The physicochemical characteristics of gandaria (*Bouea macrophylla*) leather with sugar concentration treatment

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**Abstract.** Gandaria leather is a kind of fruit leather processed by gandaria fruit in the form of thin sheets with a thickness of 2-3 mm and has a specific consistency and taste according to gandaria fruit. The purpose of this study was to determine the effect of added sugar on the physicochemical characteristics of gandaria leather. This study used a single-factor completely randomized design, with 0%, 5%, 10%, and 15% sugar concentrations. The results showed that the sugar concentration had a very significant effect on the parameters of water content, total sugar, total acid, vitamin C, and water activity (a_w), and had a significant effect on the tensile strength of gandaria leather. The physicochemical characteristics of gandaria leather from various sugar concentration treatments are as follows: water content (14.05% - 20.13%), total sugar (80.56% - 84.90%), total acid (3.10 - 12.37 mg/100g), vitamin C (59.44 - 78.48 mg/100g), water activity (0.48 - 0.62), and tensile strength (0.20-0.37 N). The resulting gandaria leather qualifies as good fruit leather, and the treatment with a 10% sugar concentration is recommended for gandaria leather which has the potential to be developed and commercialized.

1. Introduction

Gandaria (*Bouea macrophylla*) is one of the typical fruit types in Maluku Province, which is usually consumed directly as table fruit or made for juice. When the fruit is fully ripe, it is indicated by all parts of the fruit turn orange. The nutritional content of fresh gandaria fruit is very good to support the fulfillment of nutrition for the human body. The composition of gandaria fruit per 100 g of the edible portion is 85 g of water, 12 mg of protein, 600 mg of fiber, 230 mg of ash, 6 mg of calcium, 10.8 mg of phosphorus, 0.31 mg of iron, 0.043 mg of carotene, 0.031 mg of thiamine, 0.025 mg riboflavin, 0.286 mg niacin, and 75 mg vitamins [1].

Diversification of gandaria fruit is needed to increase the economic value of the fruit, given its very high nutritional content. One of the diversified products from the gandaria fruit is gandaria leather. Gandaria leather is a type of fruit leather and a snack product made from dried fruit puree to form a thin sheet that can be rolled.

Gandaria leather is similar to nori which is a traditional Japanese food made from *Porphyra* sea algae (Bangiales, Rhodophyta). Nori is in the form of thin sheets (0.2 mm in size, composed of 10-20 layers), finely cut to uniform sizes - kizaminori or aonori, dried or seasoned or toasted (nori - ajitsuke nori or okazunori [2]). Research on gandaria fruit leather reported by [3] is only limited to its organoleptic properties, therefore further testing of the nutritional composition of the gandaria leather is needed so
since the product has the potential to be developed. Based on this gap, this study aims to determine the effect of adding sugar on the physicochemical characteristics of gandaria leather.

2. Methods

2.1. Materials

The raw material used in this study was the optimal ripe gandaria fruit marked with all parts of the fruit orange. Additional ingredients used are refined sugar, kappa carrageenan, and water.

2.2. Methods

The study was designed using a single-factor completely randomized design with sugar concentration as a treatment, namely control (0%), 5%, 10%, and 15% of sugar. The research stages of making gandaria leather are as follows: gandaria fruit is sorted, washed and dried, then peeled and taken from the flesh. The pulp is then blended while adding 1% carrageenan and sugar according to the treatment (0%, 5%, 10%, and 15%) so that it becomes fruit pulp.

The pulp is then poured on a 24 x 24 cm tray which has been smeared with margarine with a thickness of ± 4 mm, after which it is dried in an oven using a kerosene stove at 60°C for 1 hour. The next drying phase uses sunlight (effective at 12.00 noon) for 3 hours. The dried fruit leather is then cut and packaged and ready for analysis.

Analysis of physicochemical characteristics includes water content with a thermogravimetric method [4], total acid and vitamin C by titration method [4], total sugar by phenol method [5], water activity (a_w) [4], tensile strength with a universal testing machine.

The research data will be statistically tested according to the design used, if the data is significant and highly significant then it can be proceeded with the Tukey test at confidence level 95%.

3. Results and discussions

Physicochemical characteristics reflect the nutritional value of a food product. Data on the nutritional value of a food product is very important to determine whether the food product conforms to standardized quality requirements or not before the food product is commercialized. The average test results for the physicochemical characteristics of gandaria leather from various sugar concentration treatments are presented in Table 1.

| Physicochemical characteristics | Sugar concentration treatment (%) |
|---------------------------------|----------------------------------|
|                                 | 0 %    | 5%     | 10%    | 15%    |
| Water content (%)               | 20.13a | 19.35b | 16.54c | 14.05d |
| Total acid (mg/100g)            | 12.37a | 7.27b  | 3.60c  | 3.10d  |
| Vitamin C (mg/100g)             | 78.48a | 67.73b | 62.38c | 59.44c |
| Total sugar (%)                 | 80.56a | 81.42c | 82.79b | 84.90c |
| a_w                             | 0.62a  | 0.61b  | 0.53c  | 0.48d  |
| Tensile strength (N)            | 0.37a  | 0.22b  | 0.20b  | 0.20b  |

Note: The numbers followed by different letters on the same line are different on the Tukey test with 95% confidence level.

3.1. Water content

The water content value of gandaria leather from various sugar concentration treatments ranged from 14.05 - 20.13% which is shown in Table 1. The sugar concentration treatment had a very significant effect on the water content of gandaria leather produced. The water content of gandaria leather decreased with increasing sugar concentration treatment. The decrease in water content of the gandaria leather product is due to the nature of sugar as a hydrating agent (water-binding) so that sugar can easily absorb and hold water so that sugar can reduce the water content in the added food [6], [7].
The water content of the Gandaria leather produced has met the requirements for good fruit leather because according to [8] good fruit leather has a water content of 10 - 20%. The effect of water content in food is very important in the formation of the durability and shelf life of these food products.

### 3.2. Total acid

The total amount of acid in the Gandaria leather produced ranged from 3.10 - 12.37 mg/100g which can be seen in Table 1. The sugar concentration treatment had a very significant effect on the total acid produced. The total acid of Gandaria leather decreased along with the increase in sugar concentration treatment. The decrease in total acid is due to the addition of sugar so that it will reduce the taste or the total acid value of the product. This is due to the nature of sugar which gives a sweet taste so that with increasing sugar concentration treatment, the total acid value will also decrease.

Most of the Gandaria fruits when ripe still have a relatively high sour taste due to the high content of organic acids, such as citric acid which is the main organic acid in these acids. The addition of sugar to the Gandaria fruit pulp can reduce the taste and acid content, so that the produced Gandaria leather has a low total acid content because it is covered by the addition of sugar.

### 3.3. Vitamin C

Vitamin C or ascorbic acid has a molecular formula of C₆H₈O₆ with a molecular weight of 178, in its pure form, it is a colorless and odorless crystal [9]. The content of vitamin C Gandaria leather produced ranged from 59.44 - 78.48 mg/100g which can be seen in Table 1. The sugar concentration treatment had a very significant effect on vitamin C in Gandaria leather. The value of vitamin C in Gandaria leather decreases with increasing sugar concentration treatment. The decrease of vitamin C in Gandaria leather is because of the addition of sugar. This is due to the nature of sugar which gives a sweet taste so that with increasing sugar concentration treatment, the vitamin C content will also decrease. Vitamin C is one of the elements forming organic acids in Gandaria fruit, so it is equal to total acid, with the addition of sugar, there is a decrease in vitamin C in Gandaria leather products.

The content of vitamin C in food products is very important for humans, because it can maintain immunity and as an antioxidant that can inhibit the oxidation process. According to [9], the amount of vitamin C intake needed by adults is 10 mg/day, so that Gandaria leather in this study can be an alternative healthy snack that can meet the needs of vitamin C.

### 3.4. Total sugar

The total sugar in the Gandaria leather produced ranges from 80.56 - 84.90% which is shown in Table 1. The treatment of sugar concentration has a very significant effect on the total sugar in Gandaria leather produced. The total sugar in Gandaria leather increases with increasing sugar concentration treatment. The increase in total sugar was due to the addition of sugar concentration treatment.

The increased total sugar in Gandaria leather is due to the addition of sugar which causes glucose and fructose resulting from the inversion of sucrose to also increase [10]. This is because sugar only consists of sucrose, while the reducing sugar found in the pulp contains simple sugars, namely glucose and fructose.

### 3.5. Water activity (a_w)

Water activity (a_w) in Gandaria leather from various treatments, the concentration of sugar is presented in Table 1 ranged from 0.48 - 0.62 mg/100g. Water activity is free water that can be used by microbes for their growth. a_w results in Gandaria leather obtained in this study are quite good because the value is less than 0.7. As [8] suggests that a_w for good fruit leather is below 0.7.

The results showed that the Gandaria leather produced had met the safe limit from microbial attack. According to [9], various microorganisms have a minimum a_w to grow, such as bacteria: 0.9, yeast: 0.8 - 0.9, and mold: 0.6 - 0.7.
3.6. Tensile strength
The tensile strength value is the maximum tensile strength that can be achieved before the product breaks or tears. The tensile strength value shows the force required to achieve maximum tensile on each unit area of the product [11]. The tensile strength in this study is related to the plastic texture of the fruit leather so that it can be rolled and does not break easily. The results showed that the tensile strength value of the gandaria leather with various sugar concentrations ranged from 0.20 - 0.37 mg/100g (Table 1). These results illustrate that gandaria leather has good tensile strength because it can be rolled and does not break easily.

4. Conclusion
The physicochemical characteristics of gandaria leather from various sugar concentration treatments are as follows: water content (14.05% - 20.13%), total sugar (80.56% - 84.90%), total acid (3.10 - 12.37 mg/100g), vitamin C (59.44 - 78.48 mg/100g), water activity (0.48 - 0.62), and tensile strength (0.20 - 0.37 N). The resulting gandaria leather qualifies as a good fruit leather, and the treatment with a sugar concentration of 10% is recommended as Gandaria leather which has the potential to be developed and commercialized.

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