

PRODUCTION OF CANARIUM (*Canarium indicum* L) BUTTER WITH DIFFERENT SUGAR CONCENTRATIONS

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Abstract. Tree nuts and groundnuts nowadays are gaining popularity due to their health benefits. Nut kernels that can be eaten raw or roasted are becoming increasingly popular in healthy diet, including canarium nut. Therefore, it should be used into a variety of food compositions, including butter, to promote a healthy diet and lifestyle. The objective of the research was to determine the exact sugar concentration in the production of canarium nut butter. A completely randomized experimental design with four levels of sugar concentrations i.e. 0%, 20%, 40%, and 60% was applied in this research. Chemical and sensory properties were analysed. Results showed that the sugar concentration of 40% was the exact concentration for producing canarium nut butter. The canarium nut butter at 40% sugar concentration had a moisture content of 17.70%, an ash content of 2.68%, a protein content of 6.19%, a fat content of 32.69%, and a reducing sugar content of 25.31%. Canarium nut butter at 40% sugar was also more liked on taste, texture, and its overall likeness; it was only slightly liked on aroma. This butter was rated as sweet, having a nutty aroma, smooth, and very easy to spread.

Keywords: canarium nut butter; sugar; chemical properties; sensory

1. Introduction

Tree nuts and groundnuts nowadays are gaining popularity due to their health benefits. Nut kernels that can be eaten raw or roasted are becoming increasingly popular in healthy diets. Almonds, hazelnuts, macadamias, chestnuts, cashews, walnuts, Brazil nuts, pecans, pinenuts, and pistachios have all been studied and found to have high medicinal values (Laddha *et al.*, 2020; Walton *et al.*, 2017). Canarium nut is a tropical plant of the family Burseraceae, genus *Canarium*, with over 100 species, most of which grow in damp forests in the Melanesian region, especially in eastern Indonesia. Through their leaves, stems, and fruit, canariums offer a number of benefits. In Indonesia, the canarium nut is used as an ingredient in food (Ellen, 2019).

The seeds, which contain 48% fat, 8–14% protein, vitamin E of 3.2 mg/100g, and vitamin C 7.6 ofmg/100g, are the most essential portion of the canarium, and provide 740-749 calories per 100 g (Millena & Sagum, 2018; Thompson & Evans, 2016). Canarium nuts also contain iron, phosphorous and zinc (Bai *et al.*, 2019). In addition to their great nutritional value, canarium nuts also provide health benefits to the body. *Canarium indicum*, contains a complete amino acid profile and can be used as a functional food source. In addition, canarium nuts exhibit antioxidant (Djarkasi *et al.*, 2017) and anti bacterial properties. Mailoa *et al.* (2019) found that canarium nuts

improved the lipid profile of hypercholesterolemic rats by reducing cholesterol, LDL, and triglyceride levels, while raising HDL and reducing endothelial dysfunction. Therefore, it should be used into a variety of food compositions, including butter, to promote a healthy diet and lifestyle.

Nut butter is a semi solid paste composed of ground and roasted nuts, assorted flavors, and sweeteners (Chang *et al.*, 2013; Shahidi-Noghabi *et al.*, 2019). Due to its flavor and nutritional value, nut butter is well-liked and widely accepted among consumers. The most common application of nut butters is in sandwich making. Additionally, nut butter is utilized in a variety of baking and cooking applications. It can be eaten alone or in combination with other foods (Shakerardekani *et al.*, 2013). Spreadability is the most important quality of nut butter; it should have a soft texture and be easily spreadable. Nut spreads that are creamy and smooth are preferred because they are ideal for spreading on crackers and breads. Like other nut butters and pastes, canarium butter is high in oil content and requires sugar to produce soft and flavorsome butter.

There is a large variation in the quality of nut butters due to the variety of ingredients that can be used. A stable nut spread product requires the proper combination of these ingredients during manufacturing. Typical nut spread formulation includes the following ingredients: selected, dry-roasted nuts; sweeteners; vegetable oils; emulsifiers; protein sources; and flavorings (Shakerardekani *et al.*, 2013).

One factor to consider when making jam or spread is the sugar concentration, because sugar helps to form an ideal appearance, taste, and texture, as well as acting as a preservative. Sugar also interacts with air and hydrocolloids, influencing the transition/change from sol to gel, lowering the total dissolved solids content, and playing a role in the caramelization and Maillard reaction processes (Di Monaco *et al.*, 2018; Goldfein & Slavin, 2015). In general, the role of sugar in plant-based butters affects their flavour, viscosity, and water activity (Gorrepati *et al.*, 2015). There has been research on the development of nut spreads, such as galohgor peanut extract butter (Alamsyah, 2015), peanut butter (Kusuma *et al.*, 2017), and coconut butter (Arsyad, 2018), which produce good butter characteristics. Alamsyah's (2015) study includes 40 g of sugar in each peanut butter formulation studied. However, there has been no reported research on the development of canarium nut butter, so the authors are interested in investigating the effect of different sugar concentrations on the characteristics of canarium nut butter and the objective of the research was to determine the exact sugar concentration in the production of canarium nut butter.

2. Methods

2.1. Materials

Canarium nuts (*Canarium indicum*L) were purchased from a local canarium farmer in

Taniwel Village, Ceram Island, Maluku, Indonesia. Commercial sugar, salt, corn oil, and milk powder were all purchased from local retailer shops in Ambon.

2.2. Preparation of Canarium Nut Butter

Canarium nut butter was prepared according to the modified method by Alamsyah (2015). The testa of the canarium nuts was first peeled, and the nuts were roasted for 15 minutes at 150°C in the oven. The roasted nuts were ground into a paste using a blender. Different sugar concentrations, i.e., 0%, 20%, 40%, and 60%, were mixed with full-cream milk powder (17.5 g each), and the mixture was solubilized in 25 mL warm water. The mixture was added to the canarium nut paste and mixed together with 4 g of corn oil and 0.5 g of salt. The canarium nut butter was placed in a glass jar for further examination. The formulation of the canarium nut butter can be seen in Table 1. The flow chart of the procedure for making the canarium nut butter is presented in Figure 1.

Table 1. Formulation of Canarium Nut Butter

Formulation	Sugar (g)	Milk Powder (g)	Salt (g)	Corn oil (g)	Canarium Nut (g)
A1	0	17.5	0.5	4	35
A2	20	17.5	0.5	4	35
A3	40	17.5	0.5	4	35
A4	60	17.5	0.5	4	35

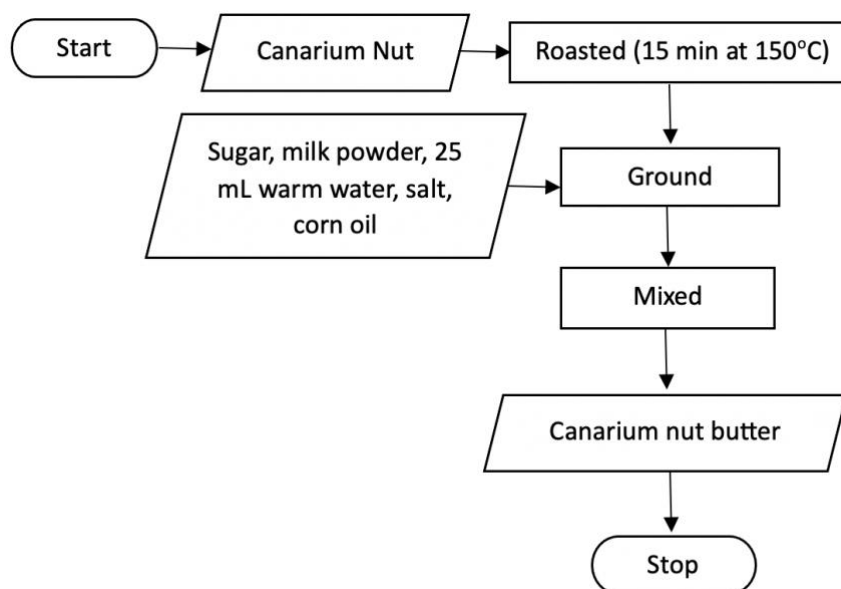


Figure 1. Flow Chart of The Procedure for Making Canarium Nut Butter

2.3. Chemical Characteristics

a. Moisture Content (AOAC, 2019)

The empty dish and lid were dried in the oven at 105°C for 3 hours and transferred to a desiccator to cool. Then, the empty dish and lid empty the dish and lid were weighed, and the

weights were recorded. Sample of 3 g were weighed into the dish and spread with spatula. The dish with the sample was placed in the oven and dried for 3 hours at 105°C. After drying, the dish was placed with a partially covered lid on the desiccator to cool. The dish was reweighed and dried until it reached a constant weight (1).

$$\text{Moisture (\%)} = \frac{(W1-W2) \times 100}{W1} \quad (1)$$

Where W1: Weight (g) of sample before drying
W2: Weight (g) of sample after drying

b. Ash Content (AOAC, 2019)

5 g of the sample was placed in the porcelain dish, which had previously been dried and weighed. The sample was burned on the electrical heater until no more smoke came out of it, and it was then ash in the furnace (Vulcan A.550 Ney, USA) at 650 °C until it reached a constant weight (2).

$$\text{Ash (\%)} = \frac{\text{ash weight}}{\text{sample weight}} \times 100 \quad (2)$$

c. Protein Content (AOAC, 2019)

A clean and dry digestion flask was filled with canarium nut butter samples weighing 1.0 g. The digesting flask was supplied with a solution of sulfuric acid (25 mL) and a Kjeldahl tablet. Three hours of digestion were performed using a tiny Kjeldahl unit. The digesting flask was cooled and the distillation procedure was carried out using an automated distillation equipment (BUCHI, USA). Lastly, a 0.25 N HCl solution was employed to titrate the sample and measure the crude protein concentration ($N \times 6.25$). 0.25 N HCl was standardized by titrating a 0.25 N sodium carbonate solution.

d. Fat Content (AOAC, 2019)

The thimble was dried in the oven. The sample, weighing 5 grams, was wrapped in filter paper and fat-free cotton. To extract the sample from the filter paper, a Soxhlet extraction apparatus with a condenser was used. In a fat flask, hexane was added and refluxed until the sample turned pale in color. The residual solvent in the fat flask was removed by heating and weighing the flask. The following formula is used to calculate the amount of fat in a given sample (3):

$$\text{Fat content} = \frac{\text{weight of fat}}{\text{sample weight}} \times 100\% \quad (3)$$

e. Reducing Sugars (AOAC, 2019)

25 g of the sample was weighed and ground in a pestle and mortar before being blended with 100 ml of water. The solution was neutralized with 1 N NaOH, and it was boiled gently for 1 hour with stirring. Water lost during evaporation was replaced, cooled, and transferred to a 500-ml volumetric flask. Volume was adjusted to 500 ml and filtered through Whatman filter paper. A

100-ml aliquot of filtrate was pipetted into a 250-ml flask, and 2 ml of 45% lead acetate was added; after 10 minutes, a few drops of 22% potassium oxalate solution were added, and the volume was increased to 250 ml with water and 2 ml of 45% neutral lead acetate solution were added. In a 250-ml conical flask, 10 ml of mixed Fehling's solution (5 ml each of Fehling A and B) and a few ml of water were pipetted. The flask containing the mixed Fehling's solution was heated on a hot plate before adding the sample solution (clarified sugar) dropwise from the burette until only the faintest blue color remained. 2-3 drops of methylene blue indicator were added, and the titration was completed when the color changed to brick red. At the end point, the titration readings were recorded and calculated for the reducing sugars (4).

$$\text{Reducing sugars}(\%) = \frac{\text{Factor for fehling solution} \times \text{volume made} \times 100}{\text{titre} \times \text{sample weight} \times \text{ml of aliquot}} \quad (4)$$

2.4. Sensory Characteristics

Twenty (20) panelists selected randomly from the university community carried out sensory evaluations on the canarium nut butter samples. These samples were evaluated for the listed quality parameters: taste, aroma, texture, and over-all likeness. A 4-point hedonic scale was used where 1 = dislike, 2 = like slightly, 3 = like, and 4 = like extremely. The descriptive analysis of canarium nut butter was also conducted on taste (1-unsweet; 2-slightly sweet; 3-sweet; 4-very sweet), aroma (1-very nutty aroma; 2-nutty aroma; 3-sugary aroma; 4-very sugary aroma), texture (1-very rough; 2-rough; 3-smooth; 4-very smooth), and spreadability (1-very difficult; 2-difficult; 3-easy; 4-very easy).

2.5. Statistical Analysis

The data collected were analysed using ANOVA for a completely randomized experimental design. The means of treatment showing significant differences ($p < 0.05$) were subjected to the Tukey test. These analyses were performed using the statistical software MINITAB version 17. The sensory characteristics were evaluated descriptively.

3. Results and Discussion

3.1. Chemical Characteristics

With the addition of sugar, the moisture content of canarium nut butter ranged from 17.70% to 27.91% (Figure 2). The butter without additional sugar had the maximum moisture content at 27.91%, while the butter with 40% sugar had the lowest moisture level at 17.70%. This demonstrates that the higher the concentration of additional sugar, the lower the moisture content until 40%, after which it increased again when sugar concentration reached 60%. According to research by Arsyad (2018) on young coconut jam, the higher the sugar level, the lower the moisture content. Figure 2 also demonstrates that canarium nut butter containing 20% sugar was not

significantly different from butter containing 60% additional sugar, however different from no sugar and 40% sugar.

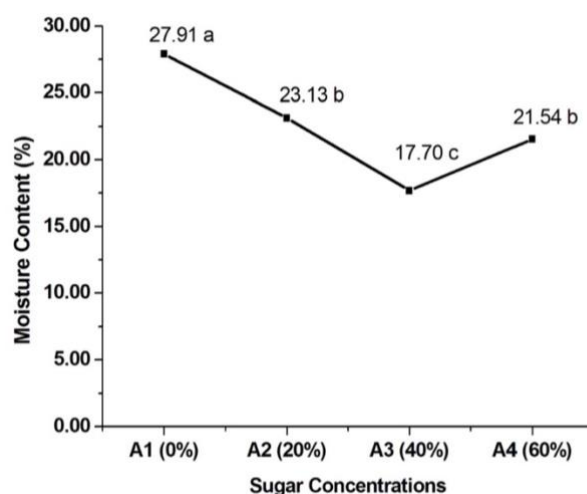


Figure 2. Moisture Content of Canarium Nut Butter With Different Sugar Concentrations

At all sugar concentrations, the moisture content of canarium nut butter did not meet the Indonesian quality standard for nut butter (SNI, 1992), which specifies a maximum moisture content of 3%. The high moisture content of canarium nut butter is due to the incorporation of water during production. Moisture content decreased as sugar concentration increased. Sugar increases the total dissolved solids, thereby decreasing the proportion of water in the material and the moisture content (Fitantri *et al.*, 2014). This is consistent with the opinion of Winarno (2008), who states that sugar absorbs water via osmotic pressure, i.e. the pressure of sugar molecules on the cell wall (extracellular) of the material until the sugar solution enters it, resulting in the removal of water from the cells.

Figure 3 shows the ash content of the canarium nut butter with different sugar concentrations. Ash content of canarium nut butter varied between 2.60 and 4.45%. The butter without added sugar had the highest ash content, at 4.45%; it was not significantly different from butter with 20% added sugar, but it was significantly different from others. The lowest level of 2.60% was found in butter containing 60% sugar. The amount of mineral composition in a substance is indicated by its ash content. Ash content is the organic matter that remains after organic matter has been destroyed (Ashaye & Adeleke, 2009). The addition of sugar concentration decreased the ash content of canarium nut butter. It was believed that the decrease in ash content was due to the low ash content of the sugar used. According to Jaldin (2019), glucose and sucrose-containing sugar has a low ash content.

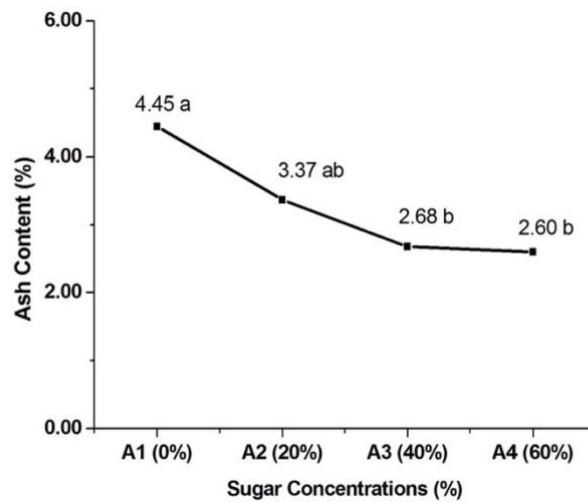


Figure 3. Ash Content of Canarium Nut Butter With Different Sugar Concentrations

The protein content of canarium nut butter was significantly influenced by the addition of sugar at varying concentrations. The highest protein content, 9.85%, was found in butter without added sugar, and the lowest, 5.90%, was found in butter with a sugar concentration of 60% (Figure 3). The canarium nut butter with a sugar concentration of 60% did not differ significantly from that with a sugar concentration of 40%, but it did differ significantly from other sugar concentrations.

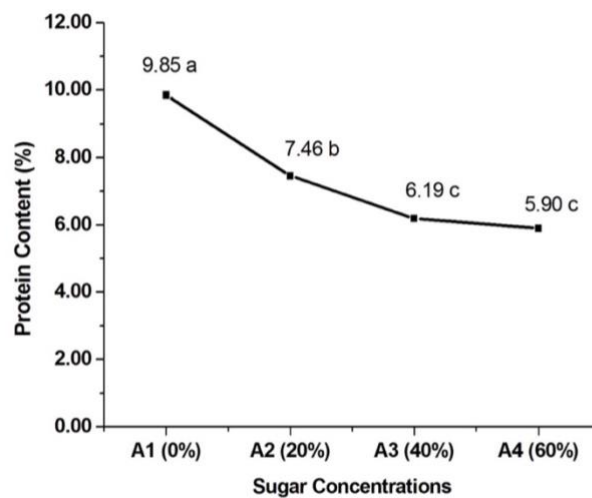


Figure 4. Protein Content of Canarium Nut Butter With Different Sugar Concentrations

The protein content of canarium butter with added sugar with different concentrations ranged from 5.90% - 7.46% (Figure 4). The higher the concentration of sugar added, the lower the protein content of canarium nut butter. This is in line with Arsyad's research (2018) on coconut jam. The addition of other ingredients such as sweeteners, stabilizers, and coloring agents in the formulation of a peanut butter usually lowers its protein contents (Ozcan & Seven, 2003). This could also be the reason for the decrease in protein content in canarium nut butter, as sugar was added in the formulation.

The concentration of sugar had a significant impact on the fat content of canarium nut butter. The butter without added sugar had the highest fat content (37.35%), while the butter with 20% sugar had the lowest fat content (32.52%), which was significantly different from the butter without added sugar but not significantly different from all other sugar concentrations (Figure 5). The fat content of butter with sugar decreased when compared to canarium nut butter without sugar.

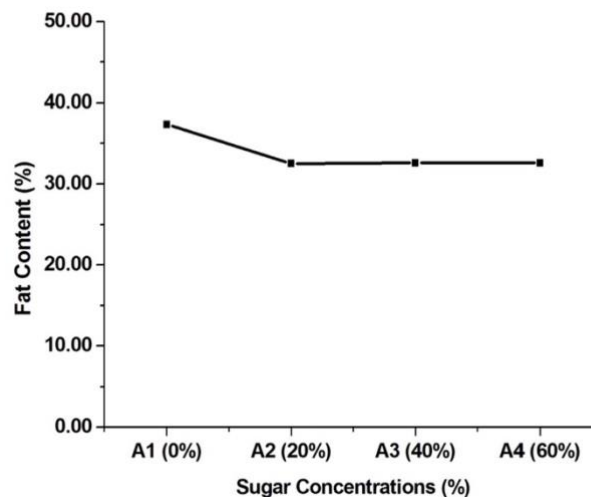


Figure 5. Fat Content of Canarium Nut Butter With Different Sugar Concentrations

This finding is consistent with [Mulindwa et al. \(2019\)](#)'s peanut butter research, which found that the more orange sweet potato puree added, the higher the fat content. [Mulindwa et al. \(2019\)](#) discovered that increasing the amount of orange sweet potato puree in the peanut butter made it sweeter and lower in fat. This is due to the high sugar content of orange sweet potatoes. The more sugar added, the less moisture and thus fat content of the butter. Water can enter and continuously break the oil phase due to the high moisture content. The water-oil phase separates more easily than the oil-oil phase ([Abegaz et al., 2006](#)). As a result, the fat content of the butter with sugar added is lower than that of the butter without sugar added.

When sugar comes into contact with components, a form of osmotic dehydration results in the loss of water. The expansion of the tissue and the flow of solutes to the exterior sugar solution bring sugar and the invertase enzyme into touch. This invertase action in sucrose will proceed at room temperature, causing a portion of the additional sugar to be converted into glucose and fructose. This chemical alteration in the mixture results in several major improvements to the product's quality, including brightness, flavor enhancement, and the prevention of crystallization when the sugar concentration is above average ([Figuerola, 2007](#)).

The reducing sugar contents of the canarium nut butter were significantly influenced by different sugar concentrations. The highest value was obtained with the addition of 60% sugar and

was not different with 40% sugar, but was different compared to 20% sugar and without sugar, which was found to have the lowest reducing sugar content. The reducing sugar contents of the canarium butter with different sugar concentrations were in the range of 23.31%–27.07% (Figure 6). The higher the added sugar concentration, the greater the reducing sugar content. The presence of sucrose, which induces the inverse process of reducing sugar, causes an increase in reducing sugar levels. This inversion increases as the sucrose content increased; additionally, during heating, sucrose is hydrolyzed into reducing sugars (glucose and fructose). Sugar also has a high solubility, so it is hydrolyzed to monosaccharides quickly. Granulated sugar (sucrose) is water soluble and, when heated, breaks down into glucose and fructose, which are known as invert sugars (Asmawatri *et al.*, 2018).

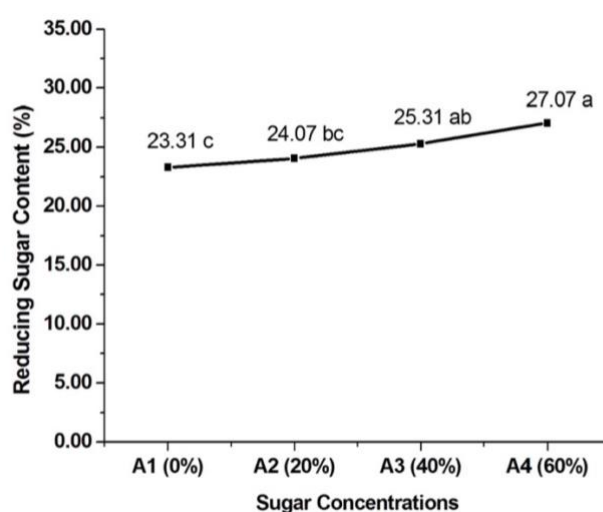


Figure 6. Reducing Sugar Content of Canarium Nut Butter With Different Sugar Concentrations

3.2. Sensory Characteristics

The hedonic test was used to determine panelists' acceptance of the butter based on taste, aroma, texture, and overall likeness. While the descriptive analysis used to determine panelists' rating on quality attribute such as taste, aroma, texture and spreadability. It is clear that the inclusion of sugar in the formulation of canarium nut butter increases the likeness for taste (Table 2). Panelists slightly liked (1.63) the butter without sugar, but as the concentration of sugar increased, so did the likeness for butter (3.00-3.37). The panelists rated the taste of the butter without sugar as unsweet, whereas the sugar with increasing concentrations added to the formulation was rated as sweet by the panelists at 20%, 40%, and very sweet at 60%, respectively. The addition of sugar improves the flavor of canarium nut butter by increasing its sweetness.

Canarium nut butter was somewhat preferred (1.97 to 2.30) on its aroma with and without increasing sugar concentrations (Table 2). The panelists perceived the aroma to be nutty (2.27-2.40). This demonstrated that increasing the sugar concentration had minimal influence on the

nuttiness imparted by the canarium nut. Even with 60% sugar, the butter had a nutty aroma that panelists liked only slightly. Alkylpyrazines are primarily responsible for most nuts' nutty aroma. These compounds are produced when amino acids and sugars undergo Maillard and other thermal degradation reactions (Abegaz *et al.*, 2006). The panelists did not detect the sugary aroma because the sugars reacted with amino acids to produce alkylpyrazine, a nutty aroma that they only slightly preferred.

Table 2. Sensory Characteristics of Canarium Nut Butter

Attributes		Sugar Concentrations			
		A1 (0%)	A2 (20%)	A3 (40%)	A4(60%)
Taste	Acceptability	1.63	3.00	3.30	3.37
		Like slightly	Like	Like	Like
	Rating	1.23	2.57	3.37	3.57
Aroma	Acceptability	Unsweet	Sweet	Sweet	Very sweet
		2.17	1.97	2.10	2.30
	Rating	2.30	2.40	2.37	2.27
Texture	Acceptability	Nutty aroma	Nutty aroma	Nutty aroma	Nutty aroma
		1.83	2.77	3.07	2.77
	Rating	1.47	2.37	3.00	2.43
Overall	Acceptability	Very rough	Rough	Smooth	Rough
		2.10	2.73	3.10	2.97
	Rating	2.12	3.37	3.97	3.4
Spreadability	Acceptability	Like slightly	Like	Like	Like
		2.12	3.37	3.97	3.4
	Rating	Difficult	Easy	Very easy	Easy

A similar trend was observed in the panelists' likeness of the texture (Table 2), just as was observed in the taste of the butter. Panelists slightly liked the texture of the butter without sugar, but as the sugar concentration increased, the likeness increased to the "like" category, with 40% sugar having the highest likeness score. When the canarium nut butter was made without sugar and with 20% sugar, panelists' ratings for texture ranged from very rough to rough. Panelists determined that when 40% sugar was added, the texture was smooth, but when 60% sugar was added, the smoothness decreased and panelists perceived it as rough again. The sensation in the mouth is expressed through texture. Sugar has an impact on this because it adds volume and consistency to many products. If there is too much sugar, it will crystallize, and if there is not enough sugar, the gelation process will perform badly (Figueroa, 2007).

Overall, panelists slightly liked the canarium nut butter without sugar, but it became more liked as sugar was added, with 40% sugar receiving the highest overall likeness score (Table 2). The spreadability of the butter was perceived by panelists as ranging from difficult to very easy.

When no sugar was added, the butter was difficult to spread evenly, but when sugar was added, the butter was spread easily. Canarium nut butter with 40% sugar was found to be extremely easy to spread.

4. Conclusions

The sugar concentration of 40% was the exact concentration for producing canarium nut butter. The canarium nut butter at 40% sugar concentration had a moisture content of 17.70%, an ash content of 2.68%, a protein content of 6.19%, a fat content of 32.69%, and a reducing sugar content of 25.31%. Canarium nut butter at 40% sugar was also more liked on taste, texture, and its overall likeness; it was only slightly liked on aroma. This butter was rated as sweet, having a nutty aroma, smooth, and very easy to spread.

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