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Cocoa Butter Characteristic on Different Roasting Temperature and Its Final Sensory Profiles

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Abstract

Cocoa butter is an intermediate product of cocoa processing separated from cocoa nibs or cocoa mass. Heat through cocoa processing affect the characteristic of fat including roasting process. The aim of this experiment is to evaluate the characteristic changes and sensory profile of cocoa butter in different operational roasting temperature. This experiment was conducted in Postharvest Laboratory of Indonesian Coffee and Cocoa Research Institute using dry cocoa bean from Glenmore estate in Banyuwangi (G) and from Kaliwining estate in Jember (K) in grade A according to standard of SNI 2323:2008/Amd1:2010 with moisture content of 7.5% originated from Trinitario bean and roasting temperature 120^{O}C (T1) and 150^{O}C (T2). Cocoa butter characteristic evaluated based on yield of separated fat, saponification, free fatty acid, peroxide value, colour and its melting profiles. Flavour description evaluated by sensory test using native panelist. Result shows no significant difference between roasting temperature but shows difference in appearance and flavour profile. Yield of separated fat is 35.95% per cocoa mass weight, saponification value is 193.36, free fatty acid is 0.72 and peroxide value 2.96 comply to the national standard of commercial butter. Cocoa butter appearance in T2 shows more intense of red colour than T1. Roasting temperature T1 and T2 enhance the chocolaty and nutty flavour but T2 shows burnt off-flavour for bean of Kaliwining (K). Melting point cocoa butter is 36.63^{O}C and qualified as hard cocoa butter.

Keywords: Cocoa butter, roasting, quality, sensory profile

INTRODUCTION

Cocoa butter as main composition of chocolate will constitute 75% of its total ingredients (Menezes *et al.*, 2015). Mechanical extraction of cocoa butter from cocoa liquor using pressing machine is conducted after roasting, deshelling and grinding process with optimum extracted butter yield is 37% (Venter *et al.*, 2007). Cocoa roasting method in industrial chocolate processing handling the whole bean roasting, nib rosting or liquor roasting by first removing the shell before the roasting (Beckett, 2008). Heat transfer during roasting process will melt the butter inside the bean and may affect on its chemical characteristic changes. Cocoa butter contains acylglycerols consist of monoacylglycerols, diacylglicerols and triacylglycerols with sensitive oxidation of unsaturated fatty acid components such oleic acid generally initiated by the excessive heat (Kashaninejad *et al*., 2016). Acylglycerols is the major component in cocoa butter as responsible for the chocolate texture and also bending volatile compounds possibly associate to final aroma origin (Ciftci *et al*., 2010).

Roasting process particularly affect to the quality changes of cocoa butter including its chemical properties and generated flavour of handling by set temperature of 150^{o}C or higher using low uniformity cocoa bean (Afoakwa, 2014). The heat transfer during roasting process related to the roasting machine construction, air speed, temperature profile and duration (Chiang *et al.,* 2017). Quality change of cocoa butter after roasting determined by parameters of free fatty acids and peroxide value (Running *et al.*, 2017). Free fatty acid (FFA) describe the acylglycerols breakdown and peroxide value (PV) identify the rupture of double bond that undergo in fatty acid chains or hydro peroxide decom-position (Samet-Bali *et al.,* 2009). The value of free fatty acid and peroxide value declared for acceptable cocoa butter are 1.75 and 4 (Krause *et al.,* 2008; de Clercq *et al.,* 2012). Cocoa butter also disperse the volatile aroma simultaneously generated by the roasting process. High content of free fatty acid possible to increase the rancid notes or bad odor as the volatiles (Zyzelewicz *et al.,* 2014). Physical appearance of overheated butter also shows brown yellow colour and decreasing its actual viscosity (Krysiak, 2014).

The final aroma of extracted cocoa butter describes the volatiles from both fermentation and roasting process which is evaluated by olfactory profiling. Some of desirable chemicals that is partially generated from roasting process is dimethyl pyrazine and trimethyl pyrazine which associate to chocolate, hazelnut, corn-like or roasted-bake odor (Jinap *et al.,* 2004). The undesired aroma or odor formed during high roasting process comes from the lypolysis and oxidation through the fatty acids exhibits some furan and pyrrol substances which apparent coumarine or musty notes (Tran *et al.,* 2015). Therefore, controlling the roasting temperature and selecting an appropiate roasters become essential. The objective of this study is to evaluate the cocoa butter quality after roasting process using the mini-roaster developed by Indonesian Coffee and Cocoa Research Institute (ICCRI) towards the national standart of cocoa butter in Indonesia.

MATERIALS AND METHODS

Cocoa butter analysis conducted to explain the potential fat contains in dry bean, determine the influence of heating temperature of roasting in both physical and chemical parameters, and also to describe its final sensory perception.

Dry cocoa bean (wt. 7-7.5%) are taken from two places of Glenmore plantation (G) in Banyuwangi and Kaliwining (K) experimental garden of Indonesian Coffee and Cocoa Research Institute (ICCRI) in Jember-East Java, harvested on 2016 with A grade. Bean roasted on indirect heating roaster with total capacity of 1 kg/batch for three times roasting for replication. Roasting temperature set on 120^{O}C (T1) and 150^{O}C (T2) for 25 minutes with preheating time for 5 minutes. Bean of Glenmore are roasted in 120^{O}C mention as GT1 and 150^{O}C mention as GT2. Bean of Kaliwining are roasted in 120^{O}C mention as KT1 and 150^{O}C mention as KT2. Roasted bean cooled in flat bad fan cooler for 15 minutes into room temperature. Bean separated between nibs and shell using Winnower then nibs crushed into pasta by Grinder and pressed by mechanical hydraulic press without heating elements to pulled out the liquid cocoa butter. Extracted liquid temper on cooler in 15^{O}C for 30 minutes to get hard CB. Roaster follows the design of cylinder type as explained by Misnawi *et al*. (2005) and Widyotomo *et al*. (2006).

Fat content of dry bean determined according to ICA method 37/1990 and saponification value from IUPAC Standard Method 2.202. CB yield from pressing process determined by weighing the hard CB from extraction using the formula:

$$\% \text{ Fat content} = \frac{100(M2 - M1)}{M0} \times \frac{100}{(100 - KA)}$$

M0 = weight of sample (g)
M1 = weight of flask (g)
M2 = weight of flask and fat (g)
KA = water content of dry bean (%)

Saponification value determined using the formula:

$$\% \textit{ Saponification value} = \frac{56.1 \times N \times (V0 - V1)}{m}$$

V0 = volume of HCl 0.5 N for blank titration (mL)
V1 = volume of HCl 0.5 N for sample titration (mL)
N = normality of KOH
m = weight of sample (g)
Molecular weight of KOH = 56.1

Colours of CB was analyzed using colour reader Konica Minota Japan with three parameters of such model represent the lightness of colour (L*), which ranges from 0 to 100 (black to white), its position between red and green (a*, negative values indicate green, while positive values indicate red) and its position between yellow and blue (b*, negative values indicate blue and positive values indicate yellow).

Melting properties of CB was analyzed using Differential Scanning Calorimetry TA Instruments Q1000 DSC according to AOCS Cj-94 method. 5-11 mg of melting CB was filled and hermetically sealed in aluminium pans, and an empty pan was used as reference. The following temperature-time procedure for non-isothermal crytallization was used equilibration at 80^{O}C/10 min and the ramp cooled at 10^{O}C/min to -40^{O}C and maintained for 10 min to be heated again until 80^{O}C at a rate of 5^{O}C/min. Each assay was performed in triplicate. Initial temperature (T_{onset}), peak melting temperature (T_{peak}) all in degrees Celcius and melting enthalpy (ÄH) in J/g were determined.

CB quality determined by free fatty acid value (FFA) and peroxide value (PV). FFA conducted according to IUPAC Method 2.201 and PV according to IUPAC Method 2.501. FFA calculated following the formula:

$$\% \text{ FFA} = \frac{V \times N \times \textit{BM fatty acid}}{m \times 1000} \times 100$$

V = volume of NaOH 0.1 N for titration (mL)
N = normality NaOH
M = weight of sample
BM fatty acid = 28.2 (relate to oleic acid)

Peroxide value (PV) determined using the formula:

$$\% \text{ PV} = \frac{1000 \times N \times (V0 - V1)}{m}$$

V 0 = volume of $Na_2S_2O_3$ 0.01 N for sample (mL)
V 1 = volume of $Na_2S_2O_3$ 0.01 N for blank (mL)
N = normality of $Na_2S_2O_3$ larutan 0,01 N
m = weight of sample (g)

CB tested into 80 native panelist to evaluate overall preferences. Evaluation calculated based Friedman test with parameters of like, rather-like and dislike. Flavour determine by Anova General Linier Model (GLM) with 12 attribute of potential aroma consist of malty, green or grassy, nutty or peanuts, almond, karamel, chocolate, sweet or candy, burnt or smoky, roasted, fermented, acidic and vanilla.

RESULTS AND DISCUSSIONS

Cocoa butter (CB) are the main component in the chocolate formulation. Physical and chemical characteristic of CB can change by heat contact during postharvest processing such roasting process involved. Evaluation for best roasting practices of dry cocoa bean held on roaster chamber temperature of 120^{O}C and 150^{O}C. CB characteristic compare to the national standart of cocoa butter in SNI 3748:2009.

Yield and Colour Profiles

Chocolate processing put the bean into roasting machine as initial processing step. Dry cocoa bean input to the roasting chamber in minimum temperature of 110^{O}C, but application of 150^{O}C proved to be more favorable than roasting at 135^{O}C (Zyzelewicz *et. al*., 2014). Table 1 shows bean from Glenmore with roasting temperature of 120^{O}C (GT1) and 150^{O}C (GT2) have similar result in all parameters with bean from Kaliwining with temperature of 120^{O}C and 150^{O}C. Bean weight reduction for roasting at 120^{O}C are 7.5 and 12.75% at 150^{O}C, with total average ±10.67% ($P < 0.05$) similar to the result conducted in 5 kg/batch by Widyotomo *et al*., (2006) with bean weight reduction of 7.1–12.2%.

Temperature during roasting process affect the cells breakage and fat extrication inside, with higher roasting temperature of 150^{O}C produce 33.73% and temperature of 150^{O}C produce 38.16% from total weight of roasted cocoa mass but not significant in $P < 0.05$. Diminished cocoa butter or ratio of unseparated fat approximately 22.96%. The fat content of this cooa cake is better than result of Septianti & Arif (2016) which resulted cocoa cake with fat content 21.85–28.53%. Saponification value shows that fatty acid content in fat of all bean from Glenmore and Kaliwining fulfilling the national standart of 194.36 for commercial cocoa butter in means fatty acid chain may appropiate to hardness qualification of Indonesian cocoa butter.

Roasting temperature correlate to oxidation potential rate and contribute in changing cocoa butter colour. Excessive oxidation reduce cocoa butter quality by accelerate its rancidity. Colour determined by parameter of brightness (L*), redness (a*) and yellowness (b*) with high value describe its high intense. Table 2 shows very small effect on L* and b* values between roasting in 120^{O}C and 150^{O}C ($P < 0.05$) but much significant compare to the changes in a* value. This result quite different with cocoa butter colour by varying temperature of extrusion which showing significant changes of L* (Kashaninejad *et al*., 2016). Finenes of filter cloth on pressing machine may affect in L*, but this CB have no bright appearance because its separation process not involving decolorisation.

The natural yellow colour of cocoa butter, mainly results from carotene (pro-vitamin A) associate in fat triglycerides and red colour related to quinone substance presence from polyphenols oxidation inside the bean during sun drying (Haryadi & Supriyanto, 2012). Roasting and grinding process can dissolve quinone into fat component in cocoa mass before pressing process, and incline the value of a*. Table 2 shows the value of a* is different between temperature 120^{O}C and 150^{O}C ($P < 0.05$), therefore roasting temperature give an influence in dissolving bioreaction and enzymatic side-products into fat component. The intensity of yellow colour both Glenmore and Kaliwining bean are low in average ±6.47. Beside oxidation product, other compond such as polyphenols and vitamins can dissolve and interact with lipids during roasting and influence the final flavour (Beckett, 2009).

Table 1. Comparison of bean and cocoa butter profiles in different roasting temperature

Location, roasting temperature (^{O}C)	Bean weight reduction (%)	Yield of pressed fat (%)	Ratio of un-separated fat (%)	Saponification value
Glenmore, 120 (GT1)	7.50 ± 0.04	34.90 ± 0.01	21.63 ± 0.08	191.21 ± 4.94
Glenmore, 150 (GT2)	11.00 ± 0.02	38.31 ± 0.01	17.14 ± 0.04	193.72 ± 2.96
Kaliwining, 120 (KT1)	7.50 ± 0.04	32.56 ± 0.01	30.12 ± 0.05	193.17 ± 5.10
Kaliwining, 150 (KT2)	14.50 ± 0.04	38.01 ± 0.02	22.94 ± 0.10	194.68 ± 3.89
Average	10.67 ± 0.04	35.95 ± 0.03	22.96 ± 0.08	193.36 ± 3.59

Remarks: value beside the average is deviation standard

Tabel 2. Cocoa butter colour in different roasting temperature

Location, roasting temperature, ^{O}C	L*	a*	b*
Glenmore, 120 (GT1)	28.18 ± 0.05	0.65 ± 0.07[a]	6.66 ± 0.62
Glenmore, 150 (GT2)	27.95 ± 0.47	1.21 ± 0.10[b]	6.51 ± 0.52
Kaliwining, 120 (KT1)	28.20 ± 1.13	0.65 ± 0.07[a]	6.33 ± 0.12
Kaliwining, 150 (KT2)	27.20 ± 1.15	1.29 ± 0.07[b]	6.23 ± 0.22
Average	27.88 ± 0.95	0.91 ± 0.31	6.47 ± 0.31

Note: value beside the mean value is deviation standard.

Cocoa Butter Melting Point

CB is responsible for texture, difussion of taste and flavour, snap and melting characteristic in chocolate products and in mouth. CB melting point provide its characteristic of acylglycerol structure and saturation of fatty acid chains (Svanberg *et al*., 2011). Table 3 shows CB for regular operating temperature of 120^{O}C between Glenmore and Kaliwining butter have close melting point. DSC instrument measure melting profile from initial melting point (T. onset), temperature for complete melting point (T. peak) and temperature for cocoa butter abandoned waxy texture (T. endset). CB change into oil phase in temperature (T.peak) 36.63^{O}C higher than human mouth temperature around 32-34^{O}C and it can be classified as hard cocoa butter (Norton *et al*., 2009). This melting point quite high compare to Brazilian cocoa butter with melting point (T. peak) 21.07^{O}C. Heat transfer required for phase changing is 106.60 J/g also higher to Brazilian butter which only require 74.78J/g in calories (Vieira *et al*., 2015). Indonesian cocoa butter is well-known as hard cocoa butter and give an advantage for CB blend or in eutectic method (Beckett, 2009).

Cocoa Butter Quality Profile

Hydrolitic rancidity in butter is characterized by off-flavours variously described as bitter, unclean, wintery, butyric or lipase. In tropical regions the oxidation is further elevated due to catalytic activity of temperature for fat oxidation and become one of the major causes of consumer rejection (Nadeem *et al*., 2014). CB deteoration and oxidation determined by free fatty acid value (FFA) and peroxide value (PV). Table 4 shows the FFA value in overall roasting temperature is 0.62–0.83 and PV value is 2.83–3.30. This result comply to the international standard for the maximum FFA value in cocoa butter is 1.75 and PV value is 4.0. Roasting temperature 120^{O}C and 150^{O}C have no significant difference in CB quality profile ($P < 0.05$) and appropiate for small scale processing. High FFA value indicate intensive fatty acid chain separation from glycerol bond and PV indicate excessive free radicals relate to rancidity and toxicity (Running *et al*., 2017).

Cocoa Butter Sensory Profile

In chocolate, the flavour/aroma volatiles are active supplementary to the pleasant taste of non-volatile constituents. The first flavour precursors are developed during fermentation and drying, then reacts by heat in roasting process. Figure 1 shows the dominant flavour in various roasting temperature are resemble except KT2. Aroma attribute of cocoa or chocolaty have high intensity followed by nutty and almod-like for GT1, GT2, and KT1. This result explain strong effect of roasting to exhibit more volatiles precursors. Final aroma such chocolaty, nutty and almond-like discribe the specific volatile substance formed by reaction between reducing sugar and amino acid mostly include pyrazine and aldehydes. The presence of chocolaty aroma deliver by 2,3,5-trimethyl pyrazine-6-ethyl pyrazine, nutty aroma deliver by 2,3-dimethyl pyrazine and almond-like deliver by 2-methyl butanal which all mostly generated during roasting (Tran *et al*., 2015).

Tabel 3. Cocoa butter melting point and heat consumption

Location, roasting temperature, ^{O}C	T. onset, ^{O}C	T. peak, ^{O}C	T. endset, ^{O}C	Enthalpy (J/g)
Glenmore, 120 (GT1)	32.49	37.13	38.91	105.25
Kaliwining, 120 (KT1)	33.03	36.13	37.31	107.95
Average	32.76	36.63	38.11	106.60

Notes: T. onset: temperature of initial melting point; T. peak: temperature of complete melting point; T. endset: temperature of forming waxy texture.

Tabel 4. Free fatty acid and peroxide value of cocoa butter

Location, roasting temperature, ^{O}C	Free fatty acid (FFA)	Peroxide value (PV)
Glenmore, 120 (GT1)	0.75 ± 0.04	2.83 ± 0.52
Glenmore, 150 (GT2)	0.83 ± 0.08	2.97 ± 0.79
Kaliwining, 120 (KT1)	0.62 ± 0.12	3.12 ± 0.84
Kaliwining, 150 (KT2)	0.69 ± 0.06	3.30 ± 0.71
Average	0.72 ± 0.12	2.96 ± 0.69

Note: Value beside the average is deviation standard

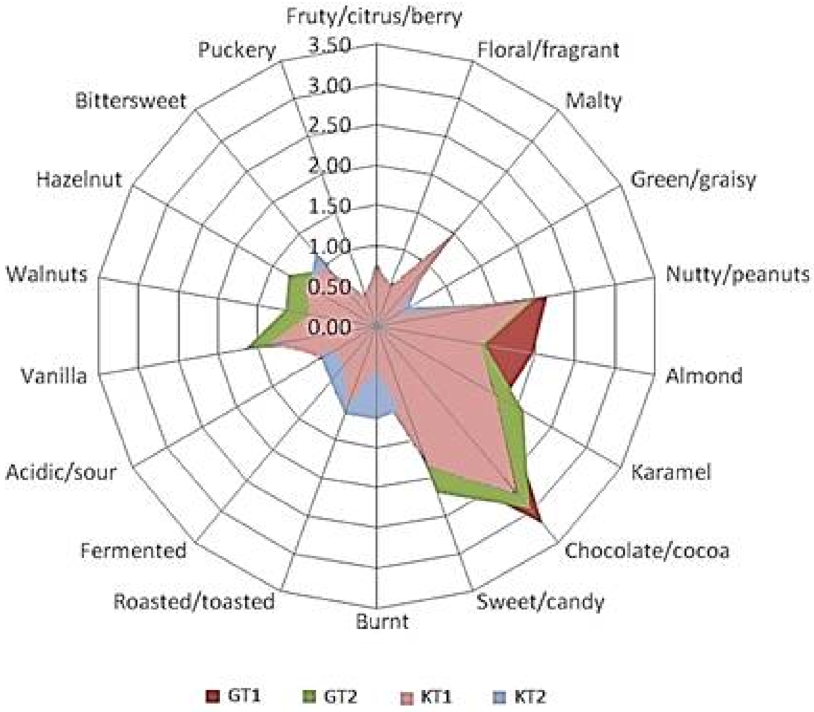

Figure 1. Cocoa butter sensory profile

Some flavour associated in CB not only contribute to roasting process but also originally formed during fermentation by involving miscellaneous substrate, inducted cultures or gene factor. Figure 1 shows Kaliwining bean with roasting temperature 120^{O}C (KT1) appearing fruity aroma in low intensity. Fruity aroma associate to precursors driven by fermentation and refers to ester or alcohols. Flowery aroma deliver by 1,3-butanediol or 2,3-butandiol, and fruity aroma deliver by 2-phenyl ethyl acetate. KT2 is not suitable for Kaliwining bean and trigger burnt aroma as one of off-flavour category. This result is lower than the average for over temperature in industries (>150^{O}C), which increase burnt aroma and bitter taste. The off-flavour prohibited by reduce time operation or set into suitable temperature (Beckett, 2009).

CONCLUSION

Roasting temperature for cocoa using cylinder type roaster in operational temperature 120l^{O}C and 150^{O}C give no significant affect to cocoa butter characteristic including yield of separated fat, saponification value, free fatty acid value, peroxide value and melting profiles, but different in colour and flavour parameters. Yield of separated fat is 35.95% per cocoa mass weight, saponification value is 193.36, free fatty acid value is 0.72, peroxide value 2.96 and melting point is 36.63^{O}C comply to the national standard of commercial butter and qualified as hard cocoa butter. Roasting enhance chocolaty and nutty aroma, but increase red colour intensity and potential of burnt aroma appearance in roasting temperature of 150^{O}C.

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