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Organoleptic Testing of Dragon Fruit Marmalade as an Effort to Increase the Marketability of Food Products

Jane Friska[1], Husnul Hatimah[1]✉, Amirayanti[1], Nurul Fathanah[2]

[1] Food Technology, Institut Teknologi Bacharuddin Jusuf Habibie, Indonesia
[2] Agricultural Technology, Universitas Sulawesi Barat, Indonesia

✉ **Corresponding Author:** Husnul Hatimah (e-mail: husnulhatiimaah@gmail.com)

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ABSTRACT

Red dragon fruit *(Hylocereus polyrhizus)* is highly perishable but has strong potential for diversification into value-added products such as marmalade. This study aimed to evaluate the physicochemical and sensory properties of red dragon fruit marmalade prepared with different citric acid and sucrose concentrations, and to identify the most acceptable formulation. Two treatments were tested: Marmalade A (2% citric acid; 68% sucrose) and Marmalade B (1% citric acid; 50% sucrose). Total titratable acidity and pH were measured, and sensory attributes (color, taste, aroma, and texture) were assessed by untrained panelists using a 5-point hedonic scale. Marmalade A showed higher total acidity (2.61%) than Marmalade B (0.51%), while both had a pH of approximately 3. Marmalade B obtained higher preference scores for color (3.5) and taste (3.6), whereas Marmalade A was favored for aroma (3.4) and texture (3.6). Overall, the formulation with 1% citric acid and 50% sucrose was identified as the optimal combination to enhance the sensory quality and marketability of red dragon fruit marmalade.

INTRODUCTION

Red dragon fruit *(Hylocereus polyrhizus)* is one of many types of fruit that are popular in Indonesia. People call it dragon fruit because of the scaly texture of its skin, which resembles dragon skin. Dragon fruit has many benefits, especially in terms of its nutritional content. Dragon fruit contains antioxidants, fiber, and vitamins B1, B2, B3, C, and E. It also contains carotenoids, flavonoids, betacyanin, and betaxanthin (Aryanta, 2022). Dragon fruit has a sweet and fresh taste, with a sugar content of 13-15° Brix for red dragon fruit. In addition to its sweet taste, red dragon fruit also has a bright color, making it more visually appealing (Kristanto, 2014). Fresh dragon fruit cannot be stored for long because it has a high-water content of 90%, so further processing is needed to maintain its nutritional value and extend its shelf life (Susanty & Sampepana, 2017).

Marmalade is a semi-wet product produced by combining orange juice and finely chopped orange peel, then adding sugar as a sweetener, and optionally adding approved food additives (Badan Standarisasi Nasional SNI, 1998). Marmalade is a food product with a consistency like fruit jam, produced from a combination of fruit juice, sucrose, citric acid, pectin, albedo, and gelling agents. Marmalade distinguishes itself by including orange peel slices in its composition (Jariyah et al., 2010). Marmalade has been modified extensively so that it is no longer made solely from citrus fruits; various fruits can be used to make marmalade. Marmalade can transform the perishable nature of dragon fruit into a semi-moist product with a longer shelf life and a sensory profile that can compete in both local and modern retail markets (Sa'adah & Estiasih, 2015). Several previous studies have investigated the production of red dragon fruit marmalade, such as those by Basuki & Nurani (2019) and Virnanda & Nurbaya (2024). However, none have investigated red dragon fruit marmalade without using the fruit peel, nor examined the effect of citric acid and sucrose concentrations on the organoleptic acceptance (color, taste, aroma, and texture) of the resulting marmalade.

Increased added value and competitiveness of dragon fruit commodities can be achieved through product diversification based on food science. Based on this consideration, this study aims to conduct organoleptic tests on various dragon fruit marmalade formulations to identify the most acceptable formulation combinations (e.g., fruit ratio, type and concentration of stabilizers, cooking time) by panelists. The results of this study are expected to provide formulation guidelines that improve the sensory quality and marketability of the product, while also recommending production practices that can be easily adopted by small to medium-scale food businesses.

RESEARCH METHODS

Making Maramalade

The work procedure for making fruit marmalade is as follows: the dragon fruit is sorted, then peeled to separate the flesh from the skin. After that, the fruit flesh is blended to obtain a fruit pulp with a concentration ratio (water:pulp = 1:2). The pulp is then filtered to obtain juice, to which sugar is added according to the treatment. The juice is heated and stirred until it boils. Once boiling, citric acid is added according to the treatment and stirred until a gel forms. Next, an organoleptic test is conducted on the marmalade using parameters of color, taste, aroma, and texture.

Total Acid Testing

Total acid testing in this study used the method from the Association of Official Analytical Chemists, (1995). The sample is weighed to a mass of 5 g. Then it is crushed and diluted into 100 ml of distilled water in a volumetric flask. After that, 25 ml is pipetted into an Erlenmeyer flask, then 3 drops of phenolphthalein indicator are added. Next, it is titrated with NaOH solution until a stable pink color forms. Then, the total acidity is calculated using the following formula:

$$\%\text{ Total Acid} = \frac{ml\ NaOH\ x\ N\ NaOH\ x\ Grek\ x\ FP}{Weight\ sample\ x\ 1000}\ x\ 100\%$$

Note:
N : Normality of NaOH solution = 0.1
Equivalent weight (G) : 64
FP : Dilution Factor = 4

pH Value

The pH of the marmalade was measured by taking a small amount of sample (± 5–10 g) and placing it in a clean beaker or dish. A pH paper strip was then applied to the surface of the marmalade sample until the indicator area was thoroughly moistened. The pH paper was removed from the sample and allowed to react for approximately 10–30 seconds (according to the manufacturer's instructions). The color on the pH paper was then compared with the standard color scale provided on the pH paper package.

Organoleptic Testing

Dragon fruit marmalade from each treatment (e.g., treatments A and B) was prepared in equal amounts. The samples were served in clean plastic cups/small glasses (±10–15 g per sample). Each sample was labeled with a three-digit random code to avoid bias. The panelists were asked to taste the samples one by one and rate their level of liking for the following attributes: color, taste, aroma, and texture. The evaluation was carried out using a 5-point hedonic scale: 1 = strongly dislike, 2 = dislike, 3 = slightly like, 4 = like, 5 = strongly like. Hedonic test data were collected from all panelists, and for each attribute and each treatment, the mean hedonic score was calculated.

Experimental Design

The research design used was a static group comparison design, which is a comparison of the acceptability of dragon fruit marmalade based on different concentrations of sucrose and citric acid added to the processed product. The treatments given to several samples were the concentrations of citric acid and sucrose.
Marmalade A: Citric Acid 2%; Sucrose 68%
Marmalade B: Citric Acid 1%; Sucrose 50%

Data Analysis

Acceptance data based on the sensory or organoleptic tests of dragon fruit marmalade products were analyzed descriptively using proportion and mean (average value) analysis. Furthermore, the data were presented in the form of tables, graphs, and narratives.

RESULTS AND DISCUSSION

The results of total acidity, pH, and organoleptic measurements for each red dragon fruit marmalade treatment can be seen in Table 1. The total acid in both marmalade treatments showed different results, with marmalade A having a total acid of 2.61% and marmalade B having a total acid of 0.51%. Meanwhile, the pH in each treatment showed a value of 3 (acidic).

Table 1. Results of Total Acidity, pH, and Organoleptic Testing of Marmalade

Sample	Total Acid	pH	Organoleptic Testing			
			Color	Taste	Aroma	Texture
Marmalade A	2.61%	3	3.1	3.1	3.4	3.6
Marmalade B	0.51%	3	3.5	3.6	3.3	3.1

Total Acid

Marmalade A shows the highest total acid content (Table 1 and Figure 1). This is due to its higher citric acid concentration compared to marmalade B. In addition, the weight of dragon fruit in marmalade A is greater than that in marmalade B, resulting in a higher citric acid content.

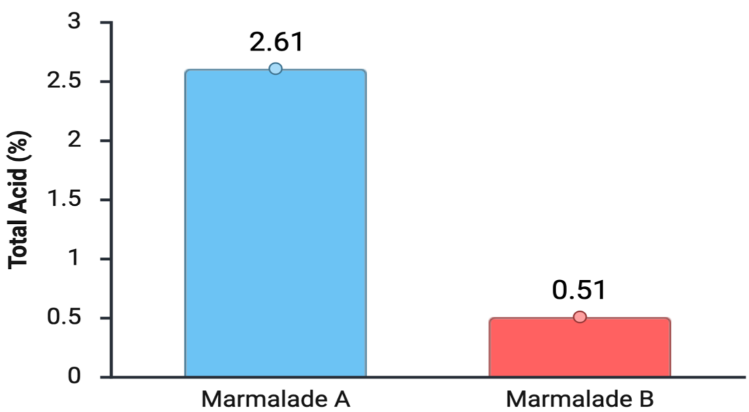

Figure 1. Total acidity chart for marmalade

The total acid in marmalade products comes from natural organic acids in fruit, with malic acid and citric acid being the dominant components in many fruits and contributing most to the total acid value (Baccichet et al., 2021; Nascimento et al., 2018). An increase in the amount of fruit (in grams) in the marmalade formulation means more fruit solids and organic acids dispersed in the liquid phase, thereby increasing the total acid value (Waweru et al., 2024).

pH

pH is a measure of acidity that indicates the acidic or alkaline condition of a product on a scale of 0–14, where a low pH value indicates a more acidic condition and a high value indicates a more alkaline condition (Rodrigues, 2024). Based on pH testing of marmalade in this study, the same pH value was obtained for marmalade A and marmalade B, which was around pH 3 (acidic; Table 1 and Figure 2), which is still within the low pH range as reported in various fruit marmalade products with a pH of around 2.4–3.0 (Emelike & Akusu, 2019; Suna et al., 2023).

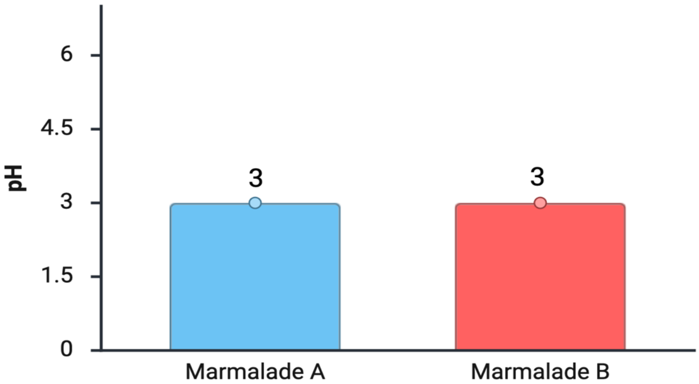

Figure 2. pH of marmalade

The same pH value in both treatments is very likely influenced by the use of pH indicator paper, because pH paper generally only provides round number readings and is less precise, while a pH meter with a glass electrode is capable of measuring up to two decimal places and is recommended for accurate pH measurement of acidic food products (McGlynn, 2016). In general, marmalade is known to have a low pH (around 2.4–3.5), which is related to the presence of organic acids derived from fruit (Emelike & Akusu, 2019; Suna et al., 2023). Citric acid and malic acid are the two main organic acids that accumulate in various climacteric and non-climacteric fruits and play an important role in determining the acidity of fruits and their processed products (Batista-Silva et al., 2018). The addition of fruit pieces in marmalade formulations will increase the organic acids in the product, thereby lowering the pH and increasing the acidity of the resulting product.

Color

Color is an organoleptic parameter that is visually observed using the sense of sight. The color of the marmalade is determined by the formation of a reddish-purple pigment produced from dragon fruit juice, namely anthocyanins. However, the addition of sucrose causes a change in the intense red color due to the browning process of the marmalade. The change to a browner color results from heating the food ingredients, leading to a Maillard reaction, a reaction between reducing sugars and amino acids that primarily occurs in foods high in carbohydrates. For products with added sugar, prolonged heating leads to caramelization, a non-enzymatic browning reaction that causes the product to turn brown (Wong & Siow, 2015). The results of the organoleptic test (Table 1 and Figure 3) on the preference level for the color parameter of dragon fruit marmalade show that Marmalade B with a sugar concentration of 50% and citric acid at 1% was preferred more, with a total average score of 3.5 compared to the color of Marmalade A with a sugar concentration of 68% and citric acid at 2%, which had a total average score of 3.1.

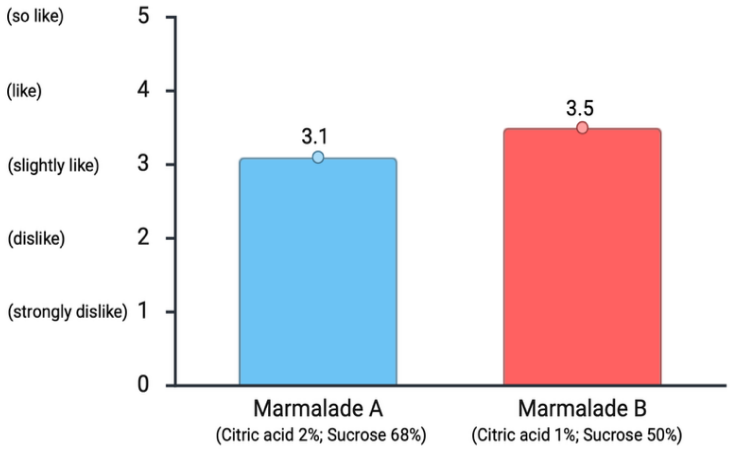

Figure 3. Organoleptic test of color parameters in marmalade

The color of the marmalade is influenced by the addition of sugar at different concentrations. Marmalade A, with a sugar concentration of 68 %, produced a deeper reddish-brown color than Marmalade B, with a sugar concentration of 50 %. This is because the addition of sugar during the heating process in marmalade causes the product to caramelize and triggers browning reactions, resulting in a browner color. Heated sugar causes marmalade to take on a reddish-brown hue. If the temperature and cooking time are too high or too long, the marmalade color will become darker because of browning. This browning reaction is caused by the activity of enzymes such as polyphenol oxidase (PPO) and peroxidase (POD). These enzymes are involved in the oxidation of phenolic compounds to quinones, which produce dark-colored melanin pigments (Nath et al., 2022).

Taste

Taste is an organoleptic test parameter that utilizes the sense of taste. The taste parameters for red dragon fruit marmalade are sweet and slightly. The sweetness comes from the dragon fruit itself and the addition of sucrose, while the sourness comes from the addition of citric acid and organic fruit acids (citric acid and malic acid).

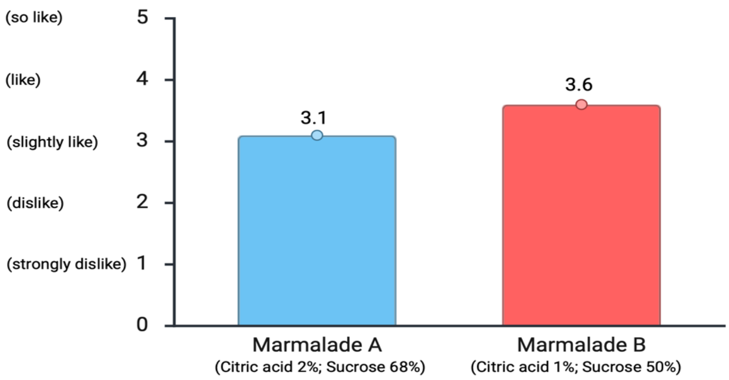

Figure 4. Organoleptic test of taste parameters in marmalade

The results of the organoleptic test of the taste parameters of dragon fruit marmalade (Table 1 and Figure 4) show that Marmalade B, with a sugar concentration of 50% and citric acid of 1%, was preferred with an average total score of 3.6, compared to Marmalade A, with a sugar concentration of 68% and citric acid of 2%, with an average total score of 3.1. The higher the sucrose concentration added to the marmalade, the sweeter the resulting product. Sucrose acts as a preservative and can also provide sweetness and enhance the flavor of food. Consistent with research by Cinderela et al. (2022), the addition of sucrose significantly improved the sensory evaluation of the product.

Aroma

Aroma is an organoleptic parameter that involves stimulation of the olfactory sense (odor), which is then perceived and processed in the brain, and it is one of the main determinants of consumer acceptance of food products. Recent studies on aroma compounds in foods emphasize that aroma (odor) is a key component in shaping consumers' perception of quality and liking for a product (Al-Khalili, 2025; Pu et al., 2025).

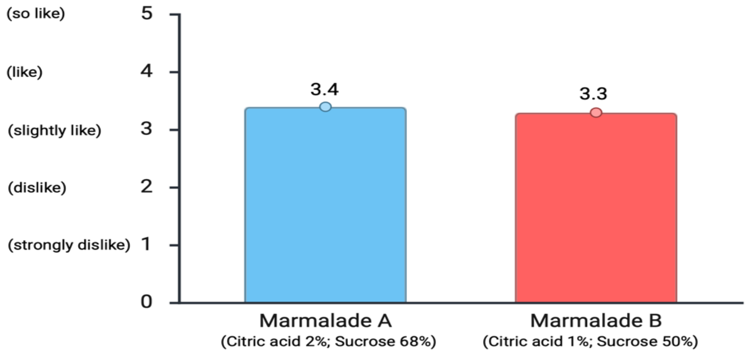

Figure 5. Organoleptic test of aroma parameters in marmalade

The results of the organoleptic test for the aroma preference of dragon fruit marmalade (Table 1 and Figure 5) showed that Marmalade A, formulated with 68% sugar and 2% citric acid, was preferred with an average score of 3.4, compared to Marmalade B, formulated with 50% sugar and 1% citric acid, which obtained an average score of 3.3. The aroma scores of the two treatments were numerically different; however, when rounded, both treatments had the same value, namely 3 (slightly like). This indicates that the sucrose and pectin concentrations used in each formulation did not affect panelists' acceptance of the aroma of the resulting marmalade.

Texture

Texture is an organoleptic parameter that can be identified through the sense of touch or taste based on the surface characteristics and internal structure of the product, and it is one of the key determinants of quality and consumer acceptance of marmalade (Javanmard & Endan, 2010; Singh et al., 2009).

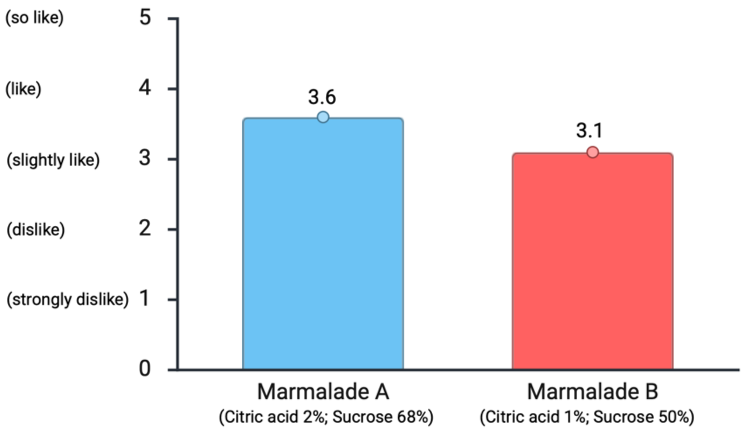

Figure 6. Organoleptic test of texture parameters in marmalade

Dragon fruit marmalade has a semi-solid texture because its matrix has undergone a gelation process (pectin–sucrose–organic acid system), which produces a gel-like structure and provides a characteristic mouthfeel. The results of the organoleptic test for the texture preference of dragon fruit marmalade (Table 1 and Figure 6) showed that Marmalade A, formulated with 68% sucrose and 2% citric acid, was preferred, with an average total score of 3.6, compared to Marmalade B, which contained 50% sucrose and 1% citric acid and obtained an average total score of 3.1.

The textural differences are influenced by the variation in sucrose concentration. Marmalade A, with 68% sucrose, had a thicker texture than Marmalade B, with 50% sucrose, which is consistent with studies on other marmalades showing that increasing the total soluble solids (mainly sugars) enhance thickness, gel strength, and spreadability (Javanmard & Endan, 2010; Singh et al., 2009). The resulting texture is a thick gel because the higher sugar content reduces the amount of free water in the system and promotes interactions among pectin chains, leading to the formation of a denser gel network. Pectin forms a network capable of entrapping water and imparting elastic and viscous properties to food systems, and an increase in pectin concentration in a food matrix is generally accompanied by higher viscosity and greater gel firmness (Said et al., 2023).

CONCLUSION

This study showed that varying citric acid and sucrose levels affect the physicochemical and sensory characteristics of red dragon fruit marmalade. Higher citric acid and sucrose increased titratable acidity, while both formulations remained in the acidic pH range, appropriate for jam-type products. Sensory evaluation indicated that the formulation with lower citric acid (1%) and sucrose (50%) was more preferred in terms of color and taste, whereas the formulation with higher citric acid (2%) and sucrose (68%) was better liked for aroma and texture. Overall, the marmalade with 1% citric acid and 50% sucrose can be considered the most acceptable formulation, offering a good balance of sensory attributes and potential for consumer acceptance.

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