STUDY OF FOOD SAFETY ON DARK CHOCOLATE ENRICHED WITH CINNAMON (*Cinnamomum burmanii*) DURING STORAGE

Dimas Rahadian Aji Muhammad, Intan Nisa Rusulantari, Anasta Ilmi, Yasmin Nabila, Muhammad Isa Dwijatmoko, Danar Praseptiangga

Department of Food Science and Technology , Sebelas Maret University
Jl. Ir. Sutami 36A Kentingan Surakarta, INDONESIA

Abstract

Fat and sugar blooming on chocolate affects on consumer acceptance, because the existing perception that blooming decrease the safety of the product. Enriching dark chocolate bar with essential oil from cinnamon (*Cinnamomum burmanii*) have been conducted. This research aims to investigate the effect of cinnamon on the blooming occurence during storage. As soon as the chocolate bloomed, FFA and TPC analysis were performed as safety indicator. The results shows that enriching essential oil from cinnamon slackens bloom appearance on dark chocolate. The bloomed product is safe to be consumed, since FFA and TPC number are under the maximum limit of the requirements of food safety.

Keywords: dark chocolate, food safety, bloom, cinnamon

1. Introductions

Chocolate is one of the fastest growing products in the sugar industry with worldwide sales of which represents an increase of 7% from 2006 to 2007 (approximately 2.2 million USD) [1] Data from BPS which is processed by the Ministry of Industry shows that the volume of Indonesia cocoa exports in 2009 reached 115.170 tonnes, consist of 83.642 tonnes of intermediate products (cocoa liquor, cocoa cake, cocoa butter, cocoa powder) and 31.528 tonnes of final product [2]. The European chocolate industry, which processes cocoa into chocolate, is the largest in the world consumption of cocoa in 2010/2011 with 1.795.000 tonnes or 48% per year. Next is America with 912.000 tonnes (25,8%), Asia with 438.000 ton (11,8%), South America with 342.000 tonnes (9,3%), Africa with 128.000 tonnes (3,5%) and Oceania with 65.000 tonnes (1,8%)., as reported in Plus News on 15th March 2012 [3].

One of the main problem in chocolate product is fat and sugar bloom. Fat bloom is the whitish haze formed on the surface of chocolate. This physical phenomenon is caused by the dispersion of light on the small fat crystals (P5 lm) that are formed on the surface and impacts both, visual appearance and textural attributes. As the effect, bloom is a major quality problem for the chocolate industry after products leave the factory [4].Poorly tempered chocolate can develop a white or grey surface layer, named fat bloom [5]. Impacts from fat bloom are simply visual appearance and textural attributes. The bloomed chocolate also has a less attractive feel on the palate [6]. Consumer perception of the fat bloom on the surface of chocolate makes opinions related to the unsafe consumption.

Chocolate with spice flavor has been developed. One of the spices is cinnamon. Cinnamon has a strong flavor and contains antioxidant compounds, which is expected to increase reception and maintain product quality [7]. Essential oils can be added to the dark chocolate bars to improve the organoleptic and physicochemical characteristics of the products of dark chocolate bars. However, the effect of cinnamon essential oil on fat bloom is not properly investigated. The purpose of this study is to know the effect of cinnamon essential oil of *Cinnamomum burmanii* to fat bloom and to determine levels of Free Fatty Acid (FFA) and Total Plate Count in chocolate suffered from fat bloom as an indicator of food safety.

2. Materials and methods

2.1. Materials

Dark chocolate couverture with 56% cocoa was obtained from Tulip Cocoa Processing Company (Jakarta, Indonesia); essential oil of cinnamon (*Cinnamomum burmanii*) was obtained from Central Java, Indonesia.

2.2. Dark chocolate bar processing method

The dark chocolate couverturesample was divided to 2 formulations (F1, F2) with 200 gr for each formulation. F1 was the dark chocolate as

control which is not contain cinnamon essential oil, while F2 was the dark chocolate with the addition of cinnamon essential oil 5%.Both of the samples were melted by manual method using a bowl of boiled water. After the samples were all melted, 2/3 of the chocolates was tempered using marbling method at 25-27° C (room temperature) until the temperature of the chocolate samples was cooler (28-29°C). It was followed by mixing the 1/3 other of samples with the 2/3 seeds and adding 0,5% cinnamon essential oil. To promote crystal growth of desired triacylglyceride fractions, the tempering method was indicated finished when the temperature has finally reached 31°C [8].

The purpose of tempering is to form a structure of β-crystal in the chocolate bar in order that the melting point will be decreased and the chocolate becomes more stable compared to the untempered chocolate. The tempered chocolate samples were moulded using plastic moulds and stored in the refrigerator (5° C) for 40 minutes before being de-moulded into plastic box. The chocolate bar was storage in temperature 5° C.

2.3. Analyzes Methods

2.3.1. Determination of total microorganism / total plate count

Total microorganism (microbes/ml) of dark chocolate was determined using pour plate method. This method is often used to assay bacterial contamination of foods. Firstly, diluted sample was prepared and then a portion of the prepared sample was placed in a labeled empty sterile plate. Pour 15 mL of melted agar into te plate, cool it down to 45 ° C and swirl to mix well. Invert and incubate the plate to develop colonies (24-48 h).

2.3.2. Determination of free fatty acid

Lipase activity was determined bu estimating the amount of Free Fatty Acid (FFA) in the chocolate samples (F1; F2) from the 0 day upto the bloom appears by alcalimetric titration (AOCS, 1998; AOCS, 2006. Increaced FFA (%) indicates lipase activity in the chocolate samples during storage.

3. Results and discussion

This study used two formulations to be compared. F1 was dark chocolate bar with no addition of cinnamon essential oil and F2 was dark chocolate bar with 0,5% addition of cinnamon essential oil. During storage and analysis, F1 was bloomed on the fourteenth day while F2 was not. Blooming affects on decreasing the glossiness of the chocolate. Enriching essential oil from cinnamon slackens bloom appearance on dark chocolate, because keep the product appears glossy.

There are four main ways that chocolate fat bloom is formed. Two have already been described, i.e. by the form IV to form V transformation following to incorrect pre-crystallisation (tempering), or by the age and temperature related to form V to form VI change, which can be slowed down by the addition of milk fat [9]

Another reason is where the chocolate has been melted and recrystallized without retempering and stored at place with a direct sunlight. The fourth mechanism is due to the migration of soft fats into the chocolate where the liquid fat from the centre moves into the chocolate and, because of the eutectic effect, makes it much softer and may even cause some of the cocoa butter to become liquid again, if the softening is bad enough. Some of the cocoa butter migrates in the reverse direction into the centre making that harder. Thus the difference in texture is lost and the sweet is less appealing. As the soft fat migrates to the surface, it takes some of the cocoa butter with it. This crystallises forming fat bloom.

The phenomenon decreases the glossiness of the chocolate results mouldy appearance. Some of consumers believe that fat bloom on chocolate decrease the safety of the product. Hence, the analysis of Free Fatty Acid and Total Plate Count were conducted the bloomed chocolate. This analysis were used as indicators of safety on bloomed chocolate. Table 1 shows the data of Free Fatty Acid and Total Plate Count Analysis of dark chocolate bar with no addition cinnammon essential oil during storage.

Table 1 Free Fatty Acid and Total Plate Count Analysis of Dark Chocolate Bar with no addition of bark cinnamon oil

Type of Analysis	Day 0	Day 14	Standard
Free Fatty Acid (g)	1,13	1,67	
Total Plate Count (coloni/g)	$7{,}0 \times 10^2$	$11{,}0 \times 10^2$	1×10^4 (BPOM, 2005)

Microbial contamination in food products may be harmful and dangerous to human health. Based on the study, the content of microbial on the chocolate sample F1 (control) on day 0 is $7{,}0x10^2$ coloni/g. After 14 days of storage, the

chocolate has bloomed and reached $11{,}0x10^2$ coloni/g. According tothe data from BPOM (2005) about Limit of Microbial and Chemistry Content Contamination in Food, maximum content of microbial in chocolate is $1x10^4$coloni/g, it was proven that the bloomed chocolate is still safe for consumption, because when it's compared to the standard number the microorganism content in the chocolate sample is still lower.

Microbial contamination on chocolate sample F1 (control) increased slowly. However, enriching the chcocolate with cinnamon essential oil is estimated decreased the contamination rate. Cinnamaldehyde, polyphenol, and eugenol are major constituen in cinnamon [10] Due to different chemical components present in the cinnamon essential oil and the mechanism and the pathway, they behave in respect of antioxidant, as well as antimicrobial (antibacterial and antifungal), properties and activities[11].

Total content of Free Fatty Acid (FFA) in chocolate was also analyzed. FFA is a fatty acid that represents a free acid whichis not bounded as triglycerides. Free fatty acids produced by the hydrolysis and oxidation processes, usually combined with neutral fat. The result of oil hydrolysis reaction is glycerol and free fatty acids. This reaction will be accelerated by the factors of heat, water, acidity and a catalyst (enzyme). The longer this reaction takes place, the more levels of free fatty acids formed. Total FFA content of the chocolate sample on day 0 is 1,13%. After 14 days of storage, total FFA content in the chocolate sample increasedto 1,67%. According to [12], when food contains free fatty acid higher than 0,2% by weight of foods, it could lead to undesirable flavor and could poison human body. However, the limit of FFA in chocolate is still uncertanty, since the Indonesian National Standard for chocolate bar does not determine the maximum limit of FFA in the product.

There is also no certain correlation between FFA and fat bloom occurance. It is proven by the level of FFA in the initial time is higher than 0,2%, however the fat bloom still did not appear.

According to the results above, even though the dark chocolate suffered from fat bloom might look a little less appetizing than a lustrous, rich chocolatey-brown piece of candy, it remains perfectly safe to eat. Fat bloom phenomenon on chocolate products is not an indicator of food safety because after being analyzed with alkalimetry and pour plate methods to know the free fatty acid and total plate count rates, both the results are still below the standard.

However, its negative effect on appearance affects consumen acceptance hence it makes fat bloom by far an important reason for the shelf life limitation of chocolate products. Dark chocolate with the addition of cinnamon oil shows better appearance compared to the controlled dark chocolate. The result indicates on the effects of cinnamon oil to reduce the occurance of fat bloom on the surface of chocolate.

4. Conclusion

Cinnamon essential oil can prevent fat blooming phenomenon on chocolate because slackens bloom appearance on dark chocolate. Fat bloom is not an indicator of food safety because both FFA and TPC results of the bloomed chocolate are still below the standards.

References

[1] Palazzo, A. B., Carvalho, M. A. R., Efraim, P., dan Bolini, H. M. A. 2011. *Determination of Isosweetness Concentration of Sucralose, Rebaudioside and Neotame as Sucrose Substitutes in New Diet Chocolate Formulations Using the Time-Intensity Analysis*. Journal of Sensory Studies, 26, Hal. 291-297.

[2] Maria, Intan. 2010. Application of Customs in Domestic Downstream Cococa Industry. Media Industri Number 2. Ministry of Industry. Jakarta.

[3] LexisNexis. 2014. *Dark Chocolate: Understanding Human Trafficking Risks in the Chocolate Supply Chain. Human Trafficking Awareness Index*. United Kingdom.

[4] Altimiras P., Pyle Leo, Bouchon Pedro. 2007. *Structure–fat migration relationships during storage of cocoa butter model bars: Bloom development and possible mechanisms*. The University of Manchester.

[5] Glicerina Virgiana, Balestra F, Dalla Rosa M., Romani S. 2013. *Rheological, textural and calorimetric modifications of dark chocolate during process*. University of Bologna. Italy

[6] Schenk H. and Peschar R. 2004. *Understanding The Structure of Chocolate*. Universiteit van Amsterdam. Amsterdam. The Netherlands.

[7] Lindasari, Fitria. 2013. Characteristics of Goat Milk Probiotic Yogurt Karakteristik Yogurt Probiotik with Carboxylic Dried Salts MixedFodder with Addition of Cinnamon Oil as Flavor. Departement of Animal Husbandry Production and Technology Ilmu Produksi dan Teknologi Peternakan. Faculty of Animal Husbandry, Bogor Agricultural InstituteI. Page 2.

[8] Afoakwa, Emmanuel Ohene, et al. 2008. *Characterization of Melting Properties In Dark Chocolates From Varying Particle Size Distribution and Composition Using Differential Scanning Calorimetry*. Food Research International 41 (2008) 751-757.

[9] Beckett, Stephen T. 2008. *The science of Chocolate 2nd Edition*. RSC Publishing. UK.

[10] Sree Satya N, Surya Prakash DV, Meena Vangalapati. 2012. Antimicrobial activity of Cinnamaldehyde from Methanolic extracts of Cinnamon on Klebsiella pneumoniae & Candida albicans. *Research in Pharmacy 2(6): 32-35, 2012*

[11] Kamaliroosta L., Gharachorloo M., Kamaliroosta Z., and Alimohammad Zadeh K. H.2012. Extraction of cinnamon essential oil and identificationof its chemical compounds. *Journal of Medicinal Plants Research Vol. 6(4), pp. 609-614, 30 January, 2012 DOI: 10.5897/JMPR11.1215*

[12] Gunawan, MA, Mudji Triatmo and Rahayu, Arianti. *Food Analysis: Determination of Peroxide Number and Free Fatty Acids in Soy Oil with Frying Variations*. 2003. JSKA. Vol. VI. No. 3.