Addition of Virgin Coconut Oil: Influence on the Nutritional Value and Consumer Acceptance of Dark Chocolate

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ABSTRACT The nutritional properties of virgin coconut oil (VCO) is well known throughout the world but the oily mouthfeel is limiting its oral consumption. The addition of VCO into dark chocolate will offer a new way of consuming VCO as well as improving the dark chocolate's nutritional properties. VCO was added into the dark chocolate formulation and the functional properties of the new virgin coconut oil (VCO) dark chocolate were investigated against selected commercial dark chocolates as references. Total phenolics content and Dipehnyl-1-hydrazyl (DPPH) scavenging activity analyses were performed to determine its antioxidant properties. VCO chocolate was tested for proximate analysis to determine its nutrition content. Sensory evaluation was also done to determine the consumer acceptability. It was found that the VCO chocolate has the highest total phenolic content (7.92 mg/g) in comparison with reference chocolate (7.48 mg/g, 7.49 mg/g, and 7.52 mg/g). Proximate analysis showed that the nutrition of VCO chocolate is high in fat, protein and ash. The sensory result showed that addition of VCO into dark chocolate formulation is acceptable among consumer. VCO chocolates proved to enhance nutritional properties of dark chocolate thereby offering a potential use for nutraceuticals and functional application.

KEYWORDS: Dark chocolate; virgin coconut oi; nutrition; antioxidant; functional application; sensory.

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INTRODUCTION

Cocoa and cocoa-derived products, particularly chocolates have gained its popularity attributed to its unique and complex flavors. Milk chocolate is the predominant form of chocolate consumed worldwide. It contains cocoa liquor and milk solids from 10-12% and 37% respectively. Meanwhile, dark chocolate or sometimes called bittersweet chocolate contains at least 15% cocoa liquor. The remainder ingredients would be sugar, cocoa butter, and other additives such as vanillin and lecithin. The characteristic of chocolate taste is universal, but the pleasure of eating chocolate is induced by its cocoa, fat and sugar content (Ackar *et al*., 2013). Meanwhile, the astringent sensation is contributed by the polyphenols in the chocolate while other compounds such as alkaloids, amino acids, peptides, and pyrazines affected its bitter taste (Sulistyowati & Misnawi, 2008).

The origin of polyphenols particularly flavonoids can be diverse in the human diet, for example, vegetables, whole grains, seeds, nuts, spices and herbs (Kris-Etherton & Mustad, 1994; Tenore *et al*., 2012). Flavonoids provide the nutritional and functional properties to food as well as an excellent antioxidant source for health (Tenore *et al*., 2012). Many studies have reported that cocoa beans contained an abundant amount of flavonoids with flavan-3-ols as its major components. These flavan-3-ols was identified to be catechin and epicatechin (Miller *et al*., 2006). The amount of flavonoids in cocoa products depends on many factors, including the bean variety, postharvest handling, fermentation, drying, roasting process and the chocolate formulation (Stahl *et al*., 2009).

Virgin coconut oil (VCO) has gained a lot of interest from the consumer due to its beneficial health effects to human. It has a sweet aroma authentic taste of coconut, stable physical and functional properties which make it suitable for food, pharmaceutical and cosmeceutical purposes (Mansor & Man, 2012). VCO contained a high amount of phenolic content and some studies reported a high correlation between total phenolic content with scavenging and reducing activity *(Nagai et al., 2003; Velioglu et al.,* 1998). The oil is rich in medium-chain triglycerol (MCT) which were easily digested and can increase the body metabolism. There are currently limited studies has been carried out to investigate the effect of VCO to dark chocolates. Hence, our study aimed to evaluate the potential application of VCO in the dark chocolate formulation and to determine its effect on the nutritional properties and sensory evaluation tests were performed to determine consumer acceptability after addition of VCO to dark chocolate. All results obtained were compared with three (3) available commercial dark chocolates as the reference.

METHODOLOGY

Materials

The cocoa liquor and cocoa butter were obtained from Guan Chong Foods Sdn. Bhd. (Johor, Malaysia). The VCO used was obtained from Institute of Bioproduct Development (Universiti Teknologi Malaysia, Malaysia) produced through the wet integrated process (Hamid *et al.,* 2011). The reference commercial dark chocolates were purchased in commercial outlets in Skudai, Malaysia and was tagged based on their cocoa liquor content as follows; Choc 1 (45%, w/w), Choc 2 (55%, w/w), Choc 3 (70%, w/w). Folin-Ciocalteu's phenol reagent and 2, 2-diphenyl-β-picryldydrazyl (DPPH) reagent were purchased from Sigma-Aldrich (Germany).

Preparation of dark chocolate with virgin coconut oil

The dark chocolate was prepared according to Camu *et al.,* (2008) with some modifications. The ingredients were shown in Table 1. Briefly, the cocoa liquor and sugar was refined using two-roll refiner, and melted cocoa butter was then added to the refiner. Next, the chocolate mix was conched at 50˚C for 24 hr together with lecithin and vanillin and the chocolate was then tempered using method mention by Lindecrantz (2014). The chocolate was molded into a block and left to set at 14°C and kept for further use. 250 g of prepared chocolate was weighted and melted using the double boiler and 25 g (10% v/w) of VCO was added to the chocolate and mixed thoroughly. The VCO chocolate was left to set at 14˚C and kept in air tight sealed pack for analysis.

Table 1. The chocolates ingredient formulation (%) of VCO chocolate and reference dark chocolate

Product	Cocoa liquor	Cocoa Butter	Other
VCO chocolate	42.5	13.2	44.25
Choc 1	45	15	40
Choc 2	55	14.5	30.5
Choc 3	70	10.5	19.5

Preparation of chocolate extract

The chocolate extract was prepared as per Wollgast *et al.,* (2001). Briefly, all chocolate sample was defatted using hexane with the ratio of 1:20 (w/v) prior to overnight drying at 40°C. The extract obtained was kept in an air-tight container, sealed and stored at -20°C for further analysis.

Total phenolic content (TPC) determination

TPC was assayed as reported by Cheng *et al.,* (2009) with some modifications. 40 ml of 80% aqueous ethanol was added to 0.25 g chocolate samples, then it was sonicated for 30 min. The crude extracts were filtered through a filter paper with a pore size 11 µm (Whatman No.1). 1 ml of the

filtrate was mixed with 2.5 ml of 0.2N Folin-Ciocalteau reagents, followed by addition of 7 ml of saturated sodium carbonate (Na_2CO_3). It was kept in the dark for 2 hr. The absorbance was measured using UV–Vis spectrophotometer (Perkin– Elmer Lambda 25, Waltham, MA) at 725 nm. Gallic acid (0–1000 mg/l) was used as a standard for calibration curve preparation. The total phenolic content was expressed as mg of GA equivalence (GAE) in 1 g of dry weight extract.

DPPH radical scavenging assay

The scavenging activity was analyzed according to the method described by Lai *et al.*, (2001). 100 mg of the chocolate extract was added with 10 ml ethanol, mixed thoroughly and centrifuged at 2655 g for 5 min (Hettich, Germany). Catechin was used as the reference standard for this assay. 1 ml of supernatant was mixed with 0.5 ml DPPH (0.1 mM) solution and left to stand for 30 min before measuring the absorbance at 517 nm using UV–Vis spectrophotometer (Perkin– Elmer Lambda 25, Waltham, MA). The results were evaluated by comparing the absorbance of samples and standard. The DPPH radical-scavenging activity was calculated using the following equation: DPPH = (1 – Absorbance of sample at 517nm / Absorbance of control at 517nm) x 100 (Othman *et al.*, 2007). EC_{50} value was also determined based on plotted graph of DPPH scavenging activity.

Proximate analysis

The proximate analysis in chocolate was determined according to AOAC (2000). Briefly, the sample was dried at 100°C in an oven (Binder, Germany) for 5 hours to determine the moisture content. The ash content was determined by further heating the sample in a muffle furnace (Carbolite, United Kingdom) at 600°C until a grey ash was obtained. Total fat content was determined by hydrolyzing the samples (2 g) with diluted hydrochloric acid prior to Soxhlet extraction. Meanwhile, protein determination at a conversion factor of 6.25 was analyzed based on macro-Kjeldahl procedure. The obtained data were used to calculate the energy of the chocolates by using the Atwater system (Stewart, 1992).

Chocolate sensory evaluation by taste panel

The chocolate sensory analysis was performed by a semi-trained panel of 30 members from Institute of Bioproduct Development, UTM, Malaysia. The age of the panels was from 19-55 years old with 10 men and 20 women. The flavour described were aroma, sweetness, bitterness, oily taste, melting properties, mouthfeel and overall acceptability expressed in a hedonic scale from 1 to 5 with 1 for extremely dislike to 5 extremely like.

Statistical analysis

All tests were done in triplicates. The ANOVA test with post hoc Tukey test was used for data processing and statistical analysis. Mean were accepted as significantly different at 95% level ($p<0.05$).

RESULT AND DISCUSSION

Total phenolics content

Our data showed that VCO chocolate yielded the highest total phenolics (7.92 ± 1.24 mg/g) followed by Choc 3 (7.52 ± 1.97 mg/g), Choc 2 (7.49 ± 1.38 mg/g) and Choc 1 (7.48 ± 1.49 mg/g). The statistical analysis using ANOVA showed there was a significant difference between chocolate's phenolic content at a significance level of ($p<0.05$). Concentration of phenolics in chocolate are associated with the amount of cocoa (cocoa liquor and cocoa butter) content, i.e. chocolate with higher amount of cocoa will have higher amount of phenolic, and this will also contribute to higher antioxidant properties of the chocolate (Cheng *et al.*, 2009; Jan, 2004). Meanwhile, according to researches done by Marina *et al.*, (2009a) and Marina *et al.*, (2009b), VCO contains 0.06 - 0.3 mg/g

total phenolics which may contribute to the higher amount of phenolics and higher antioxidant activity in the VCO chocolate.

DPPH scavenging activity

The chocolate's antioxidant activity was evaluated using radical scavenging assays as a substrate. All chocolates showed highest scavenging activity at the concentration of 1.4 mg/mL. Standard catechin exhibited scavenging activity of 97%. VCO chocolate and Choc 3 have scavenging activities of 91% and 92% respectively where it is almost comparable with standard catechin. Choc 2 and Choc 1 have a lower scavenging activity of 65% and 63% respectively. The scavenging activity was in descending order of Choc 3 > Choc 2 > Choc 1. Interestingly, VCO chocolate showed better scavenging power compared to all three reference chocolates despite the fact it contained only 42.5% cocoa content. The scavenging power may be attributed to the addition of VCO into the formulation. The temperature used to prepare the VCO chocolate is very mild (37 °C) which could preserve and enhanced the antioxidant properties in the VCO chocolate.

The activities may be best described by the EC_{50} defined as the extract concentration required to scavenge the radical concentration by 50% (Table 2). VCO Choc have lower EC_{50} than other reference chocolates. The scavenge power could be contributed by VCO as mentioned by Marina et al. (2009b) that the EC_{50} of VCO is 1.66 ± 0.01 mg/mL. The EC_{50} also showed that VCO chocolate is 2 times more efficient in scavenging free radicals than Choc 2, and 4 times more than Choc 1.

Table 2. Effective concentration 50% (EC_{50}) of VCO chocolate and reference dark chocolates extract on DPPH radicals.

Chocolate extract	EC_{50} (mg/mL)
Standard	0.25 ± 0.05^{a}
VCO choc	0.35 ± 0.012^{b}
Choc 1	1.22 ± 0.25^{c}
Choc 2	0.65 ± 0.20^{d}
Choc 3	0.4 ± 0.15^{e}

Values are given as mean ± SD (n = 3). Different superscript lower case letters in the same column indicate significant differences (*p< 0.05, Tukey's test*)

Proximate analysis

Table 3. Proximate analysis value of VCO chocolate and reference dark chocolates

	VCO Choc	Choc 1	Choc 2	Choc 3
Carbohydrate	52.8 ± 1.0^{b}	60.28 ± 1.60^{c}	58.67 ± 1.31^{c}	43.43 ± 2.00^{a}
Protein	9.8 ± 0.13^{d}	4 ± 0.11^{a}	6.2 ± 0.79^{b}	7 ± 0.11^{c}
Fat	46 ± 1.05^{c}	39.34 ± 0.6^{a}	36.6 ± 0.5^{b}	33.43 ± 1.80^{a}
Moisture	1.34 ± 0.20^{c}	0.89 ± 0.10^{b}	0.78 ± 0.05^{a}	1.46 ± 0.03^{d}
Ash	3.16 ± 0.5^{c}	2.33 ± 0.09^{b}	1.75 ± 0.05^{a}	2.11 ± 0.16^{b}
Energy	667.95 ± 19.37^{d}	583.80 ± 3.06^{b}	571.88 ± 4.67^{b}	489.84 ± 22.42^{a}

Values are given as mean ± SD (n = 3). Different superscript lower case letters in the same row indicate significant differences (*p< 0.05, Tukey's test*)

The nutritional profile of the VCO chocolate was shown in Table 3. The protein, fat, ash and energy value of VCO choc is significantly higher that reference dark chocolate. Lonchampt & Hartel (2004) proposed chocolate fat content to be around 30% (w/w). Our chocolate had a fat content value of 46 ± 1.05 %; above proposed content due to the addition of VCO in the formulation. Even though the fat content of VCO choc is higher, the type of fat in VCO is healthy and valuable as VCO contain a high amount of lipid especially MCT (Marina *et al.*, 2009b). Many studies have reported the

beneficial nutritional and functional properties of MCT (DebMandal & Mandal, 2011) for human health, pharmaceutical use as well as to the manufacturing industries. VCO choc was also found to contained higher amount of protein and ash. The Atwater system uses the average values of 4 Kcal/g of protein, 4 Kcal/g of carbohydrate, and 9 Kcal/g of fat and this high fat content resulting in the higher energy value of VCO choc. VCO was found to be significantly affecting the nutritional properties of dark chocolate.

Chocolate sensory evaluation

VCO choc has higher acceptability for aroma, sweetness, bitterness, melting properties, and overall acceptability as shown in Figure 2. Choc 3 having the most cocoa liquor was more bitter than other chocolate and has more cocoa flavour. Choc 1 and Choc 2 has medium acceptability among consumer but Choc 1 is sweeter than Choc 2 due to its higher sugar content. VCO choc has best overall acceptability than Choc 3, Choc 1 and finally Choc2.

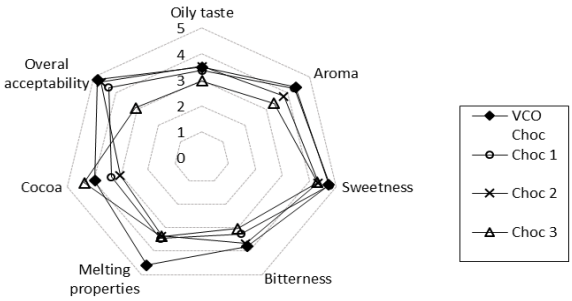

Figure 1. Flavour profile for VCO Choc, Choc 1, Choc 2, and Choc 3. The center of the diagram corresponds to the least flavour acceptability and the perimeter to the most desirable acceptability.

CONCLUSION

This study revealed that VCO can enhance the nutritional for antioxidant, medium chain fatty acid and protein content of dark chocolate compared to commercial dark chocolate. In addition, the findings also provide an alternative way to consume VCO by substitutes it in suitable food formulation like chocolate in order to provide a better choice for health food and preventing chronic diseases to the consumer.

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