Appearance, texture and flavour improvement of chocolate bar by Virgin Cococnut Oil (VCO) as Cocoa Butter Substitute (CBS)

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Abstract. The purposes of using CBS in this research is to improve the physical properties and quality of appereance and structure stability of chocolate bar. Based on chemical composition, CBS and Cocoa butter have different profile, but they have similar physical properties due to high lauric acid content. The advantage of lauric acid is to affect shinny appreance of chocolate surface, and also soapy taste that closely related to rancidity reduction. Virgin Coconut Oil (VCO) is one of lauric fat that easily found in Aceh. In this research, chocolate bar is formulated comprising various concentration of CBS (0,1,2,3,4,5%) with respect to cocoa butter, and cocoa mass composition (200 g and 300 g). It was found that melting point was affected by CBS concentration. The higher CBS concentration, the lower melting point of chocolate bar. An increase in VCO concentration reduced significantly the melting point of chocolate bar. Melting point was comparable to other chocolate bar commercial (29-32^oC). The unblooming, snap, best texture and better taste was observed for the chocolate bar containing 4-5% of VCO concentration and 27,5% of cocoa mass.

Keywords: Cocoa Butter Substitute (CBS), Virgin Coconut Oil (VCO), Chocolate

Introduction

Cocoa butter (CB) is a highly valued ingredient primarily used in the confectionery industry. Due to its its physical and chemical characteristics, the crystal lattice of CB confers desired physical properties to the manufactured product, e.g. gloss, snap, appereance, flavor release, and melting properties, etc. (Lipp et al., 2001; Miguel, 2012; Sol_ıs-Fuentes, 2004). Cocoa butter (CB) is highly appreciated because of its unique composition resulting in specific properties of the chocolate product

Among tropical fats, cocoa butter is one of the most valuable; however, its production is hampered by its difficult cultivation, low productivity and pest attacks. The demand of cocoa butter in emerging countries, and changes in chocolate consumption towards higher cocoa content chocolate products cause world cocoa prices have been increasing in recent years (Afoakwa, 2010). Because of that reason some alternative cocoa butters have been researched (Lipp and Anklam, 1998).

Cocoa butter alternatives can be classified into three groups: (1) cocoa butter substitutes (CBS), fats based on lauric fraction such as palm kernel oil or coconut oil, (2) cocoa butter replacers (CBR), non-polymorphic non-lauric fats based on partially hydrogenated oils, and (3) cocoa butter equivalents (CBE), polymorphic non-lauric fats that are defined as fat or fat blends with a similar melting profile, composition and polymorphism as CB, which should be compatible with CB without presenting any eutectic behaviour (McGinley, 1991).

One of lauric fats that available in the huge amount and easy to find in Aceh (Indonesia) is Virgin coconut oil (VCO) (Indarti and Arpi, 2007). Eventhough the profile of VCO fatty acid is not similar to cocoa butter, but some VCO properties like hardness, mouth feel and better taste is similar to cocoa butter (Ramli and Rahman, 2005). Moreover, the VCO is very stabil in term of rancidity. The possibility use VCO as CBS is consired due to the profile of fatty acid is quite similar with palm kernel oil (PKO), which was reported as CBS (Zaidul et al. 2005; Juliati, 2005). However, the use of VCO as CBS is limited reported by researcher. In this opportunity, production of chocolate bar using local cocoa butter and powder was investigated with VCO addition at different concentration and cocoa mass concentration.

Material and Methods

Cacao bean was collected from Aceh Farmer Cooperation and cocoa butter was given from small home industry in Pidie Jaya, Aceh. Sugar, milk and soy lechtin was purchased from shop and VCO had been obtained from a pharmacy in Banda Aceh.

Preparation of cocoa butter and cocoa mass

Cocoa butter was tempered to growth ß crystal of cocoa butter by mixing the butter with viscometer (*Brookfield*) spindle no. 63, speed 6 rpm with temperature setting according to the tempering temperature profile previously reported (Indarti, 2010). Liquid cocoa butter was inserted into a glass container and placed into container circulation. Next to the cocoa butter was placed stirrer use equipment spindel Viscometer. Cocoa butter was heated to 50°C and maintained for 15 minutes until the cocoa butter crystal melted perfectly, then cooled according to the tempering temperature profile. Temperature was decreased from 50°C to 22°C at rate of 3.5 ° C/min. To obtain a frozen cocoa butter, the temperature was dropped to 18˚C at rate of 0.5°C/min, then the temperature was raised back up to a constant torque of cocoa butter observed. The temperature was maintained by water cooler system circulator (Eyela CCA-1110). Cocoa mass was grinded into small particle size (100 mesh) by grinder machine. To ensure the uniform of particle size, cocoa mass was filtered by 100 mesh tray with a little pressure.

Preparation of chocolate bar

The chocolate bar was made of cocoa mass, cocoa butter, CBS, sugar, milk and lecyutin according the following formula (all units in gram):

Cocoa mass	cocoa butter + VCO *)	Sugar	milk	Lechytin	Total
200	400	300	100	5	805
300	400	300	100	5	905

*) It contains VCO at concentration ranging from 0 to 5%.

The mixture of liquor was counching under heating treatment at 65°C for 72 hours. Around 20 minutes before completion, lechytin was added. Then the liquor was cooled for 15 minutes (Minifie, 1999). Next, the moulding was conducted by pouring the liquour into the bar casting. Finally, the casting is freezed at ± 10-14°C). The chocolate bar obtained was then wraped in aluminium foil and stored for analysis.

Sample analysis
VCO and chocolate bar was analyzed for fatty acid profile using gas chromatographic method. Initial melting point was determined by melting point analyser (BI- Barnstead Elektrothermal 9100).

Experimental design
This research was arranged according to Factorial Random Block Design 2 factors, namely (a) VCO concentration consist of 6 levels: K_1 = 0%, K_2 = 1%, K_3 = 2%, K_4 = 3%, K_5 = 4%, dan K_6 = 5%, and (b) cocoa mass content comprise 2 levels: P_1 = 200 gram, dan P_2 = 300 gram. Therefore, total experiment was 12 treatments.

Results and Discussion
The melting point has a certain range temperature while the chocolate completely melts. The initial melting point is measured upon the lipid surface in the capillary starting melt. Original cocoa butter has initial melting point is about 30.4-31.8°C (terms of SNI 01-3749-1995). It was found that concentration of VCO, the amount of cocoa mass and both interaction have insignificant effect (P>0.05) on the initial melting point. Initial melting point by this research is about 29°C. This is due to all the butter in chocolate bar has the β type of crystal form, so that at the temperature of 29°C cocoa butter and other fat started melting. The tempering process in preparing cocoa butter also increased the melting point (Louise, et al,. 1997).

The end melting point is the temperature when all fat in the capillaries have completely melt. The end melting point range of chocolate bar in this research is about 31.3-31.98°C. Figure 1 shows an increase in VCO concentration resulted in lowering the end melting point. It was found that the concentration of VCO above 2% has significant effect on the end melting point, meanwhile the cocoa mass concentration has not. Although the chocolate bar has the lowest melting point of 31.1°C, it is still within desirable range of ß crystal growth.

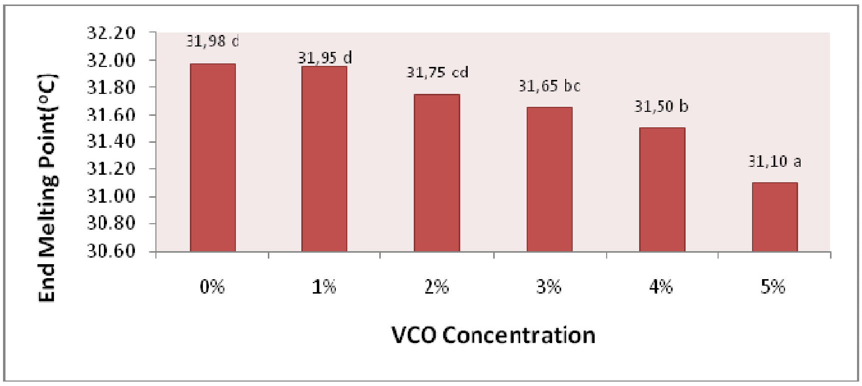

Figure 1. Influence of the VCO concentration on the end melting point of chocolate bar (BNT 0.01 = 0.233, KK = 0.82%)

Convectionary chocolate should have melting range slightly higher than room temperature to ensure this product stable at this condition. The stability of chocolate bars are determined by the amount of VCO concentration due to the nature of VCO containing significant amount lauric acid (49.7%) (Nandi et al. (2004). Addition of the VCO to 2% does not provide final melting point difference with Brown trunks of cocoa fat alone (without the VCO). The same is reported by Zaidul et al. (2006) that the addition of the trigliseridanya characteristics of PKO almost same with VCO, stating the nature of the fatty acid components, physical, slip melting point and solid fat content has the same properties CBR.

Figure 3 shows the influence of cocoa mass content on aroma preference of the panel test. It indicates that the cocoa mass strongly influenced flavour of the chocolate bar, while VCO concentration and interaction between cocoa mass and VCO concentration has insignicant influence on the chocolate bar flavour.

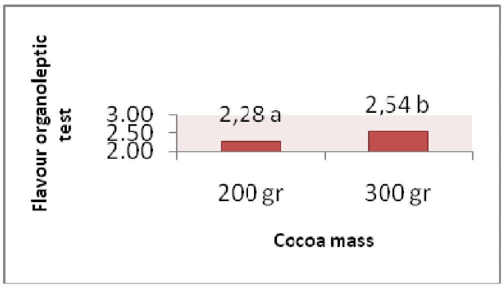

Figure 3. The influence of the cocoa mass content on organoleptik aroma (BNT 0.05 = 0.182, KK = 11.90%, preference score: 1 = no specific aroma, 2 = Specific aroma, 3 = very strong aroma).

The value of organoleptik scent increases on pasta 300 grams of pasta 200 grams, but the level of fondness panelists against the scent of chocolate stem the decline. High aroma from processed chocolate are thought to be influenced by the amount of pasta or the content of solids in the manufacture of refined chocolate. The addition of many variations of pasta that is used can also affect the sensory properties of the product organoleptik/chocolate bars such as color, aroma, and flavor (Mulattos et al. 2005). In term of VCO Concentration, it is obtained that the aroma of VCO has no affect to the aroma of specific chocolate so that VCO could use as CBS.

Figure 4 presents the influence of VCO concentration on texture preference. It indicates that the concentration of highly influential real VCO ($P \leq 0.01$) to the value of sensory the texture of chocolate bar. The influence of the number of cocoa mass used as well as the interaction between the concentration of VCO and many influential pasta is not real ($P > 0.05$) against the value of the texture sensory of chcolate barr.

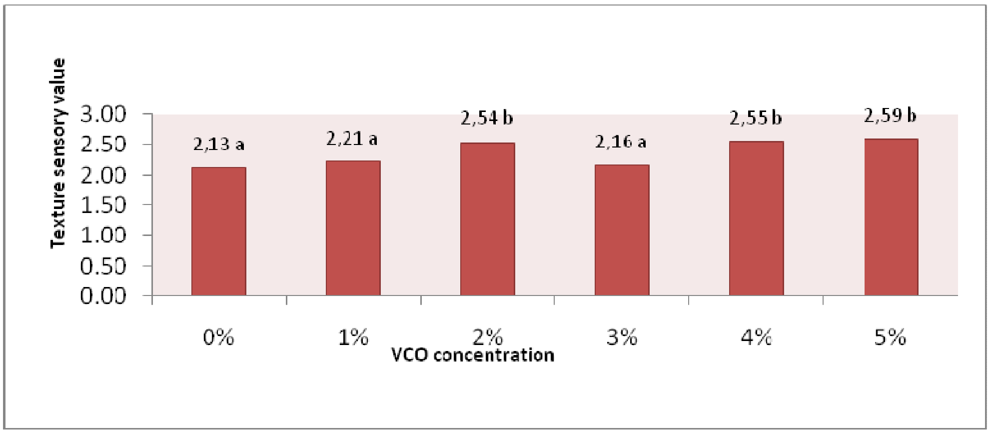

Figure 4. The influence of the VCO concentration of the VCO to the textures (BNT 0.01 = 0.131, KK = 6.20%, 1 = very hard brittle, 2 =, 3 = solid/stable, 4 = soft)

Based on the results of test BNT 0.01 (Figure 4) the value of stable texture of the chocolate bar at the 3, 4, 5% VCO concentration have signifiacant different of other of VCO concentration. The higher the amount of the VCO concentration in the formula of chocolate bar the higher of stable texture of chocolate bar. This is due to the addition of VCO caused the bond in crystal form in the texture of chocolate bars. Comapred to 100% cocoa fat the 4 and 5% VCO chocolate bar has slightly soft, but this performance prefer to very hard chocolate made from 100% cocoa butter. The main fatty acid content in VCO is lauric acid (49.7%) are beginning to melt at a temperature of 23^{o}C-26^{o}C. Lauric acid of VCO has a high fragility in the solid state (Shukla, 1997). Therefore the addition of a VCO the higher effect on the density of the product of chocolate bar. It is probably the tempering process of cocoa butter also affected the solid and stable texture of chocolate bar.

Results indicates that the VCO concentration has significantly affected ($P \leq 0.01$) to the appearance sensory value of Chocolate bar, meanwhile The amount of cocoa mass and interactions between VCO concentration and cocoa mass has no significantly affect($P > 0.05$)

to the appearance sensory value of Chocolate bar. The influence of the VCO concentration to appearance sonsory value shows in Figure 5.

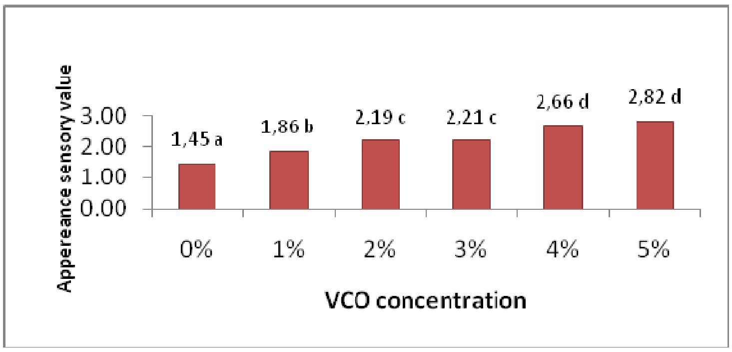

Figure 5. The influence of the VCO concentration to the Shyni appearance of chocolate bar (BNT 0.01 = 0.311, KK = 15.78%, 1 = opaque, 2 = good, 3 = glossy

Result shows that the higher consentration the glossier appereance of the surface of chocolate bar. The best appereance of sensory value obtained in 4 and 5% VCO concentration that significantly different of other VCO concentration of chocolate bar. This is due to the shyni effect of non drying oil such as VCO to the appereance of chocolate bar.

It is indicates that the value organoleptik the appearance of the most shiny chocolate bar retrieved in addition concentration VCO 4 and 5%, significant different with concentrations on adding VCO 0%, 1%, 2% and 3%. The value of osensory appearance increased by increasing of concentration of VCO, this is because the VCO provides a glossy finish on the chocolate bars were produced. It is predicted that the VCO which has the content of lauric acid is a non- Polymorph fat can be fused into a mix of cocoa fat be stable causes the appearance of shiny (Goh, 1994).

Blooming test

Blooming is the formation of a layer of white and shaped like a mushroom on the surface of milk chocolate bars. Blooming is one of those things unwanted appears on the surface of chocolate. Based on sensory testing of blooming after chocolate bar stored at room temperature for a week, showed different results among chocolate bar without and with the addition of pure coconut oil (VCO).

On Chocolate bar without the addition of VCO (Figure 6), blooming formed on the surface of chocolate bars, while in the Chocolate bar using VCO (Figure 7), blooming is not formed. This is due to the addition of the VCO and the addition of lecithin which serves as an emulsifier. This Emulsifier function is to make a well bond between VCO and cocoa butter and other component thus it will protect to cause blooming (Minifie, 1999).

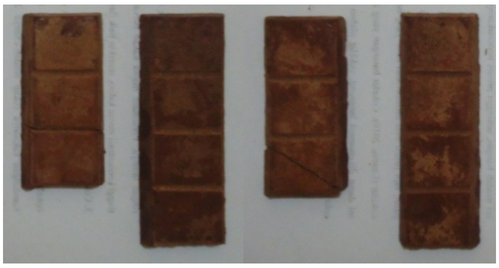

Fig 6. The glossy appereance of Chocolate bar Without VCO)

Fig 7. The glossy appereance of Chocolate bar (Made of 5% VCO)

The formation of blooming predicted due to solid mixture is not homogen and the crystal growth of cocoa butter did not very well. Solid material in chocolate, sugar, milk and cocoa mass must form a stable structure to have a smooth liquor, this will lead the smooth and glossy appearance. Other possibity to protect blooming is temperature controlled during moulding. Since more than 50% of the formula was cocoa butter, during moulding the temperature also need to be controlled because crystal in cocoa butter need to form ß crystal form. The seed growth of cocoa butter of chocolate was quantified as a function of time and temperature from 26.1°C to 32.9°C. This well-tempered chocolate was characterized by a seed crystals content of ≈ 1.15 ± 0.1% of cocoa butter, crystallisation of 23.9 ± 0.2°C in the temper meter and an equivalent viscosity of 3.0 ± 0.4 Pas. It was discovered that the lower the temperature, the faster the crystal growth (Louisel et al., 1997)

Conclussion

The higher concentration of VCO will reduce the melting point of chocolate bar. Melting point was comparable to other chocolate bar commercial (29-32^{o}C). The unblooming and glossy appereance shows at 4-5% of VCO concentrasi and 300 grams (27,5%) of cocoa mass.

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