BORNEO JOURNAL OF SCIENCES AND TECHNOLOGY (BJoST)
VOL. : 6, ISSUE: 2 , 94-100
DOI: http://doi.org/10.35370/bjost.2024.6.2-10
e-ISSN: 2672-7439 © 2018, UTS Publisher.

University of Technology Sarawak

ORIGINAL ARTICLE

Proximate Analysis of Cookies Enriched with Mashed Engkalak (*Litsea garciae*)

*[1,2,4]Nasihah Mokhtar, [1]Michael Kho Chern How, [1,2]Farah Syahirah Abdul Shukri, [1,2]Ung Hua Ting and [3,4] Sofiyah Mohd Razali

[1]School of Engineering and Technology, University of Technology Sarawak, 96000 Sibu, Sarawak, Malaysia
[2]Centre for Research of Innovation and Sustainable Development, University of Technology Sarawak, 96000 Sibu, Sarawak, Malaysia
[3]School of Foundation Studies, University of Technology Sarawak, 96000 Sibu, Sarawak, Malaysia
[4]Centre of Excellence in Wood Engineered Products, University of Technology Sarawak, 9600 Sibu, Sarawak, Malaysia

ABSTRACT - Engkalak, *Litsea garciae* is one of the seasonal native fruits of Borneo. It is also one of the underutilised fruits in Sarawak. As motivated by the desire to utilize engkalak fruit and create a market-novelty, this research explored engkalak cookies as a shelf-stable, ready-to-eat product. This study was about the production of engkalak cookies with different formulation together with proximate analysis of the product. Four engkalak cookies formulations were analysed for the moisture content, water activity, ash content, crude fat, protein content, carbohydrate content and total energy value. For the formulation, it included butter cookies mix to engkalak mash in the ratio of 10:0, 10:1, 10:3 and 10:5. It was found out that as ratio of engkalak mash increased, the moisture content and water activity of engkalak cookies increased, causing the cookies to be more susceptible to the mold growth. The crude fat content of different formulation of engkalak did not differ significantly. The addition of engkalak fruit, especially at higher concentrations (30% and 50%), significantly elevated protein content of the butter cookies. This research was crucial in expanding the use of this exotic fruit of Borneo and creating a niche in the cookies market. It benefited the consumers by providing a new snack fortifying with protein and minerals from the local fruit.

ARTICLE HISTORY
Received: 15 April 2024
Revised: 16 May 2024
Accepted: 30 June 2024

KEYWORDS
Native fruit,
Cookies,
Borneo Fruit,
Formulation,
Engkalak.

INTRODUCTION

Malaysia is one of the countries with a wide diversity of underutilized fruits grown in the wild, especially in Peninsular Malaysia, Sabah and Sarawak. Some of these underutilized fruits include bacang (*Mangifera* sp.), bidara (*Ziziphus* sp.), belimbing buloh (*Averrhoa* sp.), and engkalak (*Litsea garciae*) (Ikram et al., 2009). They have potential nutrients, and studies regarding these fruits are currently still lacking [1]. Furthermore, these underutilised fruits are commonly locally abundant but globally rare. Therefore, they can be seen as an opportunity to be cultivated and harvested to produce various food products. They may contain nutrients, however there aren't enough studies on these fruits at the moment [1]. Moreover, these underutilised fruits are abundant locally but uncommon globally.

This study focuses on *Litsea garciae*, which is commonly known as engkalak. Engkalak is a seasonal fruit with a limited shelf life and is typically available only around November till January. The fruit species is native to Borneo (Sarawak, West Sabah, and Kalimantan) and the Philippines. It can be found throughout Borneo Island. The pulp and the thin skin of the engkalak fruit are both edible. The pulp of the fruit can be eaten raw or steamed with rice. When the engkalak fruit is fully ripened, it is soft, and the locals usually eat the pulp and skin together after soaking the fruit in warm water for 5 to 10 minutes. A

*Corresponding Author: Nasihah Binti Mokhtar. University of Technology Sarawak (UTS), email: nasihah@uts.edu.my

pinch of salt or sugar helps enhancing the taste. The fruit's flesh is white, creamy, soft texture and has a delicate flavour that resembles the lighter taste of avocado [2]. Unripe engkalak shows green skin, while the skin turns pink when ripened.

Consumers nowadays seek foods with pleasing sensory characteristics, high nutritional value and a low risk of spoilage. Therefore, it is necessary to define some factors and the interactions between different components throughout the development of a new product to attain acceptable quality. Besides, there is little to no product that uses engkalak as an ingredient. Since cookies stand out in the global market due to their simplicity of production, convenience and affordability [3], an idea came out using cookies to be infused with engkalak when discussing a possible product to be made. It has characteristics such as ready-to-eat nature, cheap, long shelf life, good nutritional quality, and easily acceptable by the old and young, making it the perfect choice to further process engkalak. The ingredients not only influence the taste, texture, scent, and flavour of the final cookies, but also the physicochemical attributes that associated with the shelf life and nutritional content.

Through proximate analysis, this study determines the effect of incorporation of engkalak into butter cookies in terms of the nutrient content and physicochemical properties, which can provide the industry and market with a new nutrient-fortifying snack. This study aims to assess the impact of adding engkalak to butter cookies on their physicochemical properties and nutritional content through proximate analysis. The goal is to develop a new, nutrient-rich snack option while also exploring ways to reduce engkalak food waste and increase awareness of this exotic fruit.

MATERIALS AND METHODOLOGY

Sample Collection and Preparation

Engkalak (*Litsea garciae*) (Figure 1) was purchased from Central Market, Sibu and Kubah Ria Market, Kuching. Materials such as butter, cake flour, sugar, and eggs were purchased from the bakery shop. For preservation purposes, the engkalak flesh and the skin were mashed together to form engkalak mash paste, which was then kept frozen until use for the baking next day.

Cookies Production

A total of four formulations of engkalak cookies was produced. The formulations were different by adding different ratios of the engkalak mash paste into the dough mix. Formulation 1 (F1) was prepared using a standard butter cookies recipe without engkalak mash. This acted as the control. Formulation 2 (F2) was prepared by adding 10 g of engkalak mash to 100 g of butter cookies mix, in which the ratio of butter cookies mix to engkalak mash was 10:1 (10% engkalak). Formulation 3 (F3) was prepared by adding 30 g of engkalak mash to 100 g of butter cookies mix, making the ratio of 10:3 (30% engkalak). Finally, formulation 4 (F4) was prepared by adding 50 g of engkalak mash to 100 g of butter cookies mix, the ratio of 10:5 (50% engkalak).

Control acted as an indicator to compare the engkalak cookies with standard butter cookies. All formulation consisted of the same amount of flour, sugar, butter, and egg yolk, with the only difference being the amount of engkalak mash added. In summary, formulations 1 to 4 consisted of 0 g (F1), 10 g (F2), 30 g (F3), and 50 g (F4) of engkalak mash over 100 g of butter cookies mix.

All ingredients were weighed and mixed in a large bowl according to formulation. The dough was then flattened using a roller till desired thickness, around 4 to 5 mm. A round cookies cutter was used to get the desired shape, then the cookies was weighed to be about 4 g before baking at 150°C for 20 minutes until they turned into light golden brown. At the ambient condition at 24 – 26°C, the baked sample cookies were cooled and stored in an airtight container one week before conducting the proximate analysis (Figure 2).

Figure 1. Engkalak fruit

Figure 2. Engkalak cookies

Proximate Analysis

Each formulation of the sample cookies was blended and subsequently stored in individually labeled containers for further analysis. The cookies underwent a series of analyses to determine their physicochemical and nutritional characteristics, including moisture content, water activity, ash content, crude fat, protein content, carbohydrate content, and total energy value.

Water activity was measured using a water activity analyzer (Meter Aqualab 4TE, United States). Moisture content, ash content, protein content, and crude fat were analyzed following established methods outlined by the AOAC [4]. Specifically, moisture content was determined by drying a known sample weight to a constant mass, ash content was measured by incinerating the sample at high temperatures, protein content was quantified using the Kjeldahl method, and crude fat was extracted via Soxhlet extraction.

Total carbohydrate content was calculated using the difference method, as described in James' analytical methods, by subtracting the sum of the percentages of moisture, protein, fat, and ash from 100% [5]. The total energy value of the cookies was computed based on the caloric contributions of the macronutrients, following standard nutritional calculations. All results were expressed as percentages (%).

$$C = 100 - (P + F + M + A) \quad (1)$$

Where: *C = total carbohydrates, %; P = crude protein, %; F = crude fat, %; M = moisture, %; A = ash, %.*

The calorie content per gram for macronutrients is as follows: Protein provides 4 kcal/g, carbohydrate provides 4 kcal/g, and fat provides 9 kcal/g. As shown in Equation 2, the total energy (*TE*) content of 100 g engkalak cookies were calculated by adding the energy contributed by protein, fat and carbohydrate. *TE* was expressed in kilocalorie (kcal)/100g.

$$TE = 4P + 9F + 4C \quad (2)$$

Where: *TE = total energy value, kcal/100g; %; P = crude protein, %; F = crude fat, %; C = total carbohydrates, %*

The data were analyzed using SPSS Version 26. The t-test was employed to assess whether there was a significant difference in the mean values (p-value ≤ 0.05).

RESULTS AND DISCUSSION

Moisture, Water Activity and Ash Content

The increase in moisture content of engkalak cookies with the addition of engkalak mash into the butter cookies mix was observed (Table 1). Notably, formulations 1 and 2 exhibited moisture content levels below the typical threshold of 5% for biscuits, cookies, or crackers, as reported in previous studies [6]. However, formulations 3 and 4 showed a substantial increase in moisture content, reaching 7.86% and 12.30%, respectively. The drastic difference in moisture content between formulations 1 and 4, exceeding 60 times, underscored the significant impact of engkalak mash on the cookies' moisture levels. This could be attributed to the inherently high moisture content of engkalak mash itself.

Table 1. Moisture, Water Activity and Ash Content of Different Cookies Formulation

Attribute	F1	F2	F3	F4
Moisture (%)	0.20 ± 0.00^{a}	1.67 ± 0.03^{ab}	7.86 ± 0.02^{bc}	12.30 ± 0.07^{c}
Water Activity	0.19 ± 0.02^{a}	0.35 ± 0.01^{ac}	0.65 ± 0.01^{bc}	0.77 ± 0.00^{b}
Ash (%)	0.87 ± 0.03^{a}	0.99 ± 0.06^{b}	1.12 ± 0.02^{c}	1.25 ± 0.05^{d}

Note: The score values are presented as mean ± standard deviation (SD). For each attribute, means marked with different lowercase letters indicate a significant difference ($p \leq 0.05$) according to the t-test.

Moisture content plays a crucial role in determining various food characteristics, including taste, texture, weight, appearance, and shelf life [7]. The higher moisture content observed in engkalak cookies may suggest a softer texture and less crunchy or hard consistency compared to cookies with lower moisture levels [8]. Moreover, such variations in moisture content among different formulations of engkalak cookies may have implications for shelf life and sensory parameters, particularly in crunchiness or hardness.

Water activity refers to the ratio between the food's vapor pressure and the vapor pressure of distilled water under identical conditions [9]. It is relative important factor in a food, as it controls the rate of deterioration of food as a result of either non-microbial or microbial effects.

Based on result in Table 1, the water activity of F1, F2, F3 and F4 was 0.19, 0.35, 0.65 and 0.77 respectively. From this, it could be seen that with the increasing ratio of engkalak mash into butter cookies mix, it had increased the water activity in engkalak cookies. It is also a key point to look in to determine the shelf life on shelf-stable foods [10]. The value ranges from 0 to 1, with 0 indicating no available water while 1 indicating pure water. Food products at different water activity will be suspected to different type of spoilage.

High water activity provides a suitable environment for mold and other microorganisms to thrive. The engkalak sample cookies of F2, F3 and F4 had a high risk of mold spoilage since their water activity was above 0.6. This reflected the nature of fruits which are high in moisture content. As to achieve a better shelf life, the engkalak cookies could be improved by the other feasible ways to reduce both moisture content and water activity. For instance, adjusting the baking time or temperature and adding humectants such as glycerol.

The analysis of ash content in engkalak cookies revealed valuable insights into the mineral composition of the product. Ash content estimation is an integral part of nutritional evaluation in proximate analysis, serving as a representative for the mineral content within food items [11].

However, interpreting ash content can be complex due to its direct susceptibility to variations in ingredients and formulations. A wide range of ash content had been observed in biscuit products, emphasizing the influence of ingredients and processing methods on this parameter [12; 13].

In the case of engkalak cookies, the ash content falls within a range comparable to that of the control, indicating consistency with conventional biscuit products. Notably, as the ratio of engkalak mash increased, a corresponding rise in ash content was observed. For instance, the ash content of F2, F3 and F4 was 0.99%, 1.12% and 1.25% as compared to F1 (0.87%). This trend suggested that engkalak mash may contribute significantly to the overall mineral content of the cookies, potentially possessing a higher ash content compared to the butter cookies mix.

Crude Fat, Protein, Carbohydrate and Energy Value

The analysis of crude fat content in engkalak cookies provided valuable insights into the lipid composition of the product. Crude fat represents the crude mixture of fat-soluble material present in a sample, and it is often used interchangeably with terms such as ether extract or free lipid content in food compositional analysis [14]. Engkalak cookies, across all formulations (Table 2), exhibited high levels of crude fat, with proportions ranging from 27.91% to 28.74%. These values exceed the threshold set by the British Heart Foundation for defining high-fat foods, which is more than 17.5 g per 100 g [15]. Notably, even the control formulation (F1) displayed a high-fat content of 28.60%, it was consistent with the fat content of traditional butter cookies, as reported by the United States Department of Agriculture (USDA) [16].

Table 2. Crude Fat, Protein, Carbohydrate and Energy Value of Different Cookies Formulation

Attribute	F1	F2	F3	F4
Fat (%)	28.60 ± 0.76^{a}	28.74 ± 0.31^{a}	28.38 ± 0.04^{a}	27.91 ± 0.21^{a}
Protein (%)	3.99 ± 0.07^{ab}	3.42 ± 0.05^{c}	3.85 ± 0.07^{a}	4.14 ± 0.11^{b}
Carbohydrate (%)	66.34 ± 0.82^{ab}	65.18 ± 0.35^{a}	58.79 ± 0.11^{b}	54.40 ± 0.17^{c}
Energy value (kcal/100g)	538.75 ± 3.88^{a}	533.10 ± 1.39^{ab}	506.00 ± 0.27^{bc}	485.33 ± 0.87^{c}

Note: The score values are presented as mean ± standard deviation (SD). For each attribute, means marked with different lowercase letters indicate a significant difference ($p \leq 0.05$) according to the t-test.

The observed high-fat content in formulations F2, F3, and F4 could be attributed primarily to the presence of butter in the original recipe. However, despite variations in the ratio of engkalak mash, the difference in crude fat content among all formulations was not significant. This suggested that the contribution of engkalak mash to the overall fat content may be relatively consistent across different formulations. To further clarify the effect of engkalak mash towards fat content, additional analysis of the fat content in the mash itself could be performed.

According to USDA [16], the protein content of a cookies is 3.38 g per 100 g in the cookies, butter, or sugar, with icing or filling other than chocolate. Based on the result in Table 2, the protein content of engkalak cookies ranges from 3.42% to 4.14%, which is slightly higher compared to the protein content of cookies from USDA (3.38%). F2 (10% engkalak fruit) had a significantly lower protein content as compared to F3 (30% engkalak fruit) and F4 (50% engkalak fruit). This indicated that the inclusion of engkalak fruit, particularly at higher concentrations (F3 and F4), led to a significant increase in protein content.

The total carbohydrate in a food or beverage is the overall carbohydrate. Total carbohydrates are dietary fiber, sugars, starches, and other nutrients [17]. According to USDA, the total carbohydrate of the cookies, butter, or sugar, with icing or filling other than chocolate, is at 72.7 g per 100 g of the cookies [16]. As compared to this study, engkalak cookies had a lower carbohydrate content at 54.40% to 66.34%. This could be mainly due to the high-fat content of engkalak cookies, thus lowering the total carbohydrate content. As compared to F1 and F2, F3 and F4 showed a lower total carbohydrate content, which possibly due to the higher moisture content. As depicted in Table 1, the moisture content of F3 and F4 reached 7.86% and 12.3% respectively whereas F1 and F2 only showed moisture content of 0.2% and 1.67% correspondingly.

According to USDA data, butter cookies typically have an energy value of approximately 467 kcal per 100g [16]. However, analysis of engkalak cookies, as depicted in Table 2, indicated that their energy values were higher, with the control formulation (F1) displaying the highest energy content at 538.75 kcal per 100g.

Interestingly, formulations F2, F3, and F4 exhibited progressively lower energy values, with F4 recording the lowest at 485.33 kcal per 100g. This decline in energy content across formulations can be attributed to the higher moisture content observed in these formulations. As moisture content increases, the overall energy density of the product decreases, resulting in a reduction in calorific value.

CONCLUSION

This research explores cookies made with Engkalak fruit, promoting its use as a novel and sustainable food source. This study also underscores the importance of considering ingredient composition and formulation. Through assessing moisture, ash, protein, fat and carbohydrate content, their implications for product quality and nutritional value could be determined. F4 is nutritionally superior due to its higher protein (4.14% protein) and mineral content (1.25% ash), while F1 is optimal for shelf life due to its lower moisture (0.20%) and water activity (0.19) levels. For the future study, it is suggested to conduct the shelf-life analysis for the potential in marketability of engkalak cookies that are rich in nutrient and having a promising shelf-life quality. It is also recommended to try infusing engkalak mash into food products that does not require high heat treatment such as ice-cream, to potentially mitigate its earthy and spicy flavors.

ACKNOWLEDGEMENT

The authors would like to thank UTS for its facilities and equipments.

REFERENCES

[1] H.U. Kalsum, and A.H.S. Mirfat, "Proximate composition of Malaysian underutilised fruits," *Journal of Tropical Agriculture and Food Science*, vol. 42, no. 1, pp. 63-72, 2014.

[2] T.K. Lim, "Litsea garciae," Accessed: Dec. 20, 2021. [Online]. Available: https://link.springer.com/chapter/10.1007/978-94-007-2534-8_5

[3] J. Ndife, F. Kida, and S. Fagbemi, "Production and quality assessment of enriched cookies from whole wheat and full fat soya," *European Journal of Food Science and Technology*, vol. 2, no. 1, pp.19-28, 2014.

[4] AOAC (Association of Official Analytical Chemists), *Official Methods of Analysis*, 22nd ed. Rockville, MD, 2023.

[5] James, C.S., 2013. *Analytical chemistry of foods*. Springer Science & Business Media.

[6] S. Zydenbos, V. Humphrey-Taylor, and C. Wrigley, Cookies, biscuits, and crackers. The diversity of products. 2004.

[7] A. Appoldt, and G. Raihani, "Determining Moisture Content - Food Quality & Safety," Accessed: Dec. 20, 2021. [Online]. Available: https://www.foodqualityandsafety.com/article /determining-moisture-content

[8] S. Budžaki, D.K. Komlenić, J.L. Čačić, F.Č. Kenjerić, M. Jukić and Ž. Kožul, "Influence of cookies composition on temperature profiles and qualitative parameters during baking," Croatian Journal of Food Science and Technology, vol. 6, no. 2, pp. 72-78, 2014.

[9] FDA, "Water Activity (aw) in Foods," Accessed: Dec. 20, 2021. [Online]. Available: https://www.fda.gov/inspections-compliance-enforcement-and-criminal-investigations/inspection-technical-guides/water-activity-aw-foods

[10] Bozoglu, T.F., and Erkmen, O., 2016. *Food Microbiology: Principles into Practice*. John Wiley & Sons.

[11] B.P. Ismail, 2017. "Ash Content Determination," *Food Analysis Laboratory Manual*, vol. 2, pp.117–119, 2017.

[12] H.O. Agu, J.A. Ayo, A.M. Paul, and F. Folorunsho, "Quality characteristics of biscuits made from wheat and African breadfruit (*Treculia africana*)," *Nigerian Food Journal*, vol. 25, no. 2, pp. 123-125, 2010.

[13] G.O. Usman, U.E. Ameh, O.N. Alifa, and R.M. Babatunde, "Proximate composition of biscuits produced from wheat flour and maize bran composite flour fortified with carrot extract," *Journal of Nutrition & Food Sciences*, vol. 5, no. 5, pp.1, 2015.

[14] L. Hyvönen, "Approach to fat analysis of foods," *Food chemistry*, vol. 57, no. 1, pp.23-26, 1996.

[15] British Heart Foundation, "10 tips for understanding food labels," Accessed: Dec. 20, 2021. [Online]. Available: https://www.bhf.org.uk/informationsupport/heart-matters-magazine/nutrition/sugar-salt-and-fat/10-tips-for-understanding-food-labels

[16] United States Department of Agriculture (USDA), "Cookies, butter or sugar, with icing or filling other than chocolate," Accessed: Dec. 20, 2021. [Online]. Available: https://fdc.nal.usda.gov/fdc-app.html#/food-details/1101044/nutrients

[17] C. Winston, "What Are the Definitions of Total Carbohydrates & Other Carbohydrates?," Accessed: Dec. 20, 2021. [Online]. Available: https://healthyeating.sfgate.com/definitions-totalcarbohydratesothercarbohydrates-6150.html