



Physicochemical and Sensory Properties of Cookies Produced from Peanut (*Arachis hypogaea* L.) Skin

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ABSTRACT

Cookies are a popular snack enjoyed worldwide but missing some nutritional components. As a byproduct of processing peanuts, peanut skin is high in procyanidin, fiber, and catechins. As far as we know, no cookies are composed of peanut skin. Thus, this study aims to determine the physicochemical characteristics and their sensory acceptability of various formulations of peanut skin cookies. Four cookie formulations with peanut skin powder (PSP) percentages of 0, 10, 20, and 30% were examined for color and hardness. When compared to control cookies, the proximate analysis showed 30% of PSP cookies was significantly higher than all formulations in all analyses except for carbohydrates, whereby the result for the highest concentration of peanut skin in cookies is 3.11% moisture, 1.48% ash, 25.92% fat, 3.33% fibre, 6.56% protein, and 56.60% carbohydrate. The hardness and fracturability of peanut skin cookies were higher than control cookies while colour analysis showed that the addition of PSP caused the cookies to become darker. Sensory evaluation indicated that 10% of PSP in cookies was the most acceptable to the panellist, while 30% of PSP in cookies received the lowest acceptance due to the bitter taste and hard texture of cookies. In conclusion, incorporating PSP into cookies affects the nutritional value of the cookies in fibre content but with limited acceptability among consumers.

INTRODUCTION

One of the leading plant families is the legume family, which includes peanuts (*Arachis hypogaea* L.). The kernel and protective skin, which comprise less than 3% of the overall weight, are the edible portions [1]. The annual production of peanut skins is estimated to be 0.93 million metric tonnes, with the majority of it burned or fed to animals. Since ancient times, bakery goods have been a staple of human nutrition. Cookies are among customers' most well-liked baked goods [2]—people of all ages like cookies as a snack worldwide. Soft wheat is commonly used to make cookies, which are both handy and nutritious [3]. However, cookies are often seen as unhealthy due to high sugar and low fibre composition. Therefore, this study aimed to investigate the effects of different percentages of peanut skin in cookies in terms of their physicochemical and sensory acceptability.

MATERIALS AND METHODS

Materials

Peanut skin (*Arachis hypogaea* L.) was purchased from Home Peanut Garden Industries Sdn. Bhd. in Nilai, Negeri Sembilan. The ingredients for the cookies were purchased from the local markets.

Preparation of Peanut Skin Powder

Peanut skins were washed, dried at 63°C in a drying cabinet, ground into a fine powder with a laboratory mill, sieved, and stored. The resulting powder was stored in airtight containers in the freezer for future use.

Preparation of Cookies

Cookies were prepared following the method of [4] with slight modifications.

Fat and sugar were creamed, and egg yolk was added, creating a smooth mixture. Dry ingredients (flour, baking powder, and salt) were combined and added to the cream, followed by vanilla essence, forming a dough (**Table 1**). After chilling for 15 min, the dough was kneaded, cut into uniform thicknesses and shapes, and baked at 150 °C for 20 min.

Table 1. Formulation for cookie production with different percentages of PSP.

Ingredients	A (0% PSP)	B (10% PSP)	C (20% PSP)	D (30% PSP)
wheat flour	30 g	27 g	24 g	21 g
peanut skin flour	0 g	3 g	6 g	9 g
butter	16.7 g	16.7 g	16.7 g	16.7 g
sugar	14.2 g	14.2 g	14.2 g	14.2 g
salt	0.5 g	0.5 g	0.5 g	0.5 g
baking powder	0.6 g	0.6 g	0.6 g	0.6 g
egg yolk	2.9 g	2.9 g	2.9 g	2.9 g
vanilla essence	0.5 g	0.5 g	0.5 g	0.5 g

Proximate Analysis

The moisture and ash content, crude protein, crude fat, crude fiber, and carbohydrate were determined using the AOAC method [5].

Texture and Colour Analysis of Cookies

The hardness and fracturability of the cookie were measured by using a three-point bend rig of texture analyzer (TA-XT2i, Stable Micro Systems, UK). For colour analysis, the colour of cookies was measured using a Konica Minolta CR-400 Portable Chroma Meter (Osaka, Japan) and was placed on the cookies sample and the value was recorded.

Sensory Evaluation

A sensory evaluation of cookies involved 30 untrained panellists from the university community. The attributes covered appearance, colour, taste, aroma, crispiness, aftertaste, and overall acceptability, utilizing a 7-point hedonic scale.

Statistical Analysis

All the data was reported as mean ± standard deviation (SD). Data was assessed by Fisher test using (Minitab 21, USA) statistical software package at $p < 0.05$ to determine the level of significance.

RESULT AND DISCUSSION

Proximate composition of cookies

The proximate composition of cookies with different percentages of peanut skin powder is shown in **Table 2**. Based on the result, there were no significant differences ($p < 0.05$) between all the cookie's moisture and ash content formulations. The moisture content of peanut skin cookies was between 2.98 to 4.00 %. The standard moisture content for cookies is in the range 1 to 5%; hence, cookies have a long shelf life compared to other baked products and are free from microbial spoilage if they are protected from absorbing moisture from damp surroundings or atmosphere [6].

Table 2. Proximate composition of cookies with different percentages of PSP.

Samples	A (0% PSP)	B (10% PSP)	C (20% PSP)	D (30% PSP)
moisture	2.98±0.82 ^a	4.00±0.64 ^a	3.55±0.66 ^a	3.11±0.74 ^a
ash	1.26±0.31 ^a	1.29±0.06 ^a	1.29±0.43 ^a	1.48±0.24 ^a
fat	21.43±5.24 ^b	25.54±1.20 ^{ab}	24.34±1.91 ^{ab}	25.92±0.53 ^a
fibre	0.29±0.08 ^c	1.01±0.50 ^{bc}	1.61±0.85 ^b	3.33±0.04 ^a
protein	5.22±0.90 ^b	5.70±0.30 ^{ab}	6.24±0.35 ^a	6.56±0.40 ^a
carbohydrate	68.82±5.38 ^a	62.20±1.59 ^b	62.97±2.25 ^b	59.60±0.83 ^b

Mean values followed by same superscript letter in the same column are not significantly different ($p > 0.05$).

*PSP = Peanut Skin Powder

Furthermore, cookies with 0% and 30% peanut skin powder showed a significant difference in crude fat content, with the control at 21.43%. The highest fat content is in the 30% peanut skin powder cookies (25.92%). The increase of fat content in cookies might be due to the high composition of fat content in peanut skin powder (4.6%) compared to the wheat flour is 1.24% [7]. A similar trend was noted: as the percentage of peanut okara flour increased in relation to refined wheat flour, the fat content similarly increased. Significant differences ($p < 0.05$) existed between all the cookies formulation for fibre content. For control cookies, the fibre content was 0.29%, which was increased in all formulations, with the highest fibre content of 3.33%. The increase of crude fibre content in cookies also might contribute by the fibre content in peanut skin flour, whereby 11.7% of crude fibre is contained in peanut skin flour compared to wheat flour 0.56% [16].

For crude protein content, there was a significant difference between 0% of PSP and the highest 30% of PSP formulation of cookies. Control cookies showed that the lowest crude protein content 5.22% and the crude protein content for all the formulations increased as the peanut skin powder increased. This result might be due to the high crude protein content in peanut skin compared to the wheat flour stated that peanut skin contained 9.2% of crude protein whole wheat flour consisted 8.48% of crude protein [8]. The carbohydrate content was between 59.60% to 68.82% where this result showed slight decrease with increasing concentration of peanut skin powder in cookie formulation.

The control cookie had a high carbohydrate content of 68.82%, while the lowest carbohydrate content was 59.60% in cookies with 30% of peanut skin powder. Another study stated that the difference in carbohydrate content of cookies was clearly attributed to differences in the levels of proximate ingredients, such as the protein content increasing as the quantity of soymeal in the cookies increases [9]. On the other hand, the decrease of carbohydrate content was also due to the carbohydrate content in peanut skin powder (65.08%) being lower than in wheat flour (84.34%) [16].

Texture Profile of Cookies

The hardness and fracturability value of cookies analysed using texture analyzer are presented in **Table 3**. Textural quality, such as hardness and fracturability is a critical and desired quality attribute for cookies.

Table 3. Texture profile of cookies with different percentages of PSP.

Sample	Hardness (g)	Fracturability (mm)
A (0% PSP)	1037.0±574.0 ^b	49.54±0.19 ^{ab}
B (10% PSP)	1177.8±111.3 ^b	49.12±0.22 ^c
C (20% PSP)	1321.3±133.5 ^b	49.28±0.06 ^{bc}
D (30% PSP)	2069.0±188.6 ^a	49.65±0.32 ^a

Mean values followed by same superscript letter in the same column are not significantly different ($p > 0.05$).

*PSP = Peanut Skin Powder

The hardness of cookies significantly varied among different concentrations of PSP, except for formulations with 0% and 10%. Incorporating 20% and 30% PSP led to higher hardness values than 0% and 10% formulations. This could be due to the peanut skin's high fibre and protein content. Cookies that are made from flour with a higher protein content tend to have a stronger structure due to the strong binding of starch and protein [10]. Similarly, increasing fibre content in baked products resulted in the increasing hardness value as fibre because wheat flour could not absorb enough water to form a gluten-protein network, resulting in a hard structure [11]. Compared to this

study, the hardness was similar with peanut skin cookies as increasing peanut skin in cookies cause the cookies harder. Fracturability of cookies varied in the range of 49.12 mm and 49.65 mm with the highest value observed in cookies with 30% of peanut skin powder compared to the control cookies. Cookies with higher peanut skin powder concentrations were harder to break compared to those with lower percentages, indicating that peanut skin influenced cookie texture.

Colour of cookies

The colour measurement of cookies with adding peanut skin powder at different concentrations is presented in **Table 4**. The results showed that cookies' lightness L^* value decreased as more peanut skin powder was added. The difference in L^* value between control cookies (68.80%) and 30% of peanut skin cookies (46.40%) can be related to the peanut skin's natural color. Similar results were obtained whereby the L^* value of cookies decreased when the amount of flaxseed flour in cookies increased, hence resulting in a significantly darker and browner appearance of the cookies [12]. Furthermore, the incorporation of peanut skin in cookies was found to be significantly higher in a^* value compared to the control cookies. However, the b^* value showed a significant difference among all the formulation of cookies. In this study, the b^* value (yellowness) slightly decreased with increasing peanut skin powder added to the cookie's formulation. This result trend was comparable with a previous study that reported that the surface colour of cookies was increased for a value while decreased for b^* value as an increase of buckwheat flour content in cookies formulation [13]. The differences in colour of cookies could be related to the browning reactions that occur during baking, in which brown pigments are thought to be produced by Maillard browning and caramelization of sugar.

Table 4. Colour analysis of cookies with different percentages of PSP.

Samples	L^*	a^*	b^*
A (0% PSP)	68.80±3.98 ^a	7.41±1.76 ^b	29.70±1.47 ^a
B (10% PSP)	54.58±0.55 ^b	8.56±0.37 ^{ab}	15.48±1.42 ^b
C (20% PSP)	50.48±0.40 ^c	8.86±0.07 ^a	12.00±0.16 ^c
D (30% PSP)	46.40±0.87 ^d	8.58±0.34 ^{ab}	9.50±0.84 ^d

Mean values followed by same superscript letter in the same column are not significantly different ($p>0.05$).
 *PSP = Peanut Skin Powder

Sensory evaluation

In this study, adding peanut skin flour affected the appearance, colour, aroma, taste, crispness, aftertaste, and overall acceptability attributes (**Table 5**). Control cookies significantly differed from those with peanut skin cookies in appearance and colour. Cookies with 10% peanut skin powder scored the highest among the three formulations, indicating acceptability. The highest peanut skin concentration (30%) resulted in the lowest scores for crispness (4.17) and aftertaste (3.43), possibly due to increased hardness and the bitter flavour of peanut skin, attributed to tannins.

Table 5. Sensory evaluation of the cookies with different percentages of PSP.

Samples	A (0% PSP)	B (10% PSP)	C (20% PSP)	D (30% PSP)
appearance	6.30±0.99 ^a	5.57±1.22 ^b	5.60±1.33 ^b	5.53±1.38 ^b
colour	6.23±0.90 ^a	5.47±1.11 ^b	5.33±1.35 ^b	5.30±1.44 ^b
aroma	6.17±1.02 ^a	5.90±0.89 ^{ab}	5.53±0.94 ^b	4.67±1.49 ^c
taste	6.33±0.88 ^a	5.93±0.91 ^{ab}	5.67±1.21 ^c	3.63±1.40 ^d
crispness	6.37±0.81 ^a	6.20±0.85 ^a	5.80±1.19 ^a	4.17±1.49 ^b
aftertaste	6.33±0.96 ^a	5.87±0.90 ^{ab}	5.47±1.38 ^b	3.43±1.43 ^c
overall acceptability	6.37±0.96 ^a	6.03±0.85 ^{ab}	5.60±1.13 ^b	3.87±1.46 ^c

Mean values followed by same superscript letter in the same column are not significantly different ($p>0.05$).
 *PSP = Peanut Skin Powder

Control cookies scored the highest for overall acceptability, followed by 10%, 20%, and 30% peanut skin cookies. Control and 10% peanut skin cookies showed no significant difference, suggesting a preference for these formulations. Substituting 20% or more of peanut skin was not recommended, as it may negatively impact sensory qualities despite providing higher nutritional value. This aligns with a finding where cookies' highest chickpea flour percentage received the lowest sensory acceptance scores [14].

CONCLUSION

The physicochemical properties of these peanut skin cookies, such as color analysis, texture profile, and proximate analysis, were thoroughly assessed. The amount of moisture, ash, fat, fiber, and protein in the proximate composition of the cookies increased with the concentration of peanut skin; the amount of carbohydrates decreased slightly. The peanut with 30% PSP had a darker color, a firmer texture, and a more compact structure. Following a sensory assessment, formulation B, which included 10% peanut skin powder, was the most acceptable. The proximate composition of formulation B was moisture (4.00%), ash (1.29%), fat (25.54%), fiber (1.01%), protein (5.70%), and carbohydrates (62.20%). Thus, it can be concluded that 10% PSP in cookies had the best physicochemical properties and was favorably accepted by the test panels.

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