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FULL PAPER

Product development of passion fruit and citrus peel dark chocolate

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Abstract

Fruit wastes, mainly the peels and the seeds are produced as by-products in large quantities due to the high consumption and industrial processing of the edible parts of the fruits. The utilization of fruit wastes such as fruit peels and seeds for food production serves as a means to reduce the environmental impact. This project aimed to develop dark chocolate by using passion fruit with seeds and orange peels as functional ingredients. Dark chocolate is well known for its high antioxidant activity, especially rich in health-promoting flavonoids. Passion fruit seeds and orange peels are high in dietary fibre content. Thus, the addition of these ingredients could increase the dietary fibre content of dark chocolate. The effects of passion fruits with seeds and orange peels on the nutritive values, antioxidant properties, and sensorial properties of dark chocolate were evaluated. The passion fruit with orange peel dark chocolate contained 51.15% fat, 9.55% moisture, 8.04% protein, 3.56% ash, and 3.06% total dietary fibre. The sample contained significantly higher ($p<0.05$) dietary fibre (3.06±0.02%) than that of the control (0.93±0.10%). Sensory qualities (colour, surface smoothness, aroma, texture, melting property, and overall acceptance) of dark chocolate were evaluated by 35 panellists using a 9-point hedonic scale. The mean overall acceptance score of the sample was 6.91 out of 9 with an acceptance index of 77%. The DPPH radical scavenging activity of the sample (86.10±0.13%) was significantly higher ($p<0.05$) than that of the control (61.10±0.13%). In conclusion, the development of passion fruit and citrus peel dark chocolate provides an alternative way to deliver health-promoting antioxidants and dietary fibre to consumers. The product has acceptable sensory quality and has a potential confectionery market.

1. Introduction

Fruit wastes such as fruit pomace and seeds are produced as by-products because of large consumption and industrial processing of the edible parts of the fruits (Ibrahim *et al*., 2017). These by-products are a good source of bioactive compounds including polyphenols, flavonoids, carotenoids as well as dietary fibre. Dietary fibre is well-known for its health benefits such as evading hydrolysis, helping in intestinal and bowel health, enhancing colonic fermentation, reducing preprandial cholesterol levels and maintaining insulin levels (López, *et al*., 2010). Chocolate is one of the most popular sweet snacks. Dark chocolate contains relatively high amounts of flavonoids including catechin, epicatechin, and procyanidin. Dark chocolates possess antioxidants and a positive effect on cognitive function and mood (Scholey and Owen, 2013). This study aimed to develop dark chocolate with a flavour combination using passion fruit and orange peels as functional ingredients. Dietary fibre content, sensory quality, proximate composition, and antioxidant activity of the developed product were determined.

2. Materials and methods

2.1 Preparation of passion fruit powder

The passion fruit pulp (passion fruit with seeds) was collected and blended using Waring blender for a 1-minute interval with 10 s rest to prevent overheating. The mixture was then spread on a plate, covered with food plastic wrap, and stored at -80°C for 2 hrs. The frozen sample was then freeze-dried for 3 days. The freeze-dried sample was then ground and sieved with a 150 µm sieve.

2.2 Preparation of orange peel powder

The oranges were first dewaxed using the boiling water method. The oranges were placed into the colander

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and boiled water was poured over the oranges. Then the oranges were scrubbed using a vegetable brush under cool running water to remove any wax residue. Finally, the oranges were wiped gently using clean paper towels. The orange peel was separated from the whole fruit with the albedo part removed. The orange peel was stored at -80°C freezer for 2 hrs before freeze-drying for 1 day. The freeze-dried sample was then ground and sieved with a 150 μm sieve.

2.3 Preparation of dark chocolate

The formulations of dark chocolate are displayed in Table 1. The cocoa butter in a bowl was heated by applying the double-boil method. Once the cocoa butter was melted and the temperature reduced to 50°C, unsweetened cocoa powder was sieved, slowly added to the melted cocoa butter, and mixed well with a balloon whisk to give a smooth chocolate liquid mixture. Honey, passion fruit and orange peel powder was added slowly before the tempering step to achieve a temperature of 26° C, followed by a reheating step until the temperature reaches 31°C to obtain a stable fat crystallization of the cocoa butter. The chocolate mixture was mixed well and poured into a mould. The chocolate was set at room temperature for 20 mins and then transferred to a refrigerator. The chocolate was removed from the mould and stored at 4°C. The control dark chocolate was prepared in the same way without adding passion fruit and orange peel powder.

Table 1. Formulations of dark chocolate (control) and passion fruit and citrus peel dark chocolate (sample).

	Control	Sample
Cocoa butter	30 g	35 g
Unsweetened cocoa powder	25 g	25 g
Honey	20 g	20 g
Passion fruit powder	-	3 g
Orange peel powder	-	3 g

2.4 Proximate analysis

Proximate analysis was done in duplicate for moisture (Hot air oven method), protein (Kjeldahl method), ash, total dietary fibre (Fibretec method), and fat contents (Soxhlet method) according to the AOAC method (William and George, 2005).

2.5 Antioxidant assay

Defatting of chocolate samples was carried out according to Övet (2015). Chocolate extracts were prepared according to Cerit *et al*. (2016). The antioxidant activity was determined using DPPH (2,2-diphenyl-1-picrylhydrazyl) assay according to the method of Cerit *et al*. (2016).

2.6 Sensory evaluation

Control and sample were evaluated by 35 panellists using a 9-point hedonic scale (1: dislike extremely to 9: like extremely). The panellists were asked to evaluate the degree of liking for the various sensory attributes (surface smoothness, aroma, texture, melting properties, and overall acceptance) of dark chocolates. All samples were labelled with 3-digit random digits and were arranged on trays based on a random permutation table. A preference test was also conducted. The acceptance Index of control and sample was calculated using the formula below.

Acceptance Index = (Mean overall acceptability score/9) × 100

2.7 Data analysis

All data obtained were tabulated using Microsoft ® Excel 2016 and analyzed with IBM SPSS ® software. The mean and standard deviation values ($\bar{x}$±SD) were determined while a t-test with a confidence level of 95% was used to determine significant differences.

3. Results and discussion

Table 2 presents the proximate composition of control and sample, the sample had significantly higher fat content (51.15%) and dietary fibre content (3.06%) while lower in moisture content (9.55%), protein content (8.04%), and ash content (3.56%) compared to control. The increased dietary fibre content of the sample was attributed to the addition of passion fruit seeds and orange peels. The passion fruit raw seeds were rich in total dietary fibre (64.8 g/100 g) (Chau and Huang, 2004), while orange peels contain 64.3% total dietary fibre (Figuerola *et al*., 2005).

Table 2. Proximate composition of control and sample

	Control	Sample
Moisture content (%)	10.56±0.67^{a}	9.55±0.06^{a}
Crude fat (%)	48.82±0.33^{a}	51.15±0.23^{b}
Dietary fibre (%)	0.93±0.10^{a}	3.06±0.02^{b}
Crude protein (%)	9.00±0.03^{a}	8.04±0.50^{a}
Ash (%)	4.69±0.11^{a}	3.56±0.08^{b}

Values are presented as mean±SD. Values with different superscript within the same row are significantly different ($p<0.05$).

Table 3 shows the DPPH radical scavenging activity of the sample (86.10±0.13%) was significantly higher than that of the control (61.10±0.13%). The addition of passion fruit powder and orange peels powder caused an increase in the antioxidant activity of dark chocolate. Polyphenols in passion fruit powder and orange peel powder are major contributors to antioxidant activity. The main flavonoids in cocoa and chocolate are the

flavan3-ols catechin and epicatechin (monomeric units) and proanthocyanidins, which are polymeric compounds comprising catechin and epicatechin subunits (Steinberg *et al*., 2003). The citrus flavonoids include a class of glycosides, namely, hesperidin and naringin, and another class of O-methylatedaglycones of flavones such as nobiletin and tangeretin (Rafiq *et al*., 2018).

Table 3. Antioxidant activity of control and sample

Type of assay	Control	Sample
DPPH (%)	61.10±0.13[a]	86.10±0.13[b]

Values are presented as mean±SD. Values with different superscript within the same row are significantly different ($p<0.05$).

The mean sensory scores were analysed using a t-test. The sample scored higher in colour, surface smoothness, the aroma of passion fruit and orange peel, overall acceptability, and lower in texture and melting property compared to the control (Table 4). However, there was no significant difference between the sensory quality of the control and the sample. Figure 1 shows the comparison of the overall acceptance between the control and sample. The acceptance index of the sample is higher (77%) compared to the control (75%).

Table 4. Mean scores for different sensory attributes of control and sample

	Control	Sample
Colour	6.69[a]	6.83[a]
Surface smoothness	6.94[a]	7.23[a]
Passion fruit and orange peel aroma	5.06[a]	5.77[a]
Texture, smoothness	6.54[a]	6.37[a]
Melting property	6.86[a]	6.60[a]
Overall acceptance	6.74[a]	6.91[a]

Values are presented as mean±SD (n = 35). Values with different superscript within the same row are significantly different ($p<0.05$).

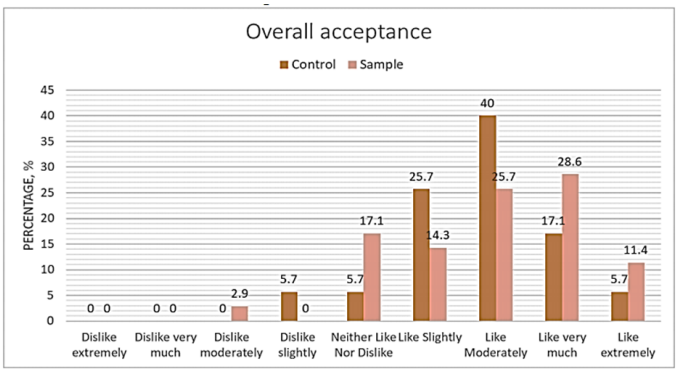

Figure 1. Comparison on the overall acceptance of control and sample

4. Conclusion

The addition of passion fruit powder and orange peels powder into dark chocolate significantly increased its dietary fibre content (3.06±0.02%) and DPPH radical scavenging activity (86.10±0.13%). The product meets the nutritional claim as a "source of" dietary fibre. The development of passion fruit and orange peel dark chocolate provides an alternative way to deliver health-promoting antioxidants and dietary fibre to consumers. The product demonstrated acceptable sensory quality with an Acceptance Index of 77%. The utilization of agricultural waste such as fruit seeds and peels in functional food production has significant implications for population health and environmental protection.

Conflict of interests

The authors declare no conflict of interest.

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