

## Effect of cinnamon essential oils addition in the sensory attributes of dark chocolate

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**Abstract.** Dwijatmoko MI, Praseptianga D, Muhammad DRA. 2016. Effect of cinnamon essential oils addition in the sensory attributes of dark chocolate. *Nusantara Bioscience* 8: 301-305. Chocolate is one of the most popular confectionery products in the world. The increasing demand for healthy foods has led to rapid growth in the innovative healthy chocolate. Cinnamon (*Cinnamomum burmannii*) has been widely used as flavoring agent in the food product as well as has been proven to have benefit for human well-being. This study aims to investigate the effect of cinnamon essential oils addition in dark chocolate on consumer acceptance. A hedonic test using untrained panelists was performed in this research. The result showed that the present of the cinnamon essential oils changed significantly on the panelist acceptability to the chocolate.

**Keywords:** Cinnamon essential oil, dark chocolate, sensory attributes

### INTRODUCTION

Indonesia is the third-biggest cocoa producer in the world after Cote d'Ivoire and Ghana. In 2015/2016, Indonesia is estimated to produce 440.000 tons cocoa beans (The Economist 2015). Chocolate, the main product of cocoa, is one of the fastest growing products in the confectionery industry, with worldwide sales showing a growth rate of 7% (about \$ US 2.2 billion). In some European countries, such as Swiss, Germany and England, the chocolate consumption was about 9.45-10.55 kg for each year (CAOBISCO 2013). Even though chocolate has an established market, product development is essential for winning market competition.

There are three main types of chocolate based on their compositions, which are dark chocolate, milk chocolate, and white chocolate (Beckett and Stephen 2008). The basic ingredients for making dark chocolate are cocoa mass, cocoa butter, sugar and lecithin (Mattia et al. 2014). Some approaches to modify dark chocolate formula has been conducted to improve the functionality of the product, such as the enrichment of phytosterol, probiotic, synbiotic, and plant extract (Efraim et al. 2011; Possemiers et al. 2010; Erdem et al. 2014; Belščak-Cvitanović et al. 2015; Belščak-Cvitanović et al. 2012).

Herbs and spices have gained a rapid interest in the development of functional food since it contains various biological active compounds (Shan et al. 2005; Viuda-Martos et al. 2011). Cinnamon (family Lauraceae, genus *Cinnamomum*) are well-known to contain bioactive compounds with antioxidative properties such as polyphenol and cinnamaldehyde (Shan et al. 2005; Singh et al. 2007). Albak and Tekin (2014) developed cinnamon-enriched dark chocolate to improve the polyphenol content. They found that the addition of cinnamon powder could

change the sensory characteristic of the chocolate. The presence of cinnamaldehyde has been reported to alter the flavor of the chocolate compared to chocolate control (Albak and Tekin 2015).

Some studies reported that cinnamon has been widely used as flavoring agent in traditional as well as modern foods and beverages (Helal et al. 2014; Ballin and Sørensen 2014). In Dhillon and Amarjeet (2013) study, the addition of cinnamon less than 2% increased appearance, texture, color, flavor, and overall acceptability of bread. Ochanda et al. (2015) observed that addition of cinnamon powder increased consumer acceptability on purple tea. However, Dima and Dima (2015) stated that the addition of plant extracts in food enrichment is limited by the sensitivity of the olfactory and taste sensors of the consumer.

The flavor profile of dark chocolate enriched with cinnamon powder has been reported in the previous study (Albak and Tekin 2014). Nevertheless, the effect of cinnamon essential oils addition in dark chocolate on consumer acceptability is still under-investigated. The effect of the cinnamon essential oil addition on the sensory attributes of the dark chocolate bar was evaluated in this study. To the best of our knowledge, the aroma and antioxidant properties of the cinnamon essential oils were observed.

### MATERIALS AND METHODS

#### Materials

Cocoa liquor, cocoa butter, sugar, lecithin, baking soda, and vanilla were obtained from Indonesian Coffee and Cocoa Research Institute (Jember, Indonesia). The cocoa butter and cocoa liquor were extracted from fermented forastero beans. Cinnamon (*Cinnamomum burmannii*)

essential oil (CV. Anugerah Alam Abadi, West Sumatera, Indonesia) was used in this study.

### GC-MS (Gas Chromatography - Mass Spectrometry) analysis

A Shimadzu GCMS-QP2010 SE instrument was employed to investigate the aroma profile of the essential oils. It was equipped with a Restek RTX-5MS low-bleed fused-silica capillary column (length 30 m & inner diameter 0.25 mm) with a film thickness of 0.25  $\mu$ m. The sample (0.1  $\mu$ L) was injected to the instrument. The injector and interface temperature was kept at 200°C and 300°C, respectively. The initial oven temperature was programmed at 60°C and then was gradually increased to 300°C. The effluent of the capillary column was introduced directly into the ion source of the mass spectrometer. The ion source temperature was 200°C. The sector mass analyser was set to scan from 30 to 400 amu. The linear velocity of the helium carrier gas was 0.75 mL/min at a split ratio of 153: 1. Components of essential oil were identified by comparing mass spectra of each peak with those of authentic samples in a mass spectra library. The result was expressed as relative content (%) based on the result of area percentage.

### Total antioxidant content

The total antioxidant content was observed by using a phosphomolybdenum method adopted from Udayaprakash et al. (2015). In short, 4.5 ml antioxidant reagent consisting of 0.6 M sulphuric acid, 28 mM sodium phosphate, and 4 mM ammonium molybdate was transferred into 0.5 ml of the sample. Afterwards, the incubation in a water bath (95°C, 90 min) was conducted. The absorbance was measured at 695 nm after the solution reached ambient temperature. The total antioxidant content was expressed as milligrams of tannic acid equivalent per gram of the plant extract (mg TAE/g extract) constructed by a standard plot of tannic acid ( $R^2=0.9902$ ).

### DPPH-radical scavenging activity

DPPH radical scavenging activity of the essential oils and its main constituent were investigated by a method described by Singh et al. (2007). In brief, 4 mL DPPH 0.01 mM was added with 100  $\mu$ L of the essential oils. The absorbance was measured by using UV-visible spectrophotometer (Varian Cary 50 Bio, Agilent Technology) after 30 minutes incubation under a dark condition under wavelength 517 nm. BHA (butylated-hydroxyanisole) 100  $\mu$ g/ml was used as the reference. DPPH-reaction inhibition can be calculated as follow:

$$\% \text{inhibition} = [(Ac - As) \times 100] / Ac$$

which Ac = absorbance control; As = absorbance sample

### Chocolate preparation

Cocoa liquor (44%), cocoa butter (35%), sugar (21%), lecithin (0.4%), baking soda (0.1%), and vanilla (0.1%) were used to formulate dark chocolate bars. Cinnamon essential oils were added in three different levels, which were 0.25%, 0.50% and 0.75%.

The chocolates were prepared by several steps including mixing, pre-refining, conching, refining, cooling, tempering, moulding, and demoulding. The mixing process was conducted at 50°C for 2-3 hours. Afterwards, pre-refining process was performed at 42°C for 21 hours to reduce the particle size. After pre-refining, conching process was employed at 60°C for 16 hours. The process led the removal of moisture content and development of flavour. Cinnamon essential oil was added in the beginning of refining process at 50°C for 10 minutes. Afterwards, the chocolate was tempered to obtain the most stable crystals followed by moulded, demoulded, and packaged using aluminum foil. The chocolate was storage at 4°C temperature in 2 weeks before evaluated by the panelist.

### Sensory evaluation

The evaluation of consumer was performed by 30 untrained panelists. A preliminary selection was conducted to obtain panelists who habitual or potential consumers of dark chocolate. Three samples of chocolate were presented to the panelists. A five-point hedonic scales (5 = extremely like, 3 = liked nor disliked and 1 = extremely dislike) was used to evaluate five sensory attributes namely color, aroma, taste, appearance, and overall. The panelists were requested to take a rest between the assessments of aroma and clean their palates with water and crackers between the assessments of taste in order to avoid sensory exhaustion.

### Color measurement

A colorimeter (Minolta Model CM-2500D Spectrophotometer, Konica Minolta Sensing, Tokyo, Japan) was used to measure the parameter of  $L^*$  (lightness component  $a^*$  (green to red component) and  $b^*$  (blue to yellow component) based on CIELAB system (Saputro et al. 2016). Total Color Difference (TCD) between the cinnamon essential oils enriched-chocolate and control could be calculated as follow:

$$TCD^* = \sqrt{(L_f - L_i)^2 + (a_f - a_i)^2 + (b_f - b_i)^2}$$

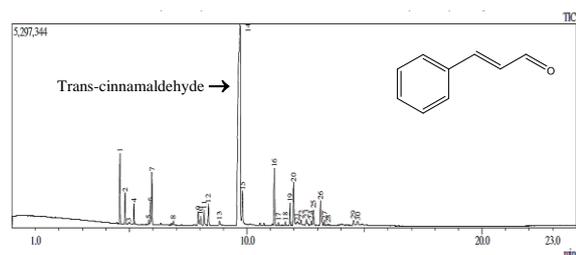
### Data analysis

Statistical analysis was performed by the software SPSS for Windows (Version 16) using One-Way Analysis of Variance (ANOVA) with Duncan's Multiple Range Test (DMRT). In all analyses, a value of  $p < 0.05$  was considered to be significant. The research design used a completely randomized design (CRD) pattern with one factorial: addition of cinnamon essential oil.

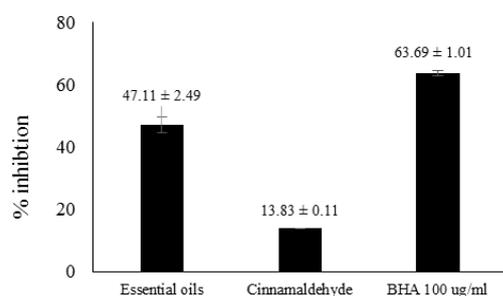
## RESULTS AND DISCUSSION

### Aroma profile and antioxidant properties of cinnamon essential oils

Phytoconstituent analysis by GC-MS provides the information of various biological active compounds of the essential oils. The chromatogram of the essential oils is shown in Figure 1.



**Figure 1.** GC-MS chromatogram of *C. burmanii* Blume essential oil. Insert: Chemical structure of trans-cinnamaldehyde



**Figure 2.** DPPH-radical scavenging activity of cinnamon essential oils, cinnamaldehyde, and BHA 100 µg/ml

In this recent study, trans-cinnamaldehyde has been detected as the main aromatic compound in the cinnamon essential oils with relative content 55.45%. This result is in agreement with several previous literatures that cinnamaldehyde is the major constituent in cinnamon essential oils (Li et al. 2013; Singh et al. 2007). Mahattanatawee et al. (2005) described the specific odor of trans-cinnamaldehyde that it has a cinnamon spicy aroma. The odor threshold has been reported in the level of 6mg/L (Narbona et al. 2010).

A considerable amount of literature shows that cinnamaldehyde has anti-microbial activity (Wei et al. 2011). Nevertheless, cinnamaldehyde has been reported to have excessive potency in human health, such as anti-inflammatory, anti-cancer, anti-mutagen, hypoglycemic and hypolipidemic activity (Babu et al. 2007; King et al. 2007; Tung et al. 2008; Koppikar et al. 2010). Singh et al. (2007) reported that cinnamaldehyde has a potency to scavenge radical activity and to inhibit an oxidative reaction. In this current research, total antioxidant activity was observed by using phosphomolibdenum method. It was found that the antioxidant activity of the cinnamon essential oils was  $0.60 \pm 0.05$  mg TAE/g. The DPPH-radical scavenging activity of the cinnamon essential oils is presented in Figure 2.

Figure 2 shows that the essential oils have a higher antioxidant activity than cinnamaldehyde. It implies that other constituents might play an important role in scavenging radical reaction. More than 30 minor compounds had been detected in the cinnamon essential oils (Figure 1). The antioxidant activity of cinnamon

essential oils was much lower than BHA 100 µg/ml. It indicates that in the point of a view antioxidant activity, enrichment cinnamon essential oils in a chocolate formula is not an effective approach. Nevertheless, the role of cinnamaldehyde as physiologically active components in the diet is being increasingly acknowledged. The addition might improve health-related properties of the chocolate such as its anti-peroxidative effect. In the paper of Babu et al. (2014), cinnamaldehyde was effective to protect pancreatic  $\beta$ -cells damage in the concentration of 20 mg/kg body weight.

### The effect of essential addition on the consumer acceptability

Due to the potential health benefit of cinnamon, the attention of researcher and food industry to formulate cinnamon-based functional food has rapidly increased in the last decade. However, it is still extremely challenging, since cinnamon is well-known to have strong aromatic compounds. It might alter consumer acceptability on the food. Consumer liking is one of the most important keys to winning a competition, particularly in a food business. According to Shyamala et al. (2006), sensory evaluation provides a representative outlook about the consumer acceptability, either like or dislike, of a particular flavor or product. Dark chocolate bars enriched with 0.25%, 0.50%, and 0.75% cinnamon essential oils were evaluated by hedonic test with scaling method. The results are presented in Table 1.

The results showed that addition of cinnamon oil at different levels resulted in non-significant differences in the color score. All the samples had an average score in which close to “like”. The basic color of dark chocolate is constructed by a high proportion of cocoa liquor. During the roasting, polyphenol compound may oxidize or react with other compounds to form dark color (Beckett and Stephen 2008). A few drops of essential oils did not contribute significantly to the changes of the darkness. Therefore, the level of panelist’ acceptability remained stable. This thesis was also supported by the result of color analysis by using a colorimeter. The obtained value of Total Color Difference between the samples and chocolate control were in the range of 1.00-3.00 (small different). (Table 2).

Appearance, particularly the glossiness, is one of the most important parameters in a chocolate product. This parameter is influenced significantly by the tempering process that it aims to form a stable fat crystal and then induces glossy appearance in chocolate (Afoakwa et al. 2008). The addition of cinnamon essential oils did not significantly influence on the appearance parameter and further the essential oils would not change the panelists’ acceptability on the dark chocolate.

Taste and aroma are important organoleptic parameters in food quality. Albak and Tekin (2014) reported that addition of cinnamon powder changed the taste of chocolate. In this study, the addition of 0.25% cinnamon essential oils obtained the highest score from the panelists on the taste parameter among the samples. In our previous part of the study, cinnamaldehyde was observed as the

**Table 1.** Sensory evaluation of cinnamon essential oil (*Cinnamomum burmannii*) on dark chocolate by hedonic scale

Essential oils addition	Sensory scale				
	Color	Aroma	Taste	Appearance	Overall
0.25%	4.23 <sup>a</sup> ±0.93	3.87 <sup>a</sup> ±1.22	3.53 <sup>b</sup> ±1.16	4.17 <sup>a</sup> ±0.79	3.70 <sup>b</sup> ±1.17
0.50%	4.37 <sup>a</sup> ±0.71	3.60 <sup>a</sup> ±1.10	2.40 <sup>a</sup> ±1.24	4.20 <sup>a</sup> ±0.76	3.13 <sup>ab</sup> ±1.16
0.75%	4.30 <sup>a</sup> ±0.79	3.60 <sup>a</sup> ±1.22	2.67 <sup>a</sup> ±1.32	4.10 <sup>a</sup> ±0.75	3.03 <sup>a</sup> ±1.18

Note: Samples with same letter in the same column are not significantly different from each other. Hedonic scale: 1. extremely dislike, 2. dislikes, 3. not liked nor disliked, 4. like, 5. extremely like

**Table 2.** Color properties of dark chocolate enriched with cinnamon essential oils

Parameter	Control	Essential oils addition		
		0.25%	0.50%	0.75%
L*	28.46 <sup>a</sup> ±0.48	30.00 <sup>b</sup> ±0.23	29.66 <sup>b</sup> ±0.70	30.32 <sup>b</sup> ±0.31
a*	7.35 <sup>a</sup> ±0.36	7.36 <sup>a</sup> ±0.35	7.52 <sup>a</sup> ±0.77	7.31 <sup>a</sup> ±0.23
b*	7.24 <sup>a</sup> ±0.65	7.22 <sup>a</sup> ±0.01	7.87 <sup>a</sup> ±0.77	7.56 <sup>a</sup> ±0.59
<sup>0</sup> Hue	44.41 <sup>a</sup> ±0.24	44.42 <sup>a</sup> ±0.19	46.30 <sup>a</sup> ±0.57	45.90 <sup>a</sup> ±3.16
TCD	-	1.54	1.36	1.88

Note: Samples with same letter in the same row are not significantly different from each other. TCD was calculated to determine the color difference between the sample and the chocolate control

major compound in the cinnamon essential oils. According to Thomas and Kuruvilla (2012), essential oils extracted from cinnamon leaves and bark oil have a spicy taste. Thus, it can be expected that adding 0.50% and 0.75% resulted in too much spicy taste, and then decreased the acceptability.

Interestingly, the panelist acceptance on aroma parameter was not significantly different in different concentration. However, addition 0.25% of the cinnamon essential oil was near to “like”, while the other samples closed to “like nor dislike”. This might be the panelists’ smelled extremely strong cinnamon aroma in addition of 0.50% and 0.75%.

In overall parameter, dark chocolate with addition of 0.25% presented the highest panelists’ acceptance, whereas addition 0.75% resulted in the lowest panelist’ acceptance. This parameter was strongly affected by the taste parameter. It shows that panelists are more likely to choose dark chocolate with a slight taste of cinnamon. Higher concentrations of cinnamon essential oil on dark chocolate might significantly reduce the acceptability of the product.

### Future perspective

This preliminary study is remarkable for the future research. Cinnamon has been reported to have a positive effect on human health, such as on the inhibition of angiogenesis in cancer cells and prevention of Alzheimer’s disease, and a series of functions such as antioxidant, anticholesterol, antidiabetic, antibacterial, antifungal, and repellent activities (Hamidpour et al. 2015). Cinnamaldehyde and polyphenol play an important role in these activities (Koppikar et al. 2010).

In this study, the addition of high-level cinnamon reduced panelist acceptance on the dark chocolate. Spicy

and bitter taste, as well as a strong flavor of cinnamon dark chocolate, might be the main reason. An alternatives approach is that the level of cinnamon enrichment in food matrix should be restricted. However, this approach may not an appropriate way for obtaining the beneficial effect of cinnamon. According to Handford et al. (2014), nano-encapsulation process can have significant impacts to solve this issue. Therefore, encapsulation might be an interesting topic for the further study.

This paper clearly indicates that the addition of cinnamon essential oils significantly influence on consumer liking of dark chocolate. Dark chocolate bar with the addition of 0.25% cinnamon essential oil showed the highest panelists’ acceptance, particularly for taste and overall attributes. The higher concentration could significantly decrease consumer acceptability. On one hand, the addition of cinnamon in a little concentration is acceptable for the consumer. However, on the other hand, the positive impact on the health would not be acquired. In order to that purpose, further research in the topic of encapsulation of the cinnamon essential oils. It might give beneficial impact to mask the aroma of the essential oils.

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