PENERBIT
Universiti Sultan Zainal Abidin

JOURNAL OF AGROBIOTECHNOLOGY
eISSN : 2180-1983

The impact of (*Canarium Odontophyllum* Miq.) Dabai Optimum Soaking Condition Towards the Development of Dabai Peanut Spread Physicochemical Properties and Sensory Evaluation

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ABSTRACT

Canarium odontophyllum miq. also known as dabai is known as Sarawak indigenous fruit and utilised for dabai peanut spread formulation. Dabai is physically hard in texture and consumed by soaking under heat treatment. Therefore, dabai optimum soaking condition is determined followed by the development of dabai peanut spread. The determination of soaking condition requires: soaking time (2, 4, 6, 8, 10 and 12) mins and soaking temperature (50°C, 60°C, 70°C and 80°C) as independent variables, and (water absorption, crude protein content, crude fat content, moisture content, ash content and colour) as dependent variables. 50°C for 4 minutes is the optimum dabai soaking condition, and it is being utilised for dabai peanut spread formulation. There were six different formulations with different ratios of soaked dabai and roasted peanut, and further underwent proximate analyses and sensory evaluation test. The combination of a low amount of soaked dabai (40 g) with a high amount of roasted peanut (160 g) has produced a high amount of crude protein (10.65%) and crude fat (35.95%) and was found significantly (p<0.05) acceptable by the panellists. The information obtained provides a better understanding of dabai as a potential food product ingredient.

INTRODUCTION

Table spread is defined as any form of spreadable semi-solid such as peanut butter, fat spread and cheese spread. According to (Intelligence, 2018), the United States of America and European countries are among major producers for table spread. Nut spread has gained consumer preference due to acceptable flavour and good nutritional value (Shakerardekani et al., 2013). The common ingredients in nut spread are nut, palm oil or sunflower as processing aid material, monoglycerides as an emulsifier, water, salt and sugar as flavouring agents. Though nut spread is highly accepted, it contains high-fat content and is known for food allergen sources. Thus, these factors lead towards the rejection by health cautious consumers.

Canarium odontophyllum miq. or dabai is a fruit with Sarawak trademark. Dabai belongs to the Burseraceae family of Sapindales order in the Eudicotyledoneae class. Dabai fruit is oval to ellipsoid in shape, with an approximate dimension of 3.5 – 4.0 cm long, 2.0 – 2.5 cm wide. The dabai fruit weight can reach up to 18 g per fruit, and its structure consists of pulp, skin and kernel. Though dabai is synonymous with the Borneo region, there are several initiatives taken towards commercialising it. Dabai is a native state that is hard in texture and usually soaked in warm water before consuming. The effect of soaking conditions towards dabai nutritional content remains unresolved. The dabai optimum soaking condition data shall bring significant impact on future research related.

Recently, dabai has been used as the main ingredients for mayonnaise, ice cream, cookies and cakes. However, the exploration of dabai in spread making remains undocumented. Concerning the potential of dabai as indigenous fruit to Sarawak, thus this study was conducted to gather beneficial information for future research related to dabai as the main ingredients in food products. There are two sections involved in this paper. Firstly, the effect of soaking conditions towards dabai physicochemical properties were conducted. This process is crucial for identifying the optimum dabai soaking condition by producing the best nutritional content of soaked dabai. Secondly, the effect of dabai peanut spread formulation towards its nutritional content and sensory evaluation were carried out.

MATERIALS AND METHODS

Source of materials

Dabai (*Canarium odontophyllum* miq.) were bought from Sibu wet market and transported to laboratories. The samples were further stored in a cold room at -18°C.

Effect soaking condition towards dabai flesh physicochemical properties

In this experiment, the effect of soaking condition towards dabai flesh physicochemical properties were analysed. Soaking temperature and soaking time were the independent variables, and were set at (2, 4, 6, 8, 10 and 12) min and 50°C, 60°C, 70°C and 80°C. The dependent variables were dabai flesh physicochemical properties: colour difference and nutritional content (crude fat, crude protein, ash content, moisture content, carbohydrate content and total energy content). Soaked dabai with higher nutritional content was selected for development of dabai peanut spread.

Preparation of soaking medium

Each dabai with approximately 20.00 g ± 0.34 was soaked in distilled water at a ratio of 1:3 (w/v). The sample was transferred to a water bath (Memmert D-91126, Germany) to soak in uniform condition. Initially, the water bath regulator was adjusted at the designed soaking temperature.

Physicochemical properties

Colour difference (⊿E)

Chromameter (CR – 400, Konica Minolta, Japan) was used to measure the colour of each soaked sample. In this experiment, *Lab* system was implemented for colour measurement. The *Lab* system is referred to *L* (lightness), *a* (redness) and *b* (yellowness). The colour difference was determined according to **Eqn. 1**. L_1, a_1 and b_1 were referred to fresh dabai, and the values were 41.25, 4.78 and 15.38.

$$\text{Colour difference } (\Delta E) \quad = \quad \sqrt{(L_1 - L_2)^2 + (a_1 - a_2)^2 + (b_1 - b_2)^2} \qquad \textbf{Eqn. 1}$$

Proximate analysis

Each of the analysis conducted to measure soaked dabai nutritional content was referred to (AOAC International, 1990). Kjedahl method and factor of 6.25 were selected for crude protein determination. Soxhlet method was utilised for crude fat identification, while petroleum ether was used as lipid extraction solvent. Ash content of soaked sample was determined using dry oven method at 550°C for 12 hours. Total carbohydrate was measured according to calculation method.

Development of dabai peanut spread

Experimental design of dabai peanut spread

The development formulations of dabai peanut were referred to Shakerardekani et al., (2013) with some modifications. There were four major ingredients involved in the formulation with varied amounts of weight. Soaked dabai flesh (0 – 200) g, roasted groundnut (0 – 200) g, sucrose 60g and red palm oil 40g. **Table 1** shows the table formulation of dabai peanut spread, while **Fig. 1.** shows the process flowchart of making dabai peanut spread. Each of dabai peanut spread formulation nutritional content were tested for proximate analyses under method mentioned previously.

Table 1. Formulation of dabai peanut spread

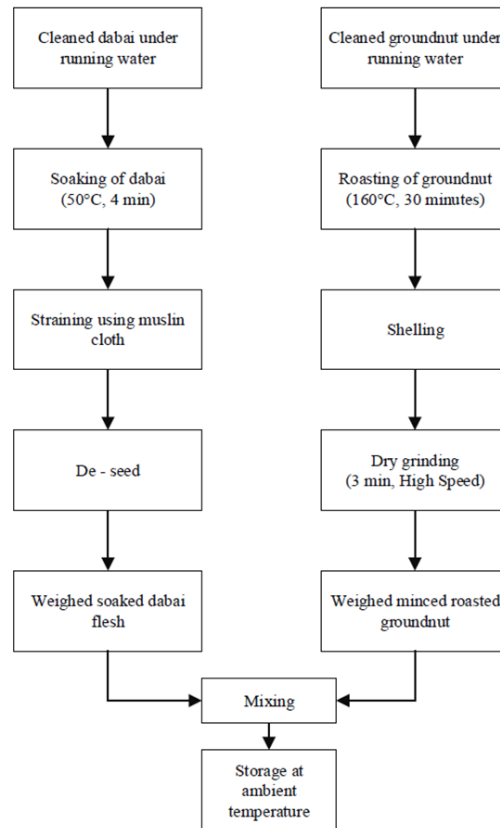| Formulation	Ingredients (g)			
	Soaked Dabai Flesh	Roasted Groundnut	Sucrose	Red Palm Oil
1	200	0	60	40
2	160	40	60	40
3	120	80	60	40
4	80	120	60	40
5	40	160	60	40
6	0	200	60	40

Fig. 1. Dabai peanut spread process flowchart

Sensory analysis

Sensory analysis was conducted to determine the acceptability of each developed formulation by 30 trained panellists. The 9 – point hedonic scale was utilised in the questionnaire with seven attributes namely: sweetness, aroma, colour, texture, dabai taste and groundnut taste. SPSS Version 23.0 was applied for statistical analysis. The analysis of variance (ANOVA) and p – values (p<0.05) were utilised for significance detection (Zulueta et al., 2013).
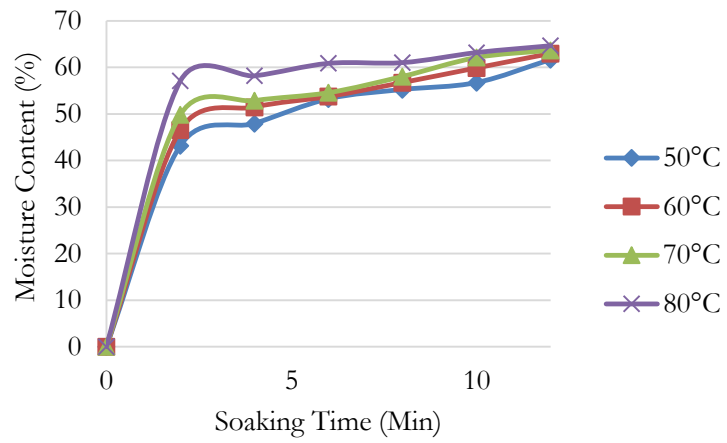
RESULTS AND DISCUSSION

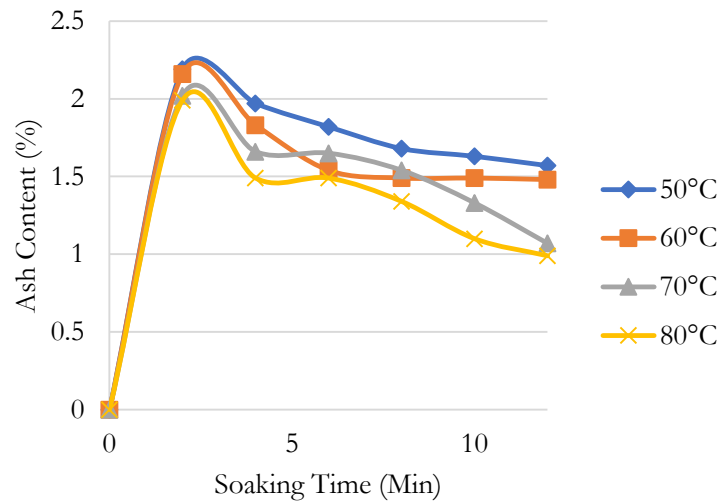**Fig. 2.** The effect of dabai moisture content towards the soaking condition

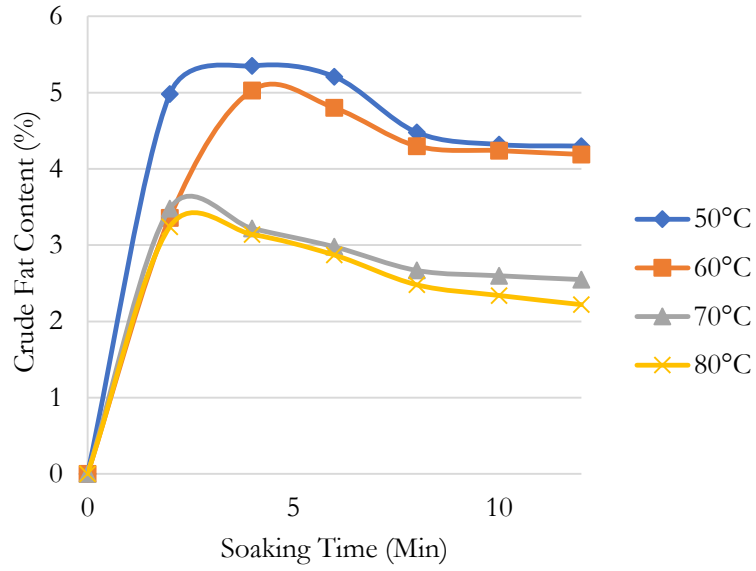**Fig. 3.** The effect of dabai ash content towards the soaking condition

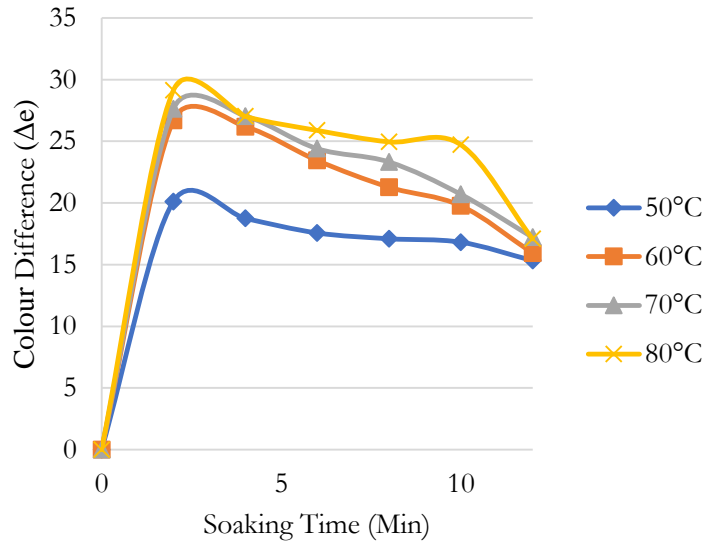**Fig. 4.** The effect of dabai crude fat content towards the soaking condition

Fig. 5. The effect of dabai colour difference towards the soaking condition
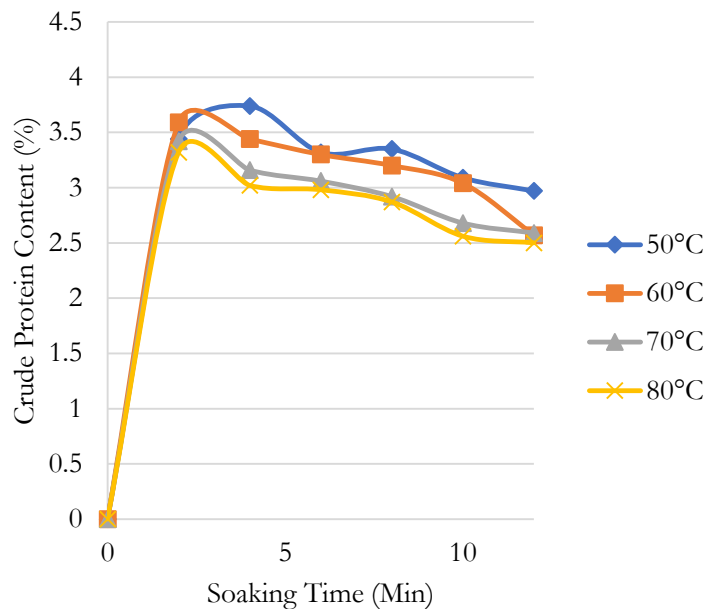
Fig. 6. The effect of dabai crude protein content towards the soaking condition

The effect of soaking condition towards dabai physicochemical properties

Fig. 2. presents the graph between dabai flesh moisture content towards soaking condition. Once the sample has reached the designed soaking temperature, dabai flesh was de-seed and further undergo proximate analyses. Each sample's moisture content was increased from 2 min until it reached the equilibrium amount of moisture content at 12 min. Soaking under 80°C for 12 min has yielded highest moisture content at 64.66%, while the lowest amount of moisture content was reported at 50°C, 2 min at 43.2%. As expected, the major contribution of dabai flesh moisture content leads by longer soaking time and higher soaking temperature. The result of dabai moisture content was found similar with other type of legume which undergone similar soaking condition. During the immersion process, water gradually penetrates into the legume until it reaches equilibrium level of moisture content (Shafaei, 2013). The application of warm water for the soaking condition has escalated moisture diffusivity leading to greater hydration frequency, thus catalysed the uptake of water absorption (Kashaninejad et al., 2009; Shafaei et al., 2016). As referred to soybean processing, the amount of moisture content in it is directly linked to characteristic textural change(Ehiem et al., 2019). However, no recent documented studies have reported the effect of soaking condition towards dabai hardness.

Fig. 3. shows the effect of soaking condition towards soaked dabai ash content. The line graph trend displays an inclination in the first 4 minutes, and gradually declines from 6 to 12 minutes. The soaking condition of 50°C for 2 minutes yielded the highest amount of ash content – 2.19%. Conversely, the soaking condition of 80°C for 12 minutes has lowered the amount of ash content to the minimum point – 0.99%. Thus, the factors of soaking temperature and soaking time do significantly affect the ash content of soaked dabai. Higher soaking temperature and longer soaking time have catalyzed dabai fruit's content to be immersed in the soaking medium. In the meantime, the permeation of legume's oligosaccharides into soaking medium has indirectly reduced legume's mineral content (Ibrahim et al., 2020).

Fig. 4. displays the graph between soaked dabai's crude fat and soaking condition. The graphs show an inclination in the first 4 minutes and consistently decline until 12 minutes. At 50°C for 4 minutes has yielded the maximum result – 5.35%. Meanwhile, 80°C for 12 minutes has produced the minimum result – 2.22%. Dabai in native form contains 27.66% of crude fat content (Chua et al., 2015) and both independent variables soaking time and soaking temperature are found significant towards affecting dabai crude fat content. Hypothetically, the soaked material crude fat content is either destroyed by heat treatment or due to the permeation process has dissolved crude fat content into a soaking medium. Food lipids are categorised into two forms: fat in solid-state and oil in liquid form. These compounds have provided texture, flavour, nutrition and caloric density to the food. Thus, the crude fat determination of pre-processed material is vital towards recognising its potential in food product development (McClements & Decker, 2017).

Fig. 5. shows the scenarios explained between soaking condition and colour difference of soaked dabai. Initially, dabai is soaked under designated condition and de-seed, followed by determination of colour difference using a calorimeter. In this research, colour difference resemblances the magnitude of differences between soaked and native dabai. At the first 2 minutes, each sample's magnitude of colour difference increased and decreased from 4 to 12 minutes. The maximum colour difference is perceived through soaking conditions at 80°C for 2 minutes, while at 50°C for 12 minutes shows colour difference with minimum value. At the end of the experiments, the colour difference of each analysis has reached the same point. Thus, this indicates that longer soaking time and heat treatment have produced the same result. Maillard reaction is a nonenzymatic reaction that is the significant factor contributing to the colour difference of each sample. Tamanna & Mahmood (2015) have reported that foods with exposure to heat treatment tend to brown due to chemical reaction between amino acids and reducing sugars.

Fig. 6. presents the overview between soaking condition and crude protein content of soaked dabai. The line graphs show an inclination in the first 4 minutes and gradually decreased until 12 minutes. The soaking condition of 50°C for 4 minutes has recorded the maximum amount– 3.74%, while high temperature and longer soaking time produced the lowest value – 2.50%. Based on the experiments, it depicted that longer soaking time and higher soaking temperature do influence the crude protein of dabai. Crude protein is sensitive to heat treatment, pH changes, and salt concentration changes (Damodaran & Parkin, 2019). Thus, higher soaking temperature has destroyed and reduced the amount of dabai crude protein content.

The effect of dabai peanut spread formulation towards its nutritional content

Dabai, which has undergone a soaking condition of 50°C for 4 minutes, is used to formulate dabai peanut spread. There were six formulations with different concentrations of dabai flesh and roasted peanuts. **Fig. 1**. shows the process flow of making dabai peanut spread. Once it is produced, the sample is stored in a glass container at ambient temperature for further analyses. **Table 1** shows the proximate compositions (moisture content, ash content, crude fat, crude protein and carbohydrate) of the whole formulations. Formulation 1 with the highest amount of soaked dabai shows the greatest moisture content – 46.27%. Meanwhile, formulation 6 with the least amount of soaked dabai has produced the minimum moisture content – 8.98%. The Anova table shows that (p<0.05), hence indicating different amounts of soaked dabai and roasted peanut, has a significant contribution towards each formulation's moisture content. The pre–processing (soaking and drying) has indirectly played a vital role in influencing each formulation's moisture content. Furthermore, (Krzyzanowski et al., 2006) stated that the moisture content of marketed groundnut is around 10.15%, and roasting for 30 minutes at 160°C has directly removed the groundnut moisture content by 11.53%.

Formulation 1 has recorded the highest ash content – 2.3%, while formulation 6 shows the least amount of ash content – 0.90%. The least amount of soaked dabai in the formulation has lowered the ash content as tabulated in **Table 1**. However, the Anova table shows no significance of ash content (p>0.05) among the formulations. Formulation 1 with the highest ash content, 2.3% shows similar data mentioned by (Ding & Yahia, 2011). Formulation 6 with the highest amount of roasted peanuts recorded the least amount of ash content. However, the ash content of roasted peanuts recorded by (Kumar et al., 2013) is 4.08%.

Theoretically, the presence of other ingredients (sucrose and red palm oil) cannot affect the lower amount of ash content on each formulation as both function as flavouring ingredients. Hypothetically, the source ash content is affected by climate region, soil type and harvesting method.

Each formulation's proximate composition shows that the presence of high amounts of roasted peanuts has increased the formulation's crude fat and crude protein content. Formulation 1 has recorded the lowest crude fat and crude protein content (5.74% and 3.29%), while formulation 6 shows the highest amount of crude fat and crude protein content (49.50% and 13.20%). The Anova table shows that crude protein and crude fat are significant ($p < 0.05$) among the formulations. Crude fat plays a vital role in flavouring and sensory attributes. Based on sensory evaluation prediction, formulation 6 shall gain consumer preference due to its nutty flavour and mouthfeel attributes. However, food products with high intensity of crude fat content may become rancid due to lipid oxidation. Hence, the addition of emulsifiers such as monoglycerides is required to retard the lipid oxidation process and prolong the product's shelf life. Crude protein is a known compound that functions to improve the physiology of the human body. According to Damodaran & Parkin (2019), fat and flavour binding and emulsification are among food protein functional roles in the food system. Thus, formulations with high amounts of crude protein are suggested to have good emulsification and are much flavourful than others.

The carbohydrate content is achieved through deduction of whole proximate composition (moisture content, ash content, crude fat and crude protein) by 100%. The amount of carbohydrate content is decreasing with the increase of roasted peanuts. The highest carbohydrate content is recorded at 47.40%, while the lowest at 27.42%. Carbohydrates are common constituents of foods, both as natural inherent components and as ingredients added. Both the quantity consumed and the range of products they find themselves in are high. Carbohydrates have many different molecular structures, sizes and shapes; they have numerous chemical and physical properties; and they have different physiological effects on the human body (Damodaran & Parkin, 2019). The Anova table shows the carbohydrate content is significant ($p < 0.05$) towards each formulator.

Sensory evaluation towards dabai peanut spread formulation

The sensory test is conducted to measure the acceptability of consumers towards six developed formulations. Linkert scale with nine-point scaling was employed to measure the six attributes: sweetness, aroma, texture, dabai taste, peanut taste and overall acceptability. The collected data were calculated through average score and tabulated in **Fig. 7**. Based on **Fig. 7.**, most panellists preferred to select neither like nor dislike, slightly like and moderately like towards formulated dabai peanut spread attributes. Formulation 5 achieved score of 7.20, while Formulation 1 showed the least preference with a 5.87 score. The aroma attributes indicate that Formulation 6 gained 7.13 scores, while Formulation 1 has the lowest score 5.93. The lower score may be due to dabai's undesirable aroma.

Formulation 6 has achieved the highest score in colour attributes – 6.60. The light colour of the sample has attracted and preferred by most panellists. In contrast, formulation 3 scored the least value with 5.30. The panellists' judgements on colour attribute were affected with the combination of soaked dabai and roasted peanut. Soaking has caused browning towards dabai flesh and the combination of roasted peanuts has darkened the formulation. Formulation 6 also achieved the highest score for texture attributes 6.77, while formulation 1 scored the most minuscule 5.63. The texture of spread with 100% of dabai flesh is hard and undesirable. However, the addition of roasted peanuts in formulation with creamy properties is preferred by most panellists. Thus, most panellists preferred a formulation with a creamy texture.

The utilisation of 100% of dabai flesh or roasted peanut has resulted in highest score for Formulation 1 for dabai taste attribute, while Formulation 6 achieved the highest result for peanut taste. The result is following the application of ingredients utilised in the formulation. In terms of overall acceptability, Formulation 6 with whole formulation of roasted peanut is preferred by the panellists with 7.33. Formulation 5 has ranked second with 7.30 with 80% of roasted peanuts and 20% of soaked dabai flesh. Hence, it can be summarised that panellist preferred formulations with low content of soaked dabai flesh and high roasted peanut content. By referring to

Table 3. shows that all attributes are significant (p<0.05) among formulations, except the colour attribute (p> 0.05). This could be due to the perception of panellists towards the formulated product.

Table 2. The proximate composition of each formulation

Formulation	Moisture Content (%)	Ash content (%)	Crude Fat (%)	Crude Protein (%)	Carbohydrate (%)
1	46.27 ± 2.11^d	2.3 ± 0.01^a	5.74 ± 0.35^a	3.29 ± 0.09^a	47.40 ± 0.05^{cd}
2	37.31 ± 0.70^{cd}	1.99 ± 0.00^a	10.7 ± 1.06^{ab}	4.36 ± 0.12^{ab}	45.64 ± 0.01^c
3	28.36 ± 9.85^{bc}	1.74 ± 0.01^a	22.14 ± 4.57^{bc}	7.23 ± 0.12^b	40.53 ± 0.25^a
4	26.87 ± 3.52^{bc}	1.50 ± 0.00^a	25.64 ± 5.98^{bc}	7.43 ± 1.39^b	38.56 ± 0.41^d
5	14.68 ± 1.06^{ab}	1.00 ± 0.00^a	35.95 ± 0.35^c	10.65 ± 2.00^b	37.72 ± 0.05^{bc}
6	8.98 ± 0.70^a	0.90 ± 0.00^a	49.50 ± 1.06^d	13.20 ± 1.42^c	27.42 ± 0.32^{ac}
p - value	0.001	0.070	0.000	0.001	0.002
Remarks	Significant	Not Significant	Significant	Significant	Significant

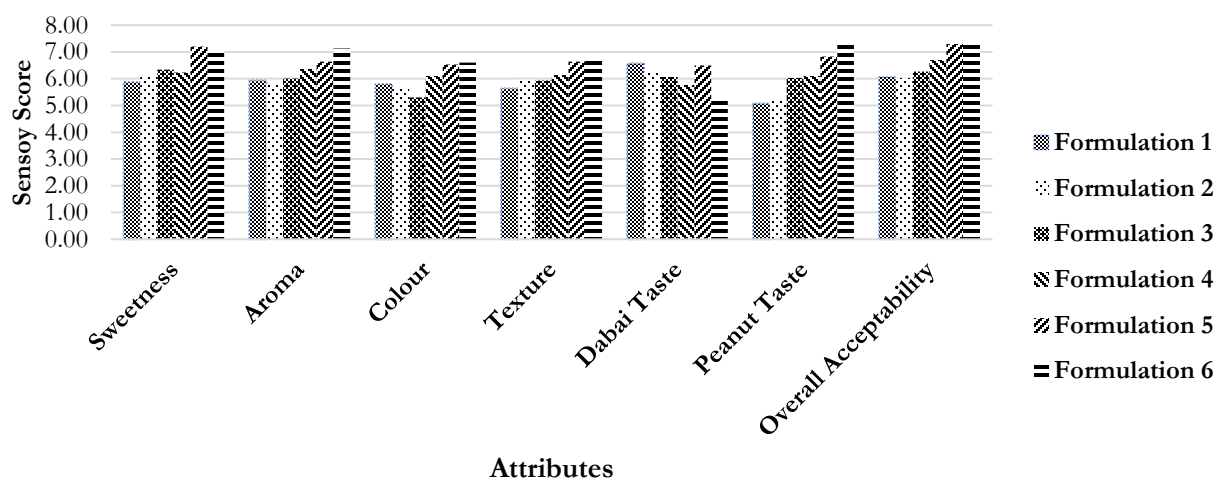Note: Identical letters in the same row do not significantly (p>0.05) among themselves.

Fig. 7. Sensory Evaluation of Formulated Dabai Peanut Spread

Table 3. Anova Table for sensory evaluation

Attributes	Sweetness	Aroma	Colour	Texture	Dabai Taste	Peanut Taste	Overall Acceptability
p - value	0.006	0.009	0.072	0.035	0.049	0.000	0.001
Remarks	Significant	Significant	Not Significant	Significant	Significant	Significant	Significant

CONCLUSION

The optimum soaking condition of dabai is at 50°C for 4 minutes, resulting in higher crude fat and crude protein of soaked dabai. Both nutritional facts components are crucial related to the sensory properties of the developed product output. The soaked dabai under the optimum soaking condition with roasted groundnut, icing sugar and red palm oil produces six different formulations. Higher content of roasted groundnut has significantly increased the formulation's crude fat and crude protein. The combination of soaked dabai and roasted groundnut has improved the acceptability considerably on the developed product. For future recommendation, the selection of appropriate emulsifiers in the formulation is required to improve the developed product quality.

ACKNOWLEDGEMENT

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