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Characterization of Dabai (*Canarium odontophyllum Miq*.) Cookies

*Norhasmillah Abu Hassan, Mohd Sabri Mohd Afandi, Abdul Fattah Abdul Razak, and Jessica Stanley Jamalti

School of Engineering and Technology, University College of Technology Sarawak (UCTS), 96000 Sibu, Sarawak, Malaysia.

Abstract: This study was conducted to determine the physicochemical and sensory characteristics of dabai (*Canarium odontophyllum Miq.*) cookies. The cookies were prepared in five different formulations according to butter to dabai mass ratio 225:0; 200:25; 175:50; 150:75; 125:100. The analyses include moisture, ash, fat, protein, total carbohydrate and total energy content. Sensory evaluation was performed amongst 40 panellists. From the analyses, it was found that the dabai cookies contained 2.7 – 4.9% of moisture, 1.0 – 1.7% of ash, 34.9 – 45.3% of fat, 3.6 – 5.6% of protein, 47.2 – 52.9% of total carbohydrate, 0.4 to 1.15% of crude fiber and 548 – 611/100g total energy content. The sensory analyses showed that Formula 2 with 15% of dabai content has the highest score which is 7.45 for overall acceptance. From this study, it is viable to produce dabai cookies with acceptable nutrient content.

Keywords: Dabai, *Canarium odontophyllum Miq.*, Dabai Cookies, Physicochemical, Sensory Analysis

INTRODUCTION

Dabai or *Canarium odontophyllum* Miq. is a seasonal fruit indigenous to Sarawak, Malaysia. It is one of the *Canarium* species from the Burseraceae family [1]. There are varieties of dabai species in Southeast Asia tropics which are valuable for their edible oil-rich kernels, fragrant resins and lumber [2]. In Sarawak, dabai trees can be found along the riverbanks of Kapit, Sarikei, Limbang and Sibu divisions [3]. According to Chua *et al.*, [4], dabai fruit contains 61.4% of pulp, 37.0% of seed and 5.6% of peel. Dabai has a unique taste with fine creamy texture like a ripe avocado. Before serving, dabai fruit flesh needs to be soften by soaking it in warm water at approximately 50°C for 15 - 20 minutes. Then, the warm water will be drained off and dabai can be served by adding a little bit of salt or sugar and dipped in soy sauce to enhance the taste. Dabai is eaten together with its dark purple skin but the seed is removed. Softened dabai is often served as a side dish with rice.

According to Azlan *et al.*, [5], fat content in raw dabai is 26.2% which is high compared to other local fruits in Sarawak. This fruit also contains calcium (200 mg), magnesium (106 mg), and phosphorus (65 mg) [6]. In addition, dabai also contain energy, moisture, fat, carbohydrate, protein and ash. Hoe and Kueh [6] reported that the energy content in dabai is 339 kcal, moisture is 41.8%, protein is 3.8%, fat is 26.2% and carbohydrate is 22.1%.

Dabai has a huge potential in food industry. Dabai paste is now available in local markets, retails and online. In addition, dabai fried rice can be found from Sibu local hawkers. Recipes for pitted pickles, salad dressing, snack, desserts and maki (dried seaweed roll) based on dabai fruit as well as other functional foods been developed by the Agriculture Research Centre, Semongok, Sarawak, Malaysia [7].

Along with the development, dabai also showed an opportunity as an alternative to improve the nutritional value of food products as it contains valuable nutrients. This is aligned with the study by Abu Hassan *et al.*, [8] on dabai cake properties, which found that the amount of mineral including Na, K, Ca, Mg, Fe and Zn had increased proportionally with dabai content in the formulation. Existing dabai based food products include dabai paste, dabai crackers, pitted dabai and dabai pizza.

Another potential dabai based products which will be further studied in this research is dabai cookies. Cookie is a baked food that is flat, sweet and usually made from flour, fats or oil, sugar and other additional ingredients such as fruits or flavour to enhance the taste as well as the nutrients. Cookies contribute to a healthy

Corresponding Author: Norhasmillah Abu Hassan, Food Technology Programme, School of Engineering and Technology, University College of Technology Sarawak (UCTS), Email: norhasmillah@ucts.edu.my

diet as it is one of good sources of carbohydrates, fibres and energy. Cookies are a practical diet, suitable to be consumed between meals as snack and always available on-the-go. As studied by Kolawole *et al.,* [9], cookies represent an important part of human diet especially as a source of energy. Cookies consumed between regular meals may have the potential to support parts of the nutrients demand especially for child growth.

Consumers nowadays are demanding on food diversity and quality [10]. Therefore, it is significant to enhance the nutrition value and qualities of cookies by modifying their recipes or formulation. In order to utilise the valuable nutrients in dabai and diversify its application, this research is conducted to study the characteristics and acceptance of cookies produced by incorporating dabai into its formulations.

MATERIALS AND METHODS

Preparation of Cookies

The cookies were prepared by modifying the butter cookies recipe from Shiran [11]. The ingredients consist of flour, corn starch, sugar, butter, vanilla essence and dabai flesh. There were five formulations comprising different composition of dabai and butter. Table 1 showed the formulation of dabai cookies. 10 kg of dabai fruits were bought from Sibu Central market and immediately delivered to Food Technology Laboratory in University College of Technology Sarawak (UCTS), Sibu. The fruits were kept in a freezer at -20°C.

Table 1: Formulation of Dabai Cookies

Ingredients (g)	Control	Formula 1	Formula 2	Formula 3	Formula 4
Butter	225	200	175	150	125
Cake flour	100	100	100	100	100
Corn flour	85	85	85	85	85
Castor sugar	80	80	80	80	80
Vanilla extract	10	10	10	10	10
Dabai flesh and skin	0	25	50	75	100

Prior to analysis, dabai was taken out of the freezer and thawed at room temperature. Dabai fruits without any physical damage were selected and washed under running tap water. Then, the fruits were soaked in warm water for 10 - 15 min to soften the pulp. Dabai seeds were manually removed while the flesh was blended.

In a large bowl, butter, castor sugar and vanilla extract were creamed together using a laboratory mixer until light and fluffy. Then, sifted flour and corn flour were added into the mixture. The blended dabai was then weigh according to the formulation as illustrated in Table 1 and added to the mixture. In order to ensure the mixture is homogeneous, it was stirred for another 60 seconds. Meanwhile, the oven was preheated for 10 minutes at 200°C. The batter was shaped using ice cream scoop and was pressed out. Baking process was conducted using an air oven at temperature ranges from 160°C to 180°C for approximately 17 minutes. The cookies were allowed to cool on a cooling rack and kept in an air tight container.

Physicochemical Analysis

The pH was determined using pH meter (Sartorius PB 10, Sartorius AG, Goettingen, Germany). Samples were homogenised with deionized water in the ratio of one part of cookies to two parts of water. The moisture, fat, crude protein, ash, crude fiber and carbohydrate contents were determined according to the Association of Official Analytical Chemists (AOAC) Method [12]. Moisture content of the cookies was determined using oven dry method (AOAC 934.01) [12]. Approximately 5.00±0.10 g of homogenised sample was prepared in triplicates and dried overnight in an air-oven set at 100±3°C. The moisture content is calculated by using Equation 1.

$$Moisture\ (\%) = \frac{weight\ of\ moisture\ (g)}{weight\ of\ sample\ (g)} \times 100 \quad \text{..... (1)}$$

Solvent extraction method (AOAC 2003.05) [12] was applied to determine the crude fat content of dabai cookies. A 2.00±0.10 g of homogenised sample was extracted with 120 ml petroleum ether on a Soxhlet apparatus for approximately 80 minutes. The extraction involved a few steps which starts from 20 minutes of boiling, 40 minutes of rinsing, 10 minutes of solvent recovery and finally 10 minutes of drying. Petroleum ether was removed by evaporation and the weight of lipid residue was measured.

Crude protein content analysis was conducted according to the principle of Kjeldahl method as described in the AOAC 976.06 [12]. A 2.00±0.10 g of homogenised sample was digested with 15 ml 95 – 98% sulphuric acid using electrically heated aluminium block digester. The digested sample was diluted and made alkaline with 50 ml 40% sodium hydroxide. This process was continued with rapid steam distillation of ammonia and the diluted sample into 25 ml 4% boric acid. The distillate was then titrated manually with 0.1 N hydrochloric acid. The measured nitrogen content was converted using 6.25 conversion factor to obtain crude protein content. In addition, crude fiber analysis was conducted according to the AOAC 978.10 method [12].

Ash content analysis was conducted by applying dry ashing the AOAC 927.02 method [12]. Sample was placed inside a muffle furnace set at 550°C for 24 hours or until grey ash was obtained. Total carbohydrates was determined by subtracting the sum of moisture, fat, protein and ash from 100. Meanwhile, total calorie content was calculated by using Eq. 2.

$$\text{Energy Value, Kcal} = \%A + \%B + \%C \quad \text{..... (2)}$$

Where,

A = % Protein × 4

B = % Total Carbohydrate × 4

C = % Fat × 9

The physical properties of cookies including the weight, thickness, diameter and spread ratio were determined according to Aziah *et al.*, [13]. The cookies were weighed using analytical balance while the thickness (T) and diameter (D) of the cookie was measured with vernier caliper. In the analysis, four samples were selected randomly from each formulation. The samples were placed side by side and the total diameter was measured. Then, the samples were rotated 90° for the second measurement. Final diameter of dabai cookie was determine by taking the average of the two measurements divided by four. Meanwhile, the spread ratio was determined by dividing the diameter of cookie with its thickness.

Colour measurement of dabai cookies was conducted using a Chromameter CR-400 (Konica Minolta, Inc., Japan) with L*, a*, b* colour system. In this system, L* means the measured value from black to white (0-100) while a* values measure redness when positive and b* values measure yellowness when positive. Hardness and fracturability were obtained using texture analyser (TA.XT plus, Stable Micro Systems, UK) with a small Three Point Bend Rig (HDP/3PB).

Sensory Evaluation

Sensory evaluation was conducted in the food sensory laboratory of Food Technology Programme, School of Engineering and Technology, UCTS, using a total of 40 untrained panelists among UCTS staff and students. The 9-point hedonic scale was used where 1 represented dislike extremely and 9 like extremely.

Data Analysis

Data were analysed using one-way analysis of variance (ANOVA) and significant difference among samples were determine using Tukey's test at the level of $p \leq 0.05$ in statistical software package SPSS version 23.

General Cost Calculation

Cost calculation was included to give a general idea for product pricing. General calculation method of raw materials cost against the amount of material required for each formula was applied.

RESULTS AND DISCUSSION

Physicochemical Properties

Table 2 showed the pH of the dabai cookies produced. A decreased in pH was observed aligned with the addition of dabai content in the formulations. The value was significantly difference between all formulations. Prior to use in the cookies preparation, dabai was steeped in warm water which may influence the pH value. This was earlier reported by Ding and Tee [14] that steeping caused a decreased in the pH of dabai fruit. As a result, this may also contribute to the dropped in pH of dabai cookies. Furthermore, the mixing and baking steps in the cookie's preparation may further cause the drop of pH value. The measurement of pH is important in assessing the effectiveness of the preservation and in monitoring performance during processing [15]. Low pH value will inhibit the microbial growth and thus, will increase shelf life.

Table 2: The pH of Dabai Cookies

Formula	pH
Control	5.79 ± 0.01^{a}
Formula 1	5.53 ± 0.01^{b}
Formula 2	5.29 ± 0.01^{c}
Formula 3	5.01 ± 0.01^{d}
Formula 4	4.91 ± 0.01^{e}

Mean values in the same column not followed by the same letter are significantly different ($p \leq 0.05$)

Proximate composition of dabai cookies is presented in Table 3. Moisture content of dabai cookies was highest in Formula 4 which is 4.87 g/100 g while Formula 1 has the lowest which is 2.73 g/100 g. The moisture content of all formulations were significantly different. The moisture content of dabai cookies is low and according to Červenka *et al.*, [16], maximum moisture content of biscuits is 5%. Meanwhile, Bassinello *et al.*, [10], reported that according to Brazilian legislation, maximum moisture content of biscuits is 14%. Moisture content is one of the important parameter which influenced the stability of bakery products during storage [16]. On the other hand, the ash and crude protein content were found to increase aligned with the addition of dabai in the formulation. Ash content was within the range of 1.07 –

1.67% while crude protein was 3.36 – 5.56%. Ash content also indicates total amount of minerals present in food. This showed that dabai cookies contain acceptable amount of nutrients.

Cookies present low fat content in their composition as a consequence of reduction amount of butter. Fat content was highest in Control (51.84 g/100 g), and lowest in Formula 4 which was 34.99 g/100 g. This contributed to low fat content in dabai cookies. Dabai cookies with reduced fat content may be an option for those keeping their ideal bodyweight. Dabai was reported to have 22.1% of carbohydrate [6] which affected the carbohydrate content in the cookies. In this study, carbohydrate content increased aligned with the increased of dabai content in the formulations. Other ingredients such as flour and sugar may also contributed to the carbohydrate content in the cookies. Furthermore, the total carbohydrate is influenced by the moisture, protein, ash and fat content as it was determined by difference from 100%. All formulation showed no significant difference except Control.

Crude fiber can be determined by treating a sample with ether to remove fats, then boiling it alternately in a weak acid and a weak alkali or base. Crude fiber is the combustible residue that is left after the other carbohydrates and proteins that have been removed by sequential digestion of a sample by acid hydrolysis and followed by alkaline hydrolysis under specific conditions. In this study, crude fibre analysis showed that Control has the lowest mean score of 0.35 g/100 g, followed with Formula 1 (0.4 g/100 g), Formula 2 which is 0.75 g/100 g, Formula 3 (0.95 g/100 g), and Formula 4 has the highest mean score of 1.15 g/100 g. Thus, crude fiber content increased gradually as the amount of dabai increased in the formulation. Adequate crude fiber intake has a number of health benefits, including maintenance of healthy laxation and the reduced risk of cardiovascular disease [17].

Calorie content was found to decrease towards decreasing butter content in the formulation. Calorie was highest in Control (638 g/100 g) while Formula 4 has the lowest (548 g/100 g). Total calorie content was calculated by adding up the calories provided by protein, carbohydrate and fat. In total calorie content, fat contributed approximately 50% and multiply by 9, the highest amount compare to protein and carbohydrate. Furthermore, fat was obtained mainly from butter. Therefore, when the amount of butter was reduced, it reduced the calorie content indirectly.

The physical properties and texture analysis of dabai cookies like colour, thickness, diameter, spread ratio, hardness and fracturability were showed in Table 4. Colour showed a significant difference ($p \leq 0.05$) between each formulations. Lightness (L*) showed a decreasing trend which pointed out that cookies are darker at higher content of dabai in the formulation. The same trend was also recorded for yellowness (b*). Meanwhile, redness (a*) values increased as more dabai added to the formulations. According to Chauhan *et al.*, [18] cookie colour is one of the factor that influenced consumer initial acceptance. On the other hand, there was no significant difference showed on thickness, diameter, spread ratio, hardness and fracturability on each formulation. As more dabai added to the formulations, the moisture and crude fiber content of the cookies also increased (Table 3). Consequently, it also affected the characteristics of the cookies where it become softer. It can be observed that hardness was reduced as the amount of dabai incorporated in the cookies was increased. This indicated that less force is required to break the cookies as higher amount of dabai added into the formulation.

Sensory Properties

Four attributes were evaluated including texture, taste, appearance and flavour in sensory analysis. The findings were shown in Table 5. In the matter of texture, the panellists preferred Formula 1 while for taste they liked Formula 3. Formula 4 showed highest score in appearance followed by Formula 3, 2, 1 and Control has the lowest score. For overall acceptability, Formula 2 has the highest score among other formulation and Control. In Formula 2, 75 g or 15% of dabai were added in the cookie's formulation. Thus, it can be reported that the panellists preferred Formula 2 compared to the other four formulations.

Table 3: Proximate composition of Dabai cookies

Formula	Moisture (g/100 g)	Ash (g/100 g)	Protein (g/100 g)	Fat (g/100 g)	Carbohydrate (g/100 g)	Crude Fiber (g/100 g)	Calorie (cal/100 g)
Control	4.07 ± 0.12^{bc}	1.07 ± 0.12^{a}	3.86 ± 0.07^{a}	51.84 ± 7.13^{c}	39.16 ± 7.31^{a}	0.35 ± 0.07^{a}	638.67 ± 34.77^{c}
Formula 1	2.73 ± 0.3^{a}	1.07 ± 0.12^{a}	3.67 ± 0.11^{a}	45.28 ± 2.77^{bc}	47.26 ± 2.48^{ab}	0.40 ± 0.00^{a}	611.18 ± 15.15^{bc}
Formula 2	3.66 ± 0.11^{b}	1.27 ± 0.12^{ab}	4.23 ± 0.12^{a}	41.17 ± 1.89^{ab}	49.68 ± 2.03^{b}	0.75 ± 0.07^{b}	586.12 ± 9.16^{ab}
Formula 3	4.33 ± 0.23^{c}	1.33 ± 0.31^{ab}	5.02 ± 0.19^{b}	38.93 ± 2.69^{ab}	50.38 ± 3.07^{b}	0.95 ± 0.07^{bc}	571.99 ± 11.55^{ab}
Formula 4	4.87 ± 0.12^{d}	1.67 ± 0.23^{b}	5.56 ± 0.46^{b}	34.99 ± 1.04^{ab}	52.92 ± 1.14^{b}	1.15 ± 0.07^{c}	548.82 ± 5.25^{a}

Mean values in the same column not followed by the same letter are significantly different ($p \leq 0.05$)

Table 4: Physical properties and texture analysis of dabai cookies

Formula	Colour			Thickness (cm)	Diameter (cm)	Spread ratio	Hardness	Fracturability
	L	a	b					
Control	46.25 ± 2.50^{c}	-0.76 ± 0.23^{a}	20.08 ± 0.84^{b}	1.30 ± 0.0^{a}	4.50 ± 0.0^{a}	3.46 ± 0.0^{a}	1000 ± 377.22^{a}	19.01 ± 0.58^{a}
Formula 1	46.84 ± 0.28^{c}	3.38 ± 0.19^{b}	13.71 ± 1.19^{a}	1.20 ± 0.0^{a}	4.90 ± 0.0^{a}	4.08 ± 0.0^{a}	769.4 ± 63.96^{a}	20.60 ± 2.44^{a}
Formula 2	44.87 ± 2.46^{bc}	5.94 ± 0.61^{c}	12.44 ± 3.81^{a}	1.20 ± 0.0^{a}	4.50 ± 0.0^{a}	3.75 ± 0.0^{a}	587.05 ± 33.98^{a}	22.27 ± 0.41^{a}
Formula 3	38.65 ± 0.44^{b}	7.86 ± 0.08^{d}	10.39 ± 0.20^{a}	1.40 ± 0.0^{a}	4.50 ± 0.0^{a}	3.21 ± 0.0^{a}	517.52 ± 114.02^{a}	22.22 ± 0.86^{a}
Formula 4	30.19 ± 4.72^{a}	7.72 ± 0.63^{d}	9.61 ± 0.23^{a}	1.50 ± 0.0^{a}	4.50 ± 0.0^{a}	3.00 ± 0.0^{a}	493.15 ± 144.90^{a}	19.26 ± 1.96^{a}

Mean values in the same column not followed by the same letter are significantly different ($p \leq 0.05$)

Table 5: Sensory analysis of dabai cookies

Formula	Texture	Taste	Appearance	Flavour	Overall Acceptance
Control	7.05 ± 1.77^{a}	6.83 ± 1.65^{a}	6.48 ± 1.74^{a}	6.65 ± 2.06^{a}	6.93 ± 1.47^{a}
Formula 1	7.43 ± 1.43^{a}	7.23 ± 1.37^{a}	6.85 ± 1.55^{a}	7.18 ± 1.52^{a}	7.20 ± 1.18^{a}
Formula 2	7.30 ± 1.22^{a}	7.10 ± 1.48^{a}	7.25 ± 1.26^{a}	7.18 ± 1.26^{a}	7.45 ± 1.18^{a}
Formula 3	6.98 ± 1.78^{a}	7.48 ± 1.36^{a}	7.30 ± 1.38^{a}	7.18 ± 1.32^{a}	7.25 ± 1.35^{a}
Formula 4	7.10 ± 1.69^{a}	7.20 ± 1.60^{a}	7.33 ± 1.25^{a}	7.08 ± 1.54^{a}	7.40 ± 1.43^{a}

Mean values in the same column not followed by the same letter are significantly different ($p \leq 0.05$)

Material Cost

Calculation of overall material costing is conducted to determine the suitability or feasibility of the food product. Total raw material costing of the cookies was calculated based on the current market price as shown in price per item in Table 6. From calculation, it was found that 2.8 – 10.9% of total material cost increased for each formulation compare to the control. Formula 2 is to be highlighted since it is the most acceptable compare to other formulations. Formula 2 was found to have approximately 6.13% cost increased compare to Control. The calculation is based on RM18.00/kg dabai price and it showed total cost was RM4.33. The

quantity of cookies produced was approximately 393 g considering the losses during preparation. Basically, this information may help in the determination of the potential selling price if the cookies are to be commercialised.

Table 6: General Material Cost of Dabai Cookies

Ingredients	Price (RM)	Control (RM)	Formula 1 (RM)	Formula 2 (RM)	Formula 3 (RM)	Formula 4 (RM)
Butter	26.00 / kg	2.93	2.60	2.28	1.95	1.63
Cake flour	2.80 / kg	0.28	0.28	0.28	0.28	0.28
Corn flour	6.00 / kg	0.02	0.02	0.02	0.02	0.02
Castor sugar	3.75 / kg	0.35	0.35	0.35	0.35	0.35
Vanilla extract	0.10 / ml	0.50	0.50	0.50	0.50	0.50
Dabai	18.00 / kg	0.00	0.45	0.90	1.35	1.80
Total material cost (RM)	-	4.08	4.20	4.33	4.45	4.58
Cookies production (approx.) (g)	-	378	365	393	407	390

CONCLUSION

In conclusion, it is possible to produce dabai cookies with acceptable amount of nutrients. Results showed that dabai cookies contained acceptable amount of nutrient which includes protein, fat, fibre and energy. In proximate analyses, it was found that amounts of dabai added to the cookies formulation influenced significantly the nutrient content as well as the pH of dabai cookies. However, there is no significant differences ($p > 0.05$) between all formulations in the sensory attributes. The dabai cookies was generally accepted with the mean score of more than 7. It is hoped that this study will contribute to gather new information in terms of nutrient contents as well as the characteristics of dabai cookies.

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