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Development of Functional Cookie from Kenaf (*Hibiscus Cannabinus* L.) Seed Meal

Choy Mun Ngah[1], Gita Addelia Nevara[2], Roselina Karim[1#]

[1]*Department of Food Technology, Faculty of Food Science and Technology, Universiti Putra Malaysia, 43400 Selangor, Malaysia*

[2]*Department of Nutrition, Universitas Mohammad Natsir Bukittinggi, Jalan Tan Malaka Bukit Cangang, Bukittinggi 26136, Sumatera Barat, Indonesia*

#Corresponding author: E-mail: rosaz@upm.edu.my

***Abstract*— Kenaf seed (*Hibiscus cannabinus* L.) is one of the potential and excellent food ingredients of kenaf processing by-products. This study aims to develop functional cookies by incorporating 0% (control), 15%, 20%, 25%, and 30% of kenaf seed meal flour (KSMF). The physicochemical quality of kenaf seed meal cookies (KSMC) revealed that KSMC had higher ash, protein and fat content but lower moisture and carbohydrate content than the control. In terms of texture and colour, the hardness and colour values of the KSMC increased and decreased with increasing levels of KSMF, respectively. Sensory scores on acceptability using hedonic test depicted that KSMF addition had no effect on the overall acceptability score of all the cookies. The finding of this study suggested that 30% of KSMF is suitable for use in the development of functional cookies with improved nutritional quality while maintaining the sensory acceptability of the cookies.**

***Keywords*— Functional cookies, kenaf seed meal flour, proximate analysis, sensory evaluation**

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I. INTRODUCTION

Kenaf (*Hibiscus cannabinus* L.) is a non-woody fibrous plant from the *Malvaceae* family. It is actively cultivated in Southeast and East Asian countries such as India, Bangladesh, China, Thailand, Indonesia and Vietnam [1] . Nowadays, the world production of kenaf and allied crops has already reached 202 thousand tonnes [2]. Kenaf is a valuable commercial fibre crop as its fibrous stem can be used to make a variety of materials such as paper and pulp, fabrics, textiles, bio composites, insulation mats and absorption materials [3]. As the kenaf industry has gradually become an important source of economy worldwide, the utilisation of the by-product of the kenaf plant has become important. In fact, the kenaf industry produces a large amount of by-product. Kenaf processing by-products primarily consist of leaves and seeds, and the kenaf seeds are normally discarded as waste or rendered into animal feed [4]. The by-product may lead to environmental problems if the waste is not discarded properly.

Recently, there has been worldwide recognition of the problems associated with the by-products from agricultural and food processing industries. Recent studies have shown interest in the potential application of these by-products, intending to reduce the environmental issue while maximising the use of beneficial composition in the residue [5]. Many researchers have utilised agricultural by-products to produce different types of functional food products such as bread, cookies and muffin. In fact, kenaf is promising in food enrichment applications due to its high nutritional content. Several studies report that kenaf seed is a good source of protein, fat and fibre [5]–[9]. Nyam et al. [10] found that kenaf contains 9.1% moisture, 21.8% protein, 20.8% lipid, 13.6% fibre and 5.9% ash content. These beneficial components of kenaf seed have prompted people's interest in the development of functional foods by using kenaf seed. Chan et al. [11] claimed that defatted kenaf seed meal is potentially used as functional food ingredients due to its high nutritious properties. On the basis of its nutritional profile and functional properties, kenaf flour has also been reported as a potential source of edible flour for the production of bread, noodles, cakes and cookies [8]. Several studies have investigated the application of kenaf seed in various food products. According to Chan et al. [4], defatted kenaf seed meal (DKSM), a by-product of kenaf seed oil extraction, is a new edible flour with increased phenolic content and antioxidant activity compared to wheat, sweet potato, and rice flour. Similarly, a study by Ramlan et al. [12] explored the use of kenaf seed dietary fibre (KSDF) as a functional ingredient in high-fibre bread. The results indicated that KSDF had good functional qualities, and the quality of bread formed from it was relatively similar to that of bread prepared from wheat bran or rice bran. Furthermore, yellow noodles made with defatted kenaf seed flour were shown to have significantly higher mineral, fibre, and total phenolic content [13]. Despite these promising findings, studies on the nutritional properties of kenaf enriched food products remain scarce.

Cookies is a common bakery food that can be easily found in the market. It is one of the most popular snacks among both kids and adults due to its low manufacturing cost, increased convenience, long shelf-life and ability to serve as a vehicle for essential nutrients [14], [15]. Cookies provide energy as they are high in fat, protein, carbohydrates and also serves as a good source of minerals [16]. As consumers become more health-conscious these days, the incorporation of functional ingredients into cookies is growing into a trend. Many researchers have studied functional cookies made from various types of potential functional ingredients such as roselle seed [17], okara [18], barley [19], lentil [20], pitaya peel [21], grape marc and parboiled rice bran [22]. To date, research on the utilisation of kenaf seed as a functional food ingredient to develop value added products remains narrow. Hence, the aim of this research is to study the potential application of kenaf seed meal as a food ingredient in the development of functional cookies and to assess the effect of the incorporation in the product.

II. MATERIAL AND METHODS

In the preparation, formulation and analysis of KSMC, a series of analytical techniques were used to evaluate the impact of KSMF on the quality of cookies. These methods provide a comprehensive evaluation of the physical, chemical and sensory characteristics of KSMC.

A. Material

Dried kenaf seeds meal (variety V36) is obtained from Food 3, Faculty of Food Science and Technology, Universiti Putra Malaysia, Serdang, Selangor. The kenaf seeds have previously undergone 6 hours of soaking, the milk was extracted and kenaf seed meals dried in the oven at 50℃ overnight. Other materials including butter, wheat flour, corn flour and icing sugar were purchased from local supermarkets. Samples of kenaf seed meal was shown in **Fig.1**.

Fig. 1. Samples of V36 kenaf seed meal.

B. Methods

Preparation of Kenaf Seed Meal Flour (KSMF)

KSMF was prepared by grinding the dried kenaf seed meal using a grinder (Waring, Torrington, USA), and passed through a 0.5 mm sieve. The flour was then kept at -20℃ in polypropylene bags before further use, as shown in **Fig.2**.

Fig. 2. Kenaf Seed Meal Flour (KSMF) in polypropylene bags

Preparation of Kenaf Seed Meal Cookies (KSMC)

KSMC were prepared using KSMF, wheat flour, butter, corn flour and icing sugar according to the formula as shown in **Table 1**. Five formulations of cookies were prepared by substituting wheat flour with kenaf seed flour at 0%, 15%, 20%, 25% and 30% without changing the total flour content. Cookies formulated without KSMF were served as the control. Firstly, the dry ingredients were weighed using an electronic scale (A&D FX-3000i, Toshima, Japan). Then, the butter was mixed thoroughly with icing sugar until it became fluffy. Next, other ingredients were added, and the dough was thoroughly kneaded for about five minutes. Later, the dough was weighed and separated into 10 g each. Each of the weighted dough was rolled into a round shape and lightly pressed to a thickness of 5 mm. The shaped dough was baked on a tray with baking paper at 170°C for 15 min in an oven (Salva, Kuala Lumpur, Malaysia). The cookies were cooled at room temperature for 10 min before packing in polypropylene bags and stored at room temperature prior to further analyses.

Table 1.
Formulation of cookies

Ingredient (g)	Control	KSMF 15	KSMF 20	KSMF 25	KSMF 30
Wheat flour	90	76.5	72	67.5	63
KSMF	-	13.5	18	22.5	27
Icing Sugar	35	35	35	35	35
butter	80	80	80	80	80
Corn flour	20	20	20	20	20

Notes: KSMF is Kenaf Seed Meal Flour; KSMF 15 = 15% of Kenaf Seed Meal Flour; KSMF 20 = 20% of Kenaf Seed Meal Flour; KSMF 25 = 25% of Kenaf Seed Meal Flour; KSMF 30 = 30% of Kenaf Seed Meal Flour; - indicates without ingredient

Texture profile analysis of cookies

Each cookie was subjected to Texture Profile Analysis (TPA) in triplicate using a Texture Analyzer (TA.XT2 model, Puchong, Malaysia), with no further modifications or cutting prior to analysis. Texture of cookies was determined by compression with 50 kg of load with a 36 mm^2 probe. Other parameters used included pre-test speed of 1.0 mm/s, test speed of 5 mm/s, post-test of 10 mm/s, waiting time of 1.5 s, trigger force of 5 g and compression of 75%.

Colour analysis of cookies

The colour of the cookies was measured using a chroma metre (Konica Minolta, Tokyo, Japan). The colour of cookies was determined according to L* (black to white in the range of 0-100), a* (+a* for red, -a* for green), b * (+b* for yellow and -b* for blue). The chromameter was calibrated using a standard white and black plate before analysis.

Proximate analysis of cookies

Proximate analysis of ash content, crude protein and crude fat contents were conducted based on the AOAC 923.03, 960.52 and 920.39 respectively [23]. Before the analysis, the sample was first pulverised into smaller pieces using a mortar and pestle. The sample was then stored and labelled in an airtight container in the dry clean and cool environment for further analysis. The moisture content was evaluated by using a moisture analyser (A&D MX-50, Toshima, Japan), while ash content is evaluated using the dry ashing method. Crude fat is determined using Soxhlet extraction method, and percentage of nitrogen was multiplied by a constant factor of 6.25 to obtain the percentage of crude protein. The total carbohydrate content in the samples was measured by difference method. All the proximate analysis was performed in duplicate for each cookie formulation.

Sensory evaluation of cookies

Sensory analysis on five types of samples was performed by 30 untrained panelists consisting of students and staff of the Faculty of Food Science and Technology, Universiti Putra Malaysia using a 9-point hedonic scale. Firstly, cookies samples with five different formulations were placed in identical sample containers before being coded with three-digit random numbers. Each sample had a unique number. The five randomised-coded samples were presented all at once to the panelists with the order of the samples were randomised. Panelists were requested to evaluate the coded samples in terms of colour, aroma, taste, texture and overall acceptability based on the degree of preferences (1 = dislike extremely; 2 = dislike very much; 3 = dislike moderately; 4 = dislike slightly; 5 = neither like nor dislike; 6 = like slightly; 7 = like moderately; 8 = like very much; 9 = like extremely).

Statistical analysis

Results obtained from the analysis were statistically analyzed using one-way analysis of variance (ANOVA) and the difference was tested at 5% level of significance by using the Tukey test. Minitab Statistical Software (MINITAB®, Minitab Inc.) was used to perform the calculations. The findings were presented as mean ± standard deviation.

III. RESULT AND DISCUSSION

The findings highlight the effects of incorporating KSMF into cookie formulations. The results are discussed in relation to the changes in the physical, chemical, and sensory characteristics of the cookies, with an emphasis on understanding how KSMF incorporation affects key quality attributes.

A. Textural characteristics of cookies

The result of the textural analysis of five types of cookies substituted with different levels of KSMF is presented in **Table 2**.

Table 2.
Textural properties of KSMC incorporated with different levels of KSMF

Concentration of KSMF (%)	Hardness (Kg)	Cohesiveness	Chewiness
0	$39.96±1.17^{b}$	$0.24±0.06^{a}$	$4.08±0.79^{a}$
15	$47.45±1.38^{ab}$	$0.25±0.03^{a}$	$5.61±0.78^{a}$
20	$52.59±4.14^{ab}$	$0.26±0.02^{a}$	$6.37±1.61^{a}$
25	$53.53±0.05^{a}$	$0.27±0.01^{a}$	$5.67±1.29^{a}$
30	$53.86±5.98^{a}$	$0.28±0.01^{a}$	$5.33±1.22^{a}$

Note: KSMF is Kenaf Seed Meal Flour. Data reported are mean ± SD of three determination. Mean values within the same column with different superscripts indicate significant difference ($p < 0.05$).

Texture is one of the major acceptability factors used by consumers to interpret food [24]. Hardness is a textural parameter which is measured as the peak force that occurs during the first compression. Table 2 revealed significant differences ($p < 0.05$) in the hardness value between control and the KSMC. The hardness of the cookies ranges from 39.96 kg to 53.86 kg as the level of KSMF increased from 0% to 30%. Substitution of wheat flour with KSMF at 30% indicated the highest value in hardness (53.86 kg) while the control had the lowest value of hardness (39.96 kg). The high protein content in KSMF could be the cause of the harder texture as Cheng & Bhat [25] reported that protein interaction during dough development may be a factor that contributes to a harder texture. The formation of a gluten network in the protein induces the hardness of a cookie as gluten facilitates network development by attracting water molecules [21], [26]. Similar results were observed by [27] who observed an increase in hardness of cookies prepared with increasing levels of okara.

Cohesiveness indicates structural integrity of cookies to withstand compressive or tensile stress. Results showed that no significant differences ($p > 0.05$) between control cookies and all the formulated KSMC supplemented with 15, 20%, 25% and 30% of KSMF. Chewiness is the amount of energy needed to chew a solid food until it is ready to swallow [28]. The result of the cohesiveness of the cookie showed a similar result to the chewiness in which the substitution of KSMF to wheat flour did not significantly ($p > 0.05$) affect the chewiness of the cookies.

B. Colour of cookies

Three colour parameters L*, a* and b* were used to evaluate the colour of the KSMC. The analysis of the colour of the control and KSMC are shown in **Table 3**.

Table 3.
Colour measurement of KSMC incorporated with different levels of KSMF.

Concentration of KSMF (%)	L*	a*	b*
0	67.10±1.17^{a}	6.68±0.27^{a}	31.99±1.26^{a}
15	44.74±0.75^{b}	6.61±0.15^{a}	19.60±0.16^{b}
20	42.71±1.22^{bc}	6.46±0.13^{a}	16.51±0.16^{c}
25	42.52±0.92^{bc}	6.39±0.28^{a}	16.03±0.42^{c}
30	41.06±1.56^{c}	5.76±0.44^{b}	13.91±0.55^{d}

Note: KSMF is Kenaf Seed Meal Flour. Data reported are mean ± SD. Mean values within the same column with different superscripts indicate significant difference ($p < 0.05$).

Colour is the first factor that consumers rely on for acceptability of any food product [29]. According to the author, colour development in bakery products during baking is caused by non-enzymatic chemical reactions, such as the Maillard reaction and caramelization, which generate various compounds and affect the final colour. The reaction between proteins and carbohydrates is responsible for the browning effect and the organoleptic properties of bakery products [30], [31].

The L* value is the lightness factor that gives values ranging from 0 (black) to 100 (white). Based on the result, it showed that the lightness (L*) of the cookies decreased significantly ($p < 0.05$) as the substitution level of KSMF increased. At higher levels of substitution of KSMF, the reducing values of L* indicate that the KSMC became darker in colour as shown in **Fig.3**. They may be associated with the colour of KSMF which was darker in colour compared to wheat flour and therefore producing cookies with lower L* value.

Fig. 3. Photos of cookies substituted with different levels of KSMF, from top left to bottom right ordered as follows: 0%, 15%, 20%, 25%, and 30%

The a* parameter indicates the degree of greenness/redness ranging from -60 (green) to +60 (red). The a* value was found to slightly decrease in cookies with addition of KSMF up to 25%, while a significant decrease ($p < 0.05$) was only observed in cookies prepared from 30% of KSMF. The 30% level of KSMF substituted cookies had the lowest a* value among all the samples (5.76).

The b* value indicates the blueness/yellowness ranging from -60 (blue) to +60 (yellow). A significant difference ($p < 0.05$) in b* value compared to control was observed among all the cookies formulation. The b* value decreased as the substitution level of KSMF increased from 0% to 30%. This indicated that there was a decrease in the yellow colour of the cookies as the level of KSMF increased. This result is consistent with the finding by Zawawi et al. [13] who found that the b* value decreased when the percentage of defatted kenaf seeds flour used to make the noodles increased.

C. Chemical composition of cookies

The chemical composition of cookies incorporated with different levels of KSMF (0%, 15%, 20%, 25% and 30%) is depicted in **Table 4**. Significant ($p < 0.05$) differences were observed in moisture content, ash, crude protein, crude fat and carbohydrate contents with the incorporation of KSMF up to 30%.

Table 4.
Chemical composition of KSMC incorporated with different levels of KSMF.

KSMF addition (%)	Proximate composition of KSMC (%)				
	Moisture	Ash	Protein	Fat	Carbohydrate
0	3.23 ± 0.13^{a}	0.96 ± 0.06^{b}	4.49 ± 0.19^{b}	31.19 ± 1.08^{b}	60.17 ± 1.15^{a}
15	2.52 ± 0.20^{b}	1.20 ± 0.09^{ab}	4.87 ± 0.32^{ab}	34.41 ± 1.35^{ab}	57.00 ± 1.31^{ab}
20	2.25 ± 0.13^{b}	1.25 ± 0.06^{ab}	5.47 ± 0.04^{ab}	34.75 ± 0.59^{a}	56.29 ± 0.56^{b}
25	2.59 ± 0.01^{b}	1.41 ± 0.01^{a}	5.56 ± 0.17^{ab}	34.96 ± 0.41^{a}	55.47 ± 0.22^{b}
30	2.60 ± 0.21^{b}	1.43 ± 0.11^{a}	6.21 ± 0.64^{a}	34.21 ± 0.04^{ab}	55.55 ± 0.91^{b}

Note: KSMF is Kenaf Seed Meal Flour. Data reported are mean ± SD. Mean values within the same column with different superscripts indicate significant difference ($p < 0.05$).

The result revealed that there is a significant difference ($p < 0.05$) in moisture content between the control cookies and KSMF supplemented cookies. The moisture content of the cookies decreased with the addition of KSMF. This difference may be attributed to the higher dry solids within the KSMF compared to wheat flour that cause KSMF has lower moisture content. The moisture content in kenaf seed meal and wheat flour was previously reported as 9.34% [4] and 12.17% [32] respectively. Similar results were reported in the biscuits that were supplemented with alfalfa seed flour [33]. Cookies normally have a moisture content of less than 5%, giving them a long shelf life and a low risk of spoilage [34]. This result may indicate that the low moisture content of KSMC developed by KSMF have a long shelf life.

Based on **Table 4**, a significant ($p < 0.05$) increase in ash content was observed when 20% and 30% of KSMF were incorporated into cookie formulation compared to the control. The highest ash content was observed in KSMC incorporated with 30% KSMF (1.43%) while the lowest was found in control (0.96%). The higher ash content in KSMC may be due to the higher mineral content in the KSMF than wheat flour. Kenaf seed meal contains a lot of essential minerals. Minerals that mainly found in defatted kenaf seed meal (DKSM) were phosphorus, potassium, magnesium with 3.28%, 3,21% and 1.54% respectively [4]. Other trace minerals were also found in DKSM such as sodium, calcium, sulphur, copper, zinc and selenium. The present results are similar to the findings by Ghoshal & Kaushik [32] who found that the levels of minerals in cookies increased when wheat flour was replaced with soymeal flour, suggesting that fortification of cookies with minerals-rich flour could improve their nutritional value.

In terms of crude protein, the substitution of KSMF for wheat flour in cookies affects the protein content of the KSMC. **Table 4** showed that the protein content increased significantly ($p < 0.05$) from 4.49% to 6.21% with the substitution of 30% KSMF. This may be the result of the use of KSMF in the formula containing a large amount of protein, which leads to the increase of the protein content in cookies. According to Chan et al. [4], defatted kenaf seed meal flour is a potential alternative source of essential protein because it contains 26.19% of protein which is higher than wheat flours that contain less than 9% of protein. Nguyen et al. [35] reported similar results for roselle seed incorporated cookies that contain higher protein content as compared to cookies prepared from only wheat flour.

Fat is considered as a basic component in cookie formulation that is normally present in high amounts to provide preferable eating qualities and contributes to the product's texture and flavour [36]. The fat content of cookies ranges from 31.19 to 34.96% with increasing KSMF in cookies from 0% to 30%. The fat amount of cookies increased significantly ($p < 0.05$) when the wheat flour was replaced by KSMF up to 20% and 25%. The highest fat content was observed in the substitution of 25% KSMF which was 34.96%. The high fat content of cookies could be attributed to the high fat content of KSMF.

The carbohydrate content in the investigated cookies prepared from KSMF (55.47% - 57.00%) was lower than control (60.17%). Results revealed that significant decrease ($p < 0.05$) was recorded in cookies supplemented with KSMF at a level of 20%, 25% and 30%, compared to control. The reduction in carbohydrate content could be attributed to higher levels of other proximate constituents which are ash, protein and fat. Comparable results were observed by Hawa et al. [18], who discovered that cookies developed from a combination of okara and wheat flour had a lower carbohydrate content than cookies made completely of wheat flour and suggesting that okara could be used to produce low-carbohydrate cookies to improve the health of obese people. The increase of protein content and the decrease of carbohydrate content in cookies containing higher levels of KSMF could contribute to the darker colour of the cookies (**Table 3**). Proteins are known to undergo Maillard reactions when subjected to heat, resulting in a darker colour [31], [37].

D. *Sensory score of cookies*

The results of the sensory evaluation for colour, aroma, taste, texture and overall acceptability of KSMC prepared from different levels of KSMF are shown in **Table 5**.

Table 5.
Sensory acceptance of KSMC using hedonic test.

KSMF (%)	Colour	Aroma	Taste	Texture	Overall acceptability
0	7.47 ± 1.36^{a}	6.57 ± 1.76^{a}	6.90 ± 1.54^{a}	7.17 ± 1.37^{a}	7.13 ± 1.36^{a}
15	6.73 ± 1.70^{ab}	6.90 ± 1.27^{a}	6.97 ± 1.63^{a}	7.53 ± 1.20^{a}	7.17 ± 1.34^{a}
20	6.30 ± 1.42^{bc}	6.70 ± 1.26^{a}	7.10 ± 1.09^{a}	7.20 ± 1.21^{a}	7.17 ± 1.05^{a}
25	5.93 ± 1.74^{bc}	6.67 ± 1.45^{a}	6.37 ± 1.69^{a}	6.67 ± 1.49^{a}	6.47 ± 1.41^{a}
30	5.53 ± 1.74^{c}	6.10 ± 1.47^{a}	6.33 ± 1.69^{a}	6.77 ± 1.61^{a}	6.43 ± 1.41^{a}

Note: KSMF is Kenaf Seed Meal Flour. Data reported are mean ± SD. Mean values within the same column with different superscripts indicate significant difference ($p < 0.05$).

Results showed that there were no significant differences ($p > 0.05$) on the acceptability scores of aroma, taste and texture attributes of all the cookies except for colour attribute. The colour of the cookie is an important factor in the initial acceptance of food products by consumers [38]. According to **Table 5**, the result showed that KSMC had a significant difference ($p < 0.05$) in terms of colour compared to control. The average scores showed a decline in colour as the amount of KSMF substituted in the formulation of cookies increases. This result was in accordance with the colour measurement data (**Table 3**) where lower L* value of KSMC was associated with the increment of KSMF substitution. The colour of the control cookies obtained the highest score of 7.47 while cookies prepared from 30% KSMF obtained the lowest score of 5.53. It could be said the panellist preferred cookies which had a lighter colour compared to KSMC that gave darker colour. This is in line with the result by Martínez et al. [39] who found that the cookies made with chia and poppy seed flours scored lower due to the darker colour.

The sensory score of aroma was not significantly influenced ($p > 0.05$) by the KSMF substitution to replace wheat flour at various levels. KSMC prepared with 15% of KSMF obtained the highest score of 6.90 in aroma whereas cookies with 30% of KSMF had the lowest score with 6.57. Likewise, there was no significant ($p > 0.05$) differences in taste score between all the cookie samples. Cookies prepared from 20% KSMF achieved the highest rating (7.10) while cookies from 30% KSMF obtained the lowest rating (6.33).

In terms of the texture of the cookies, the incorporation of KSMF into the cookies formulations had no significant ($p > 0.05$) influence on the texture of KSMC. Kulthe et al. [24] stated that texture is a very important characteristic that contributes significantly to the overall acceptance of food products. KSMC made from 15% KSMF had the highest score (7.53) while cookies prepared from 25% KSMF had the lowest score (6.67).

The substitution of KSMF resulted in a different average rating in the overall acceptability of KSMC (6.43-7.17) compared to the control (7.13). The overall acceptability score found that the cookies substituted with 15% and 20% KSMF had most acceptable sensory attributes (7.17), while cookies with 30% KSMF achieved the lowest rating (6.43).

Despite the result disclosed that the gradual increasing level of KSMF in cookies gave lower ratings in terms of all sensory attributes when compared to control, no significant difference ($p > 0.05$) was observed in overall acceptability of all the KSMC. Hence, it could be suggested that substitution of KSMF up to 30% resulted in cookies with acceptable sensory properties. Similar results were observed by Ho and Abdul Latif [21] substituting up to 15% pitaya peel flour had no effect on the overall acceptability of the substituted cookies when compared to cookies prepared from 100% wheat flour.

IV. Conclusion

KSMF is a good source of protein and fat which has the potential to be used as a food ingredient for producing cookies with high nutritional value. The analysis on the physiochemical properties of the cookies showed that increased KSMF content increased hardness and decrease colour attributes (L^*, a^* and b^*) of KSMC. The substitution of KSMF to replace wheat flour in the cookies formulation resulted in higher ash, protein, fat content but lower moisture and carbohydrate content in KSMC. Sensory evaluation of the cookies revealed that as the amount of KSMF was increased, the average rating on the acceptance of all the sensory attributes decreased. However, there was no significant effect in overall acceptability between control and all the KSMC. This implied that substituting KSMF up to 30% resulted in cookies with acceptable sensory qualities. The finding of this study suggested that 30% of KSMF is suitable to be used in developing functional cookies with improved nutritional quality while maintaining the sensory acceptability of the cookies. The outcome of the present study contributes to application of kenaf seed by-product of the kenaf industry as a source of functional ingredients in the development of functional food such as cookies.

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Conflict of Interest to Disclosure

The authors have no conflict of interest to declare.

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