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*Corresponding author: Lee-Hoon Ho, Faculty of Bioresources and Food Industry, Department of Food Industry, Universiti Sultan Zainal Abidin, Tembila Campus, 22200 Besut, Terengganu, Malaysia
E-mails: holeehoon@yahoo.com, holeehoon@unisza.edu.my

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FOOD SCIENCE & TECHNOLOGY | RESEARCH ARTICLE

Nutritional composition, physical properties, and sensory evaluation of cookies prepared from wheat flour and pitaya (*Hylocereus undatus*) peel flour blends

Lee-Hoon Ho[1]* and Nadratul Wahidah binti Abdul Latif[1]

Abstract: Food waste produced from fruits and vegetables processing plants possesses an important natural and valuable material in producing less expensive functional food due to the presence of several bioactive substances. Therefore, the aim of the present study is to investigate the nutritional composition, physical properties, and sensory quality of the control, wheat flour cookies substituted with 5, 10, and 15% pitaya peel flour (PPF). The proximate analyses results demonstrated that PPF-containing cookies had significantly higher ash, fiber, and carbohydrate content but lower moisture and protein than the control. Physical analyses results showed that cookies incorporated with PPF had higher diameter and spread ratio but lower crumb height than the control. Sensory evaluation results indicated that wheat flour partially substituted with PPF up to 15% level did not affect to the overall acceptability ratings of cookies by panelists. Thus it can be concluded that PPF can be partially substituted for wheat flour in cookies to improve the nutritional quality without affecting the sensory acceptability of composite cookies.

Subjects: Food Analysis; Nutrition; Sensory Science

Keywords: pitaya peel flour; cookies; nutritional composition; physical properties; sensory evaluation

ABOUT THE AUTHORS

Lee-Hoon Ho is a senior lecturer working at the Universiti Sultan Zainal Abidin, Terengganu, Malaysia. Her research area includes food product development and food quality evaluation. She has several publications related with health food product development, sensory studies, and compositional analysis of foods. The present study focuses on the development of healthy baked product with high nutrient composition by utilizing pitaya fruit peel, a byproduct of pitaya beverage industry.

Nadratul Wahidah binti Abdul Latif completed her bachelor's degree in Food Technology from Universiti Sultan Zainal Abidin, Terengganu, Malaysia. This is a part of her final year research work. She is presently working as a quality assurance executive at a local private food industry in Malaysia.

PUBLIC INTEREST STATEMENT

The research reported in this article deals with utilization of fruit waste material from food industry. Pitaya fruit (dragon fruit) is one of the major tropical fruits that can be processed into various products such as jams, beverages, and candied fruits. A large amount of peel is generated during processing of pitaya fruit from beverage industry. This byproduct might become a major environmental problem if not handled properly. Several studies have proved that intake of natural bioactive compounds contribute to health benefit in protection against cardiovascular disease and cancer. Because of this, many studies had been conducted in order to modify the food products with higher nutritional values using functional ingredients sources from fruits and vegetables. Therefore, a detailed investigation dealing with development of food product using pitaya fruit peel was performed; physical studies to know the quality of the end product and sensory studies to understand its acceptability.

1. Introduction

Cookies or biscuits represent the largest category of snack item among bakery products (Pratima & Yadave, 2000). It has become one of the popular snack foods for both young and elderly people due to their affordable price, convenience, shelf-stable, and nutritive value (Akubor, 2003). Cookies often refer to a baked product that is generally prepared using three major ingredients: refined flour, sugar, hydrogenated fats, and some minor ingredients such as additives and emulsifiers (Wani, Gull, Allaie, & Safapuri, 2015). Cookies are widely accepted and consumed by almost all profiles of consumers from many countries and therefore offer a valuable supplementation vehicle for nutritional improvement (Arshad, Anjum, & Zahoor, 2007). It provides an excellent means of improving the nutritional quality (protein, minerals, vitamins, and bioactive compounds) of foods through incorporation of less expensive non-wheat flour for food product enrichment (Okafor, Ozumba, & Solomon, 2002). Recently, cookies are prepared from composite flour or fortified with some other good source of nutrient flour such as whey protein concentrate, wheat germ, oyster mushroom, cassava, and water chestnut flours to improve its nutritive value (Arshad et al., 2007; Bala, Gul, & Riar, 2015; Noor Aziah, Mohamad Noor, & Ho, 2012; Okafor et al., 2002; Wani et al., 2015).

Pitaya (*Hylocereus* spp.), or locally known as dragon fruit, is one of the popular tropical plants that produce edible fruits. It belongs to the family Cactaceae and is widely grown in tropical countries such as Malaysia, Thailand, Vietnam, and some other parts of the world (Jamilah, Shu, Kharidah, Dzulkifly, & Noranizan, 2011). There are three varieties of pitaya, namely white-fleshed pitaya with yellow peel (*Selenicereus megalathus*), white-fleshed pitaya with red peel (*Hylocereus undatus*) and red-fleshed pitaya with red peel (*Hylocereus polyrhizus*) (Barbeau, 1990). The fruit consists of small black seeds scattered in white-flesh (*H. undatus*) or intense red-purple flesh (*H. polyrhizus*) and peel (Ariffin et al., 2009).

In Malaysia, the size of pitaya farm is increasing substantially due to high demand from local and export markets (Cheah & Zulkarnain, 2008). Pitaya has recently drawn much attention from growers worldwide because of its attractive red-purple color, high nutritive value, and economic value as a fruit and beverage product (Wybraniec & Mizrahi, 2002). Pitaya peels are often discarded during processing, especially in the beverage production industries. Jamilah et al. (2011) reported that pitaya peel consisting approximately 22% of its whole fruit weight is discarded during processing. Furthermore, they also found that this discarded material contains high pectin, soluble, insoluble fiber, and betacyanin pigment but low total soluble solids, protein, ash, and fat.

The use of byproduct from fruit processing industry is an important new step for the food industry. Reusing pitaya processing byproduct, such as pitaya peel, could increase the raw material yield, thus minimizing the problems caused by the disposal of large amount of industrial byproduct and also could expand alternative food production (Bertagnolli, Silveira, Fogaça, Umann, & Penna, 2014). Many authors had reported their potentials as natural colorants and thickening agent or as a moisturizer in cosmetic products (Harivaindaram, Rebecca, & Chandran, 2008; Phebe, Chew, Suraini, Lai, & Janna, 2009; Stintzing, Schieber, & Carle, 2002). To our knowledge, there are no published reports of utilizing pitaya in cookies making. However, pitaya peel is prone to microbial spoilage after fruit processing hence, drying is necessary before further exploitation. Therefore, this research was conducted to assess the nutritional composition, physical quality, and sensory properties of cookies incorporated with pitaya peel flour (PPF).

2. Materials and methods

2.1. Materials

Pitaya (*H. undatus*) fruit was purchased from a local wet market of Besut, Terengganu, Malaysia. The pitaya flour was then processed as described in the Section 2.2. Bakery ingredients such as refined flour, sugar, butter, milk powder, baking powder, sodium chloride salt, and vanilla essence were procured from local grocery store of Besut, Terengganu, Malaysia. All reagents used were of analytical grade.

2.2. Preparation of pitaya flour

Clean pitaya peel was separated from the fruits manually with a sterile knife. Then, the peel was soaked in 0.2% sodium metabisulphite solution for 15 min to prevent browning. The peel was then sliced using the slicer before drying in a cabinet dryer at 55°C for overnight. The dried peel was then ground in laboratory mill to fine flour and kept in an airtight plastic container and stored in chiller prior to use.

2.3. Cookies preparation

Cookies were prepared according to the method proposed by Noor Aziah et al. (2012) with slight modifications. The formula used to produce the cookies is shown in Table 1. PPF replaced the refined flour at the levels of 5, 10, and 15% for the preparation of PPF5, PPF10, and PPF15, respectively. Cookies formulated without PPF was used as the control (PPF0). The butter was creamed with sugar until it became fluffy, this was then followed by adding an egg and other dry ingredients (milk powder, salt, baking powder, and flour). The dough was thoroughly kneaded for four min and then rolled manually to thickness of 5 mm using rolling pin. The sheeted dough was cut with a 3.2 mm diameter cookie cutter. All shaped dough was baked on greased tray for 14 min at 180°C in an oven. The cookies were cooled at room temperature for 30 min before packing in an airtight plastic container prior to analyses.

2.4. Proximate analyses

The proximate contents of the cookies were determined according to the official method as described by AACC (2000). Oven drying (AACC method 08–01), Kjeldahl's (AACC method 44–15A), semi-continuous solvent extraction method (AACC method 46–13), dry ashing (AACC method 30–25), and gravimetric method (AACC method 54–21) were used to analyze moisture, crude protein, crude fat, ash, and crude fiber contents, respectively. Carbohydrate content was estimated by difference [Carbohydrate (%) = 100% − % (Moisture + Ash + Crude protein + Crude fat)].

2.5. Measurement of water activity (a_w)

Water activity of the cookies was measured using a Decagon's Aqualab Series 3 water activity meter (Pullman, WA) at 25°C. Cookies crumb (about 2 g) was evenly placed into plastic cells and was allowed to equilibrate within the headspace of the sealed chamber. The reading was then recorded when the equilibration is achieved (Decagon, 2007).

2.6. Color measurement

The color of cookies was determined according to L* [Lightness (L = 100; white and L = 0; black], Chroma a* [green chromaticity (−60) to red (+60)] and Chroma b* [blue chromaticity (−60) to yellow

Table 1. Formula for the production of cookies from PPF and wheat flour

Ingredients (g)	PPF0	PPF5	PPF10	PPF15
Refined flour	180	171	162	153
Pitaya peel flour	–	9	18	27
Sugar	60	60	60	60
Butter	100	100	100	100
Egg (unit)	1	1	1	1
Milk powder	6	6	6	6
Baking powder	3.5	3.5	3.5	3.5
Sodium chloride salt	1	1	1	1
Vanilla essence (mL)	2	2	2	2

Notes: PPF5, refined flour substituted with 5% PPF; PPF10, refined flour substituted with 10% PPF; PPF15, refined flour substituted with 15% PPF.

–, Indicates without ingredient.

(+60)] space value using Konica Minolta Chroma Meter CR-400. The Chromameter was calibrated prior analysis using Konica Minolta white calibration plate.

2.7. Weight loss, diameter, thickness, and spread ratio of cookies

The cookies were selected randomly for physical analyses (weight loss, diameter, thickness, and spread ratio). The weight of the cookies before and after baking was taken to calculate weight loss. The height and diameter were measured with a caliper before and after baking. To determine the diameter of cookies, four samples were placed next to another and the total diameter was measured. All of the cookies were rotated at an angle 90° and the new diameter was measured, this was then repeated for angles of 180, 270, and 360°. The average of diameter was recorded. Thickness of the cookies was measured by four cookies stacking above the others and restacking four times. The average of thickness was recorded. The spread ratio was calculated by dividing diameter of cookies with thickness of cookies (Zoulias, Piknis, & Oreopoulou, 2000)

2.8. Hardness of cookies

Hardness of cookies was determined using a texture analyzer TA–XT2i (Model TAHDI, Stable Microsystem, Surrey, UK) with a load cell of 2 kg weight (AACC, 2000). Cookies was measured within 24 h after baking using sharp cutting bladed probe type HDP/BS blade set at a pre-test speed of 2 mm/s, test speed of 1 mm/s, post-test speed of 5 mm/s, and compression distance of 3 mm. The data of hardness were analyzed using Texture Expert Version 1.05 Software (Stable Micro System Ltd, Surrey, UK).

2.9. Sensory analysis

The sensory evaluation of the cookies was performed by 30 semi-trained panelists from the Department of Food Industry, Faculty of Bioresources and Food Industry, Universiti Sultan Zainal Abidin, Besut, Terengganu, Malaysia. The sensory evaluation was conducted using the seven-point hedonic scale as described by Watts, Ylimaki, and Jeffery (1989). The food samples were prepared in identical sample containers, coded with three-digit random numbers and each sample was presented with different number. The randomized order of the sample was presented once at a time to each panelist. Panelists were asked to evaluate the coded samples for each sensorial parameter including color, aroma, texture, flavor, and overall acceptance based on their degree of liking (1 = dislike very much; 2 = dislike moderately; 3 = dislike slightly; 4 = neither like nor dislike; 5 = like slightly; 6 = like moderately; 7 = like very much).

2.10. Statistical analysis

Statistical analyses were conducted using Statistical Package for the Social Sciences version 17.0 software (SPSS Inc., Chicago, IL, USA). The results obtained from the present study are represented as the mean values of three individual replicates ± the standard deviation. Significant differences between the mean values were determined using Duncan's multiple range tests at a significance level of $p < 0.05$.

3. Results and discussion

3.1. Nutritional compositions and water activity of cookies

The nutritional compositions of cookies (PPF0, PPF5, PPF10, and PPF15) are shown in Table 2. The substitution of PPF for refined flour beyond 5% level significantly ($p < 0.05$) lowered the moisture content of cookies. The results obtained from the present study showed similar findings from Bertagnolli et al. (2014). The authors reported that guava peel flour containing cookies has moisture content ranging from 2.7 to 4.9%. According to Bertagnolli et al. (2014), cookies with low moisture content will have longer shelf life conditions if they are stored under the control conditions such as appropriate packaging (i.e. packaging which is impervious to moisture, gasses, and preferably with a light barrier) and proper storage condition (i.e. dry and cool place). Thus, substitution of PPF for refined flour in the preparation of cookies will produce more shelf-stable product due its lower moisture content.

Table 2. Nutritional compositions and water activity of cookies

Composition	PPF0	PPF5	PPF10	PPF15
Moisture (%)	$4.35^{b} \pm 0.59$	$4.66^{b} \pm 0.19$	$1.98^{a} \pm 0.75$	$2.79^{a} \pm 0.01$
Ash (%)	$2.17^{a} \pm 0.04$	$2.39^{b} \pm 0.03$	$2.73^{c} \pm 0.04$	$3.11^{d} \pm 0.11$
Crude protein (%)	$6.73^{a} \pm 0.33$	$7.04^{a} \pm 0.02$	$6.92^{a} \pm 0.00$	$6.85^{a} \pm 0.00$
Crude fat (%)	$26.62^{b} \pm 0.22$	$26.59^{b} \pm 0.20$	$26.80^{b} \pm 0.01$	$25.87^{a} \pm 0.06$
Crude fiber (%)	$0.07^{a} \pm 0.07$	$0.73^{b} \pm 0.10$	$1.43^{c} \pm 0.05$	$2.00^{d} \pm 0.13$
Carbohydrate (%)	$60.43^{b} \pm 0.08$	$59.42^{a} \pm 0.19$	$61.17^{c} \pm 0.02$	$61.32^{c} \pm 0.02$
Water activity (a_w)	$0.35^{a} \pm 0.00$	$0.38^{b} \pm 0.00$	$0.26^{c} \pm 0.00$	$0.23^{d} \pm 0.00$

Notes: Values in the same row with different superscripts are statistically significant from each other ($p < 0.05$).
PPF5, refined flour substituted with 5% PPF; PPF10, refined flour substituted with 10% PPF; PPF15, refined flour substituted with 15% PPF.

Significant difference ($p < 0.05$) in ash content was found for all samples (Table 2). Ash content of cookies increased from 2.17 to 3.11%. The highest value of ash content (3.11%) was observed in PPF15 (15% PPF-substituted cookies) followed by PPF10 (2.73%), and PPF5 (2.39%), while lowest value for ash content (2.17%) was reported in PPF0 (control). Increase in ash content with increasing PPF substitution level may be associated with the presence of greater ash content in the pitaya peel than in the refined flour (10.57 and 0.98% for pitaya peel and refined flour, respectively) (Bala et al., 2015; Chia & Chong, 2015). These results are in accordance with Wani et al. (2015) who reported that an increase in the ash content with corresponding increase in the proportion of whey protein in cookies production.

The substitution of PPF for refined flour at levels of 5–15% did not affect to the protein and fat contents of the cookies (Table 2). This might be attributed to the similar size particle of both refined and pitaya flour which facilitates similar amount of oil extraction from food product (Chia & Chong, 2015). Fiber content of the composite cookies (0.73, 1.43, and 2.00% for PPF5, PPF10, and PPF15, respectively) was revealed to be significantly higher than in the control (0.07%). This was attributed to the higher fiber content in pitaya than refined flour. According to Chia and Chong (2015), the peel of pitaya is a good source of fiber. They reported that dried pitaya fruit peel powder has 23.75% of crude fiber which is 44-fold higher than in refined flour (Bala et al., 2015). Partial replacing of PPF for refined flour at levels 10 and 15% significantly ($p < 0.05$) increases the carbohydrate content of cookies (61.17 and 61.32% for PPF10 and PPF15, respectively). Results obtained from the present study showed similar trend with those reported by Bertagnolli et al. (2014) who observed cookies made with guava peel flour has higher carbohydrate value than in the cookies without the presence of composite flour.

The water activity results of the cookies analyzed in this study are shown in Table 2. The substitution of PPF for refined flour at levels of 10 and 15% resulted in significantly decreased in the water activity (0.26 and 0.23 for PPF10 and PPF15, respectively). Lower water activity content was observed in composite cookies may be attributed to the PPF which has component (fiber) that is able to absorb or hold large quantities of water and hence reduce the amount of available water. The stability of the baked products depends on their moisture and water activity contents. According to Cauvain and Young (2000), in a given product, as the moisture content increases or decreases, the water activity increases or decreases accordingly, which is in accordance with previous results as shown in Table 2. Similarly, for a given product, it is possible for its moisture content to change without making a major change to its water activity (Cauvain & Young, 2000).

3.2. Physical properties of cookies

The physical properties (weight loss, diameter, thickness, spread ratio, and crumb hardness) of cookies are tabulated in Table 3. Results of these studies indicated that there is significant difference ($p < 0.05$) between PPF-containing flour with control (PPF0) in terms of diameter, thickness, and

Table 3. Physical properties of cookies

Parameter	PPF0	PPF5	PPF10	PPF15
Weight loss (g)	$0.90^{a} \pm 0.04$	$0.97^{a} \pm 0.07$	$0.93^{a} \pm 0.03$	$0.94^{a} \pm 0.01$
Diameter (mm)	$17.27^{b} \pm 0.02$	$17.15^{a} \pm 0.01$	$17.36^{c} \pm 0.03$	$17.41^{c} \pm 0.03$
Thickness (mm)	$2.92^{b} \pm 0.02$	$2.91^{b} \pm 0.02$	$2.85^{a} \pm 0.04$	$2.87^{a} \pm 0.09$
Spread ratio (mm)	$5.90^{a} \pm 0.06$	$5.88^{a} \pm 0.06$	$6.09^{b} \pm 0.09$	$6.00^{ab} \pm 0.05$
Hardness (kg)	$1.40^{a} \pm 0.71$	$1.54^{a} \pm 0.18$	$1.67^{a} \pm 0.22$	$1.31^{a} \pm 0.19$

Notes: Values in the same row with different superscripts are statistically significant from each other ($p < 0.05$).
PPF5, refined flour substituted with 5% PPF; PPF10, refined flour substituted with 10% PPF; PPF15, refined flour substituted with 15% PPF.

spread ratio. However, weight loss of the composite cookies (PPF5, PPF10, and PPF15) was unaffected by partial substitution of PPF for refined flour. The cookies with 15% PPF and 85% refined flour (PPF15) had significantly greater size (17.41 mm) and were thicker (2.87 mm) than the control (cookies made with 100% refined flour). The greater size of composite cookies than the control was attributed to the protein dilution as partial substitution of PPF for refined flour. The results obtained in the present study are in agreement with those reported by Leon, Rubiolo, and Anon (1996), who stated that the diameter value has inverse correlation with protein content. Protein gluten in wheat flour plays a vital role in forming a web-like structure during dough heating and this structure is important for irreversible dough expansion (Leon et al., 1996). Furthermore, Miller, Hoseney, and Morris (1997) stated that protein content influences the viscosity of cookies dough. The formation of continuous gluten web increases the viscosity and stops the flow of cookies dough (Miller et al., 1997). Thus, the substitution of PPF for refined flour resulted in lower protein gluten and decreased its dough viscosity. Low dough viscosity results in high flow rate (spread rate) of the dough and contributes to large diameter of cookies.

The thickness is significantly affected by increasing the level of incorporation of PPF. The thickness of the control was 2.92 mm highest among samples, while the lowest thickness was observed in both PPF10 and PPF15 (2.85 and 2.87 mm, respectively) (Table 3). This decrease in the thickness was due to the dilution of gluten (Aslam et al., 2014). Moreover, Chia and Chong (2015) reported that dried pitaya peel powder has high crude fiber content (23.75%). The high water absorption characteristic of fiber (insoluble fiber of pitaya peel; 56.50%) (Jamilah et al., 2011) can attract more water, thus, the dough viscosity decreased leading to decreased thickness.

PPF-containing cookies (more than 5% level) had higher value of spread ratio (6.00–6.09 mm) than control (5.90 mm) (Table 3). According to Hoseney and Rogers (1994), cookie spread rate appears to be controlled by dough viscosity; dough with low viscosity causes cookies to spread at fast rate and vice versa. Furthermore, more sugar is dissolved in the presence of high amount of water in the dough system during mixing. This lowers the initial dough viscosity and thus, the cookie is able to spread at a faster rate during heating (Noor Aziah et al., 2012). According to Hoseney and Rogers (1994), a high water absorption property of flour components may cause less water to be available for dissolving of sugar. Thus, the initial viscosity is higher and the cookies spread less during baking.

The hardness values of the cookies analyzed using texture analyzer are shown in Table 3. The substitution of PPF for refined flour in cookies preparation did not affect the hardness of cookies (1.31–1.54 kg for composite cookies) as compared with control (1.40 kg). These obtained results showed similar trend with those of Ramarathinam (2007), who found that the substitution of sorghum flour for wheat flour at different percentages (10–60%) are unaffected to the hardness of the cookies. According to Aslam et al. (2014), the hardness of cookie is resulted from the development of gluten network whereby gluten promotes the network development by attracting the water molecules. Thus, refined flour (low gluten flour) used in the present study for cookies preparation might contribute to the insignificant development of gluten network.

Table 4. Color attributes of cookies

Attributes	PPF0	PPF5	PPF10	PPF15
L*	62.14^{c} ± 2.90	43.73^{b} ± 7.67	41.68^{b} ± 3.17	28.50^{a} ± 4.14
a*	−1.32^{a} ± 0.13	7.43^{b} ± 1.09	10.80^{c} ± 1.36	10.87^{c} ± 1.42
b*	28.08^{c} ± 0.85	20.65^{b} ± 1.89	18.50^{ab} ± 0.08	17.83^{a} ± 1.72

Notes: Values in the same row with different superscripts are statistically significant from each other ($p < 0.05$).

PPF5, refined flour substituted with 5% PPF; PPF10, refined flour substituted with 10% PPF; PPF15, refined flour substituted with 15% PPF.

L*, Lightness (L = 100; white and L = 0; black); a*, green chromaticity (−60) to red (+60); b*, blue chromaticity (−60) to yellow (+60).

3.3. Color of cookies

Table 4 shows the color attributes of cookies (PPF0, PPF5, PPF10, and PPF15). The color of cookies was assessed in terms of lightness (L*), redness (a*), and yellowness (b*). The PPF-containing cookies (PPF5, PPF10, and PPF15) had significantly lower L* values (28.50–43.73) than the control (62.14). The lowest L* value (28.50) was observed in 15% PPF incorporated cookies. This was attributed to caramelization of the sugar in pitaya fruit peel or a Maillard reaction causing browning during baking at high temperature (Chia & Chong, 2015). The results revealed a similar trend with Wani et al. (2015) who reported that the incorporation of whey protein resulted in a darker surface of cookies.

The a* values are indicative of the red or green color (positive value indicates red and negative value indicates green) (Table 4). Results revealed that the composite cookies (PPF5. PPF10, and PPF15) differed significantly with control (PPF0) for a* value. The a* value of control cookies was negative (−1.32), which indicates that red hues were absent on the surface of cookies. Redness (positive a*) of composite cookies shows an increasing trend from lowest value (7.43) observed in PPF5 to highest value (10.87) found in 15% PPF-incorporated cookies (PPF15). The increase in redness of PPF-containing cookies could be attributed to the presence of red or purple pigments in peels of pitaya fruit. Chia and Chong (2015) reported that dried pitaya fruit peel has high content of betacyanin (red or purple pigments) (13.56%). Therefore, the a* values of composite cookies increased upon increasing the level of PPF substitution. According to Tenore, Novellino, and Basile (2012), betacyanins exhibited the highest antioxidant activities in both DPPH and FRAP assays and its activity is almost 10-fold higher in peels than in flesh of pitaya. Moreover, these pigments may give a protection against certain oxidative stress-related diseases (Kanner, Harel, & Granit, 2001). However, further studies on the total phenolic compounds and antioxidant properties of cookies are warranted to investigate the radical scavenging ability of betacyanins, which might provide more details.

The b* color value indicates the yellow or blue colors (a positive value indicates yellow and negative value indicates blue). Table 4 presents the significantly different crust yellowness values of the various cookies formulations. The substitution of PPF for refined flour (PPF5, PPF10, and PPF15) resulted in significantly lowered b* values (17.83–20.65) from the control (28.08). The yellowness of composite cookies decreases may be due to degradation of unstable yellow compounds during baking (Chia & Chong, 2015). Moreover, a decrease in the b* value of composite cookies can also be attributed to the lower b* value (3.61–4.61) of dried pitaya fruit peel (Chia & Chong, 2015; Jamilah et al., 2011) than the refined flour (8.42) (unpublished data). Hence, dilution of yellow compounds of composite cookies might occur.

3.4. Sensory score of cookies

The scores of sensory evaluation for color, aroma, texture, flavor, and overall acceptability were obtained from semi-trained panelists are tabulated in Table 5. The substitution of PPF did not affect all the sensory properties of the cookies as compared to the control, with the exception of color and flavor. According to ANOVA results, the PPF-containing cookies exhibited lower scores for color (4.80–5.10) than the control (5.73). The color of the food samples plays a vital role in sensory characteristics for consumers. Results obtained from the present study indicated that consumers expect

Table 5. Sensory evaluation of cookies

Parameter	PPF0	PPF5	PPF10	PPF15
Color	$5.73^{b} \pm 1.31$	$4.80^{a} \pm 1.54$	$5.10^{a} \pm 1.26$	$4.93^{ab} \pm 1.48$
Aroma	$5.10^{a} \pm 1.15$	$5.13^{a} \pm 1.30$	$5.50^{a} \pm 1.04$	$5.37^{a} \pm 1.35$
Texture	$4.67^{a} \pm 1.70$	$5.10^{a} \pm 1.47$	$5.23^{a} \pm 1.40$	$4.93^{a} \pm 1.66$
Flavor	$4.33^{a} \pm 1.51$	$5.27^{b} \pm 1.57$	$4.53^{ab} \pm 1.45$	$4.67^{ab} \pm 1.47$
Overall acceptability	$4.97^{a} \pm 1.45$	$5.27^{a} \pm 1.46$	$5.50^{a} \pm 1.25$	$5.23^{a} \pm 1.54$

Notes: Values in the same row with different superscripts are statistically significant from each other ($p < 0.05$).
PPF5, refined flour substituted with 5% PPF; PPF10, refined flour substituted with 10% PPF; PPF15, refined flour substituted with 15% PPF.

the cookie to have an either light or dark (brown) and may reject a cookie with the incorporation of PPF, which would be reddish in color (betacyanin from pitaya fruit flour).

The incorporation of PPF into the formulations did not affect the texture and aroma. The texture (hardness) results obtained from sensory evaluation were correlated to the hardness values obtained from texture analyzer (Table 3); both consumer and equipment were unable to detect the difference between the hardness of the control cookies and composite cookies samples. The flavor of the cookies were improved with the incorporation of PPF in cookies (scores 4.53–5.27 for composite cookies), this can be explained by the view of a typical taste present in composite flour (PPF). However, the scores of flavor indicate a slightly decrease with increasing substitution level to 15%. A decrease in the score of flavor for the composite cookies was attributed to the slightly sour taste derived from higher substitution level of PPF. Jamilah et al. (2011) reported that pitaya fruit peel contains the total acid of 1.72%.

All formulations were acceptable as they received scores greater than 4 (neither like, nor dislike), ranging from 4.97 to 5.50. There were no significant differences in overall acceptability for all the PPF-containing cookies (5.23–5.50) as compared with control (4.97). Therefore, PPF has potential use in cookies applications. The present obtained results are similar to that reported by Ubbor and Akobundu (2009), who noted that partially replacing wheat flour with cassava flour up to 15% did not alter the composite cookies acceptability.

4. Conclusion

The cookies prepared from PPF and refined flour had higher crude fiber, ash, and carbohydrate content than the control cookies. The substitution of PPF for refined flour at 15% level indicated lower moisture, crude fat, and water activity content. However, it did not affect to the crude protein content of composition cookies. In term of physical properties, an increase in the amount of PPF in cookies results in an increase in diameter and spread ratio without affecting the crumb hardness. Betacyanin of pitaya contributes to a superior color (reddish) of composite cookies but it receives fewer score than the control. However, all the PPF-containing cookies were comparable to the control cookies in term of the overall acceptability. Therefore, it has potential use in cookies applications.

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The authors declare no competing interest.

Author details
Lee-Hoon Ho[1]
E-mail: holeehoon@yahoo.com
Nadratul Wahidah binti Abdul Latif[1]
E-mail: S08978@gmail.com
[1] Faculty of Bioresources and Food Industry, Department of Food Industry, Universiti Sultan Zainal Abidin, Tembila Campus, 22200 Besut, Terengganu, Malaysia.

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