0.14	49.78^{a}±0.02
0.3% (F2)	37.17^{c}±0.19	10.25^{b}±0.41	13.53^{c}±0.23	52.86^{b}±0.64
0.5% (F2)	36.15^{b}±0.12	7.36^{a}±0.03	12.22^{b}±0.00	58.92^{c}±0.12

To determine the color of milk chocolate bar range based °Hue value can be determined by Table 3

Table 3. Value of °Hue and color range[a]

°Hue	Color range
18°-54°	Red
54° -90°	Red-Yellow
90° -126°	Yellow
126° -162°	Yellow-Green
162° -198°	Green
198° -234°	Green-Blue
234° -270°	Blue
270° -306°	Blue-Magenta
306° -342°	Magenta
342° -18°	Magenta-Red

[a]Source: Etikawati [18]

3.3.Moisture Content

Table 4. Moisture content analysis on milk chocolate bar with addition cinnamon essential oils

The addition of cinnamon essential oil	Moisture content (%wb)
0.1 % (F1)	2.32^{a}±0.07
0.3% (F2)	2.33^{a}±0.35
0.5% (F3)	2.37^{a}±0.00

Water is an important component in food ingredients, since water can affect the appearance, texture and flavor of food. Water content can determine acceptability, freshness, and shelf life of a food stuff [10]. Based on Table 4, moisture content of milk chocolate was not significantly different. Chocolate generally has low moisture content. When moisture content of chocolate more than 2% caused the chocolate has lower shelf life, and the quality of the chocolate texture will also decrease. In addition, the high moisture content in chocolate will induce fat bloom development [11].

4. Conclusion

This study evaluated the consumer acceptance of milk chocolate with cinnamon essential oil addition. In terms of sensory attributes, milk chocolate bar with the addition of 0.1% of cinnamon essential oil has the highest level of panelists' acceptance. Panelists acceptance level decreased with increasing concentrations of cinnamon essential oil added, while moisture content and color analysis results did not show any significantly different for each formula. The results provided additional information in

developing Indonesian chocolate signature products, particularly in development of milk chocolate with an addition of cinnamon essential oil.

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