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Sensory evaluation of cookies formulated with rhizopora propagules flour using 9-point hedonic scale

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ABSTRACT

This research aims to evaluate sensory using a 9-point hedonic scale and different statistical approaches on cookies made from Rhizopora propagule flour. This research used flour made from Rhizopora propagule and wheat flour with varying compositions to make cookies (C_1= Rhizophora flour 100% wheat flour 0%, C_2 = Rhizophora flour 75% wheat flour 25%, C_3 = Rhizophora flour 50% wheat flour 50%, C_4 = Rhizophora flour 25% wheat flour 75%). Respondents gave evaluations using a 9-scale hedonic score for the treatments in 4 parameters, including appearance, aroma, taste, and texture. Evaluation scores were analysed using four statistical approaches: Kruskal-Wallis, Freidman, ANOVA-CRD, and ANOVA-RCBD. The results show that different treatments resulted in significantly different respondent evaluation scores. All respondents give evaluation scores higher than the threshold except for C_1. This result means that the addition of wheat flour is still needed in Rhizophora cookie production. All treatments have the same evaluation score in appearancetreatment, while C_3 and C_4treatments have the highest evaluation scores in aroma, taste, and texture. It could be concluded that the potency of Rhizophora flour from its propagule as an ingredient in cookies is confirmed based on sensory evaluation using a 9-point hedonic scale and the ANOVA-RBCD statistical approach. The best treatment is Rhizophora flour 25% wheat flour 75%.

Keywords: cookies; rhizophora; sensory evaluation

INTRODUCTION

Rhizopora Sp. is the dominant mangrove species on Lombok Island. This species is well distributed in Lembar Bay and plays an essential role in this area(Kusumadewi & Idrus, 2023). RhizoporaSp is an essential mangrove species that can prevent coastal damage due to abrasion and intrusion(Hamzah et al., 2023). Mangrove forest, dominated by Rhizopora Sp., is the natural habitat of crustaceans, which is a valuable fisheries commodity that has a social impact on the society around the coastal area (Murugan & Anandhi, 2016). Further exploration ispromising since this mangrove species still has several rarely exposed potencies. One of that potency is as a food source

raw material (FransinMamuaja et al., 2023).

Research about the potency of Rhizopora Sp. as food source material has been conducted in several places in Indonesia (Rosulva et al., 2021). This mangrove species reported has good proximate properties and can be processed into a stick with good sensory appeal in the Lampung region (Rina et al., 2024). Rhizopora Sp. fruit also can be processed into flour, which can be an additional ingredient to make dodol, jelly, and candy in Riau (Titisari et al., 2023). In the East Java region, Rhizopora flour is used as an additional ingredient to make ice cream products with antioxidant activity (Ernawati et al., 2021). RhizoporaSp is distributed well in Tomini Bay of Sulawesi and was used as an additional ingredient to improve the organoleptic quality of crackers (Firdani et al., 2022). However, there is no report about using Rhizopora Sp. from Lombok Island.

Propagule (mangrove fruit) is one of the parts in Rhizopora Sp. that can be utilised as food material. Rhizopora propagule contains starch with highly branched amyloses and similar amylopectin characteristics to sweet potatoes (Hanashiro et al., 2004). This characteristic starch reveals the potency of flour from Rizopora propaguleto beutilised in cookie products (Z. Zhang et al., 2020). Thus, utilisation of Rhizopora propagule from Lombok Island can potentially be processed into flour as a cookie's ingredients. This processing can become a valuable novel utilisation of Rhizoporasp from Lombok Island, which has rarely been explored. Studies about mangrove utilisation in Lombok Island primarily use Sonneratia SP. and Bruguiera Sp., which are processed into syrup and candy (Lestari et al., 2023).

The potency of cookies made from Rhizopora Sp. propagule as a new product from Lombok Island can be examined based on market research development. One of the market research projects that is essential because it can measure consumer preference is the sensory evaluation (Świąder & Marczewska, 2021). In sensory evaluation, respondents express the degree to which they like a particular product on a hedonic scale. Thus, the sensory evaluation result can be affected by the hedonic scale used in the test (Mazur et al., 2018).

The hedonic scale has several ranges based on the number of used grades. Most sensory evaluation for food products in Indonesia uses a 5-point hedonic scale(Adrianar et al., 2015; Batubara & Pratiwi, 2018; Larasati & Issutarti, 2017; Triandini & Wangiyana, 2022). Meanwhile, most sensory evaluations conducted by

international researchers are 9-point hedonic scales. Sensory evaluation with a 9-point hedonic scale has a broader range scale than 5- a point hedonic scale, which can give more sensitivity to the measurement (Feng & O'Mahony, 2017; Wichchukit & O'Mahony, 2015, 2022; Yang & Lee, 2018). However, sensory evaluation using a 9-point hedonic scale is rarely conducted in Indonesian local food products (Wangiyana et al., 2024). Furthermore, data analysis using a 9-point hedonic scale can also be improved using different statistical methods. This approach can give robust information about consumer preferences (Baharudin et al., 2023).

This research aim to conduct sensory evaluation using 9-point hedonic scale and different statistical approach on cookies made from Rhizopora propagule flour.

METHODOLOGY

Research material

This research used Rhizopora propagule taken from Lembar Bay, West Lombok. Additional ingredients to make Rhizopora cookies including wheat flour (Bogasari), sugar (Gulaku), butter (Blue Band), chicken egg, and vanilla. Chemical compound for carbohydrate, protein, and lipid analysis including: $CuSO_4$, K_2SO_4, NaOH, HCl, and H_3BO_3 (Merck).

This research used a grinding machine (Miyako BL-22 PLY), flour shiver (Lionstar), mixer (RRC), electric stove (Eastern Electric), analytical digital scale (Jadever), electric oven (Olike), and syringe cookies.

Rhizopora flour preparation

The skin of Rhizopora propagules was peeled and washed two times with clean water, then soaked overnight in water. Then, the propagules were cut into small pieces and dried in an oven at 100 ^oC. The dried propagules were ground into powder and sieved with flour shiver to make Rhizophora flour (Figure 1).

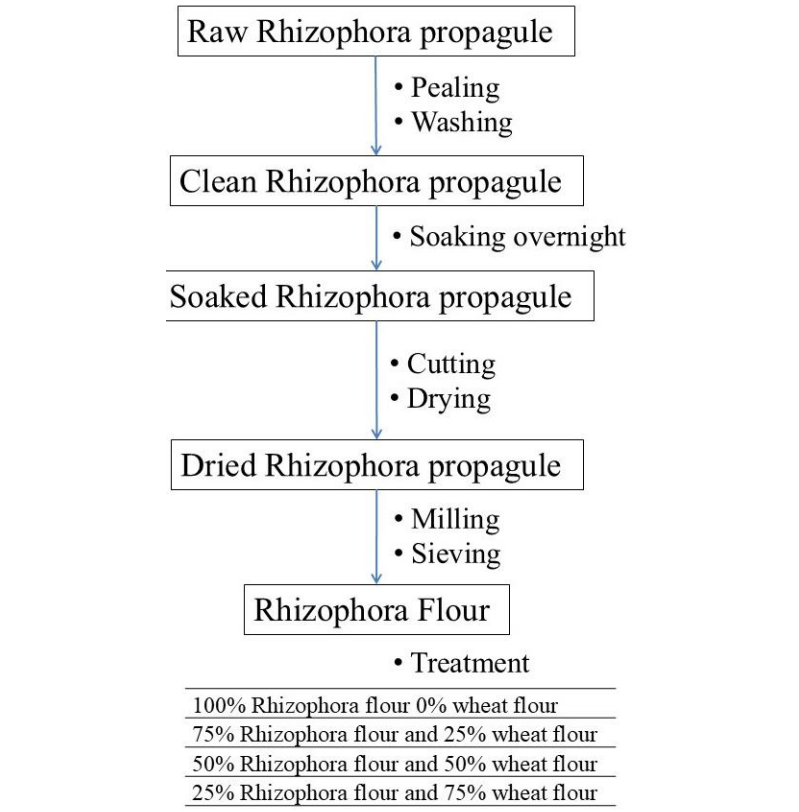

Figure 1. Rhizophora flour production scheme (top) and the morphology of Rhizophora flour (bottom)

Proximate analysis

Proximate analysis is an essential measurement of the composition of mangrove flour. This assay can determine the quality of Rhizophora flour as raw food product material (Rina et al., 2024). Proximate analyses that were conducted in this research are total water, total ash, total carbohydrate, total protein and total lipid content(Thangaraj, 2016).

Proximate analysis was conducted in accordance with INS 01-2891-1992 standards. The

thermogravimetric test was used to determine the total water content. The drying ash method by furnace combustion was used to determine the total ash content. The Soxhlation method was used to measure the total fat content. The Kjehdahl technique was used to calculate the total protein content.Carbohydrate content is estimated based on calculations (Eden & Rumambarsari, 2020):

$$\%C = 100\% - (\%P + \%L + \%A + \%W)$$

%C = Total Carbohydrate
% P = Total Protein
% L = Total Lipid
% A = Total Ash
%W = Total Water

Preparation of Cookies from Rhizophora

According to Table 1, cookies were made from different compositions of Rhizophora flour and wheat flour. Every batch of Rhizophora cookies was given additional ingredients, including 100 g sugar, 250 g butter, and one chicken egg. All ingredients were homogenised using a mixer into a dough. The dough was then moulded using a cookie syringe and baked in the oven at 130^{o}C for 25 minutes. Rhizophora cookies were stored in glass containers at room temperature for sensory evaluation.

Table 1.
Composition description of Rhizophora cookies treatment

Code	Main Composition description
C_1	100% Rhizophora flour (without addition of wheat flour)
C_2	75% Rhizophora flour and 25% wheat flour
C_3	50% Rhizophora flour and 50% wheat flour
C_4	25% Rhizophora flour and 75% wheat flour

Sensory evaluation

A nine-point hedonic scale was used for sensory evaluation, which can be divided into verbal and numerical (Table 2). The hedonic scale that most clearly conveys the respondent's degree of preference is the verbal hedonic scale. For statistical analysis, the verbal hedonic scale is converted to a numerical hedonic scale (Xia et al., 2021).

Thirty individuals, ranging in age from twenty to twenty-four, were selected to participate in this study. The 9-point hedonic scale training participants are food sensory responders from UniversitasPendidikan Mandalika (Wangiyana et al., 2023).All respondents gave an evaluation in four parameters, including

appearance, aroma, taste, and texture.

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Table 2.
Verbal hedonic scale and numerical hedonic scale

Verbal Hedonic Scale	Numerical Hedonic Scale
Like extremely	9
Like very much	8
Like moderately	7
Like slightly	6
Neither like nor dislike	5
Dislike slightly	4
Dislike moderately	3
Dislike very much	2
Dislike extremely	1

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Data Analysis

Data analysis is conducted using descriptive and inductive statistical approaches. The numerical score of each treatment was analysed descriptively in the form of a spider web diagram. Inductive statistics is performed using different statistical approaches, including the Kruskal-Wallis test, Freidman test, ANOVA-CRD (Analysis of Variance – Completely Randomised Design), and ANOVA-RCBD (Analysis of Variance – Randomized Complete Block Design). Duncan Multiple Range Test (DMRT) α 0.05 was also conducted to examine the treatment effect on the numerical hedonic scale of each parameter. All data analyses were performed using co-stat for Windows (Wangiyana & Triandini, 2022).

Table 3.
Summary of statistical method approaches in this research to conduct analysis of the numerical hedonic scale

statistical Approach	Assumption	Linear model	Description
Kurskal-Wallis	Rhizophora cookies and respondents are homogenous	$H = \frac{12}{N(N+1)}\sum_{i=1}\frac{R_i^2}{n_i} - 3(N+1)$	Ri = ranking in the column N = Total Number of Sample ni = Number of treatments
Freidman Test	Respondents are heterogeneous (become group)	$X^2 = \frac{12}{bt(t+1)}\sum r^2 - 3b(t+1)$	b = Number of Group t = Number of Treatments r = Number of rankings
ANOVA CRD	Normal distribution of numeric scale and respondents are homogenous	$Y_{ij} = \mu + \tau_i + \varepsilon_{ij}$	Y_{ij} = An observation μ = The Experimental Mean τ_i = The Treatments Effect ε_{ij} = The Experimental Error
ANOVA RCBD	Normal distribution of numeric scale and respondents are heterogeneous (become block)	$Y_{ij} = \mu + \tau_i + \beta_j + \varepsilon_{ij}$	Y_{ij} = An observation μ = The Experimental Mean τ_i = The Treatments Effect B_j = The Block Effect ε_{ij} = The Experimental Error

RESULTS AND DISCUSSION

Proximate analysis shows that Rhizophora flour is dominated by carbohydrates (Figure 2). Flour containing high carbohydrate content, especially undamaged starch, is essential to improve the product quality of cookies (Moiraghi et al., 2019).

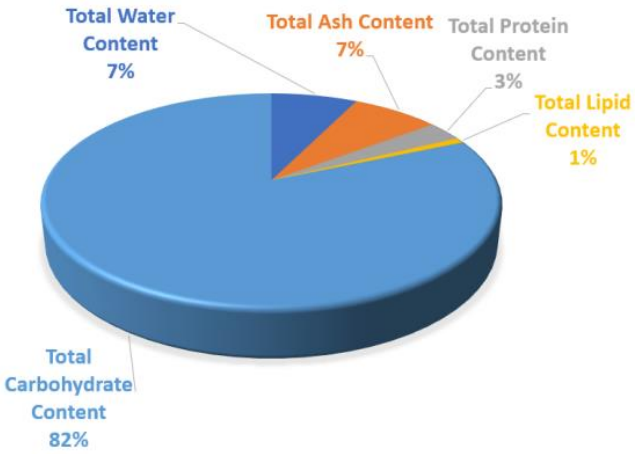

Figure 2. Proximate analysis of Rhizophora flour

Rhizophora flour from Lombok Island has carbohydrate content in a similar range to Rhizophora flour from the East Java region, which reported carbohydrates contained around 82% (Ernawati et al., 2021) and 83% (Dwi Sulistiyati, 2015). The high carbohydrate content in Rhizophora flour from this research makes it suitable for making cookies. If the carbohydrate content is lower (below 80%), Rhizophora flour can be used to make other food

products, such as noodles (Mahdevi et al., 2023).

Figure 3. Rhizophora cookies with different composition (C_1, C_2, C_3, and C_4)

Different composition of Rhizophora flour not significantly affecting the appearance of cookies (Figure 3). However, addition of wheat flour in different concentrations slightly affecting the size of the cookies after baking process. The color of cookies also slightly affecting by the addition of wheat flour concentration. The colour of cookies become lighter with addition of wheat flour. This result was aligned with the result of Jariyah et al. (2018) which incorporated wheat flour with various mangrove fruit flour. The mechanism of the colour changing is also similar which involving the kinetic modeling of cookie browning during baking (Lukinac et al., 2017).

Table 4 shows a comparison of p-values from different statistical approaches. This p-value determines the significance of the hedonic score given by the respondent (Shrestha, 2019). The lower P-value of the hedonic score means a higher significant impact level (Andrade, 2019). Based on the result, the Kruskall-Wallis approach has a similar pattern to the ANOVA-CRD approach, while the Friedman test approach has a similar pattern to ANOVA-RCBD. This result shows the correlation between the parametric and non-parametric approaches (Sedgwick, 2015).Based on the result, ANOVA-RBCD is the most suitable statistical approach that could fit the sensory evaluation model of Rhizophora cookies in this study.

Table 4.
P-value comparison of different statistical approaches

Statistical Approach	**Parameter**	**P Value**
Kruskal Wallis	Appearance	0.3824ns
	Aroma	0.0806 ns
	Taste	0.00001 ***
	Texture	0.0066 ***
Friedman Test	Appearance	0.00001 ***
	Aroma	0.00001 ***
	Taste	0.00001 ***
	Texture	0.00001 ***
ANOVA CRD	Appearance	0.1373ns
	Aroma	0.0764 ns
	Taste	0.00001 ***
	Texture	0.0016 **
ANOVA RCBD	Appearance	0.0103 *
	Aroma	0.0043 **
	Taste	0.0002 ***
	Texture	0.00001 ***

Note: ns = non-significant (P value is more than 0.05), * = significant (P value is 0.01 – 0.05), ** = highly significant (P value is 0.001 – 0.01), *** very highly significant (P value is less than 0.001)

Table 5.
DMRT analysis of treatment hedonic score in different parameter

Treatment	**Average Numerical Hedonic Scale ± Error Value**			
	Appearance	**Aroma**	**Taste**	**Texture**
C_1	6.97 ± 0.21 (a)	5.93 ± 0.25 (b)	4.17 ± 0.33 (c)	5.67 ± 0.31 (c)
C_2	6.93 ± 0.22 (a)	6.73 ± 0.23 (a)	6.10 ± 0.22 (b)	6.27 ± 0.20 (b)
C_3	6.30 ± 0.33 (b)	6.40 ± 0.26 (ab)	6.70 ± 0.35 (ab)	6.57 ± 0.19 (ab)
C_4	7.03 ± 0.21 (a)	6.67 ± 0.21 (a)	7.33 ± 0.18(a)	6.93 ± 0.19 (a)
	LSD 0.05 = 0.48	LSD 0.05 = 0.47	LSD 0.05 = 0.65	LSD 0.05 = 0.47

Note: Different mean values followed by the same letters are significantly different ($p<0.05$). C_1= Rhizophora flour 100% wheat flour 0%, C_2= Rhizophora flour 75% wheat flour 25%, C_3 = Rhizophora flour 50% wheat flour 50%, C_4 = Rhizophora flour 25% wheat flour 75%

DMRT analysis shows that the respondent tends to slightly dislike the taste if the cookies are only made from Rhizophora flour without the addition of wheat flour (table 5). This result shows that wheat flour (the most common ingredient in making cookies) is still needed to make cookies from Rhizophora flour(Goswami et al., 2021). DMRT results might show that the dominant ingredient of wheat flour (75% wheat flour) can give the highest hedonic score. However, since the result is not

significantly different compared to the addition of 50% wheat flour (except for the appearance parameter), it could be indicated that Rhizophora flour: wheat flour = 1: 1 is the ideal composition to produce Rhizophora cookies.

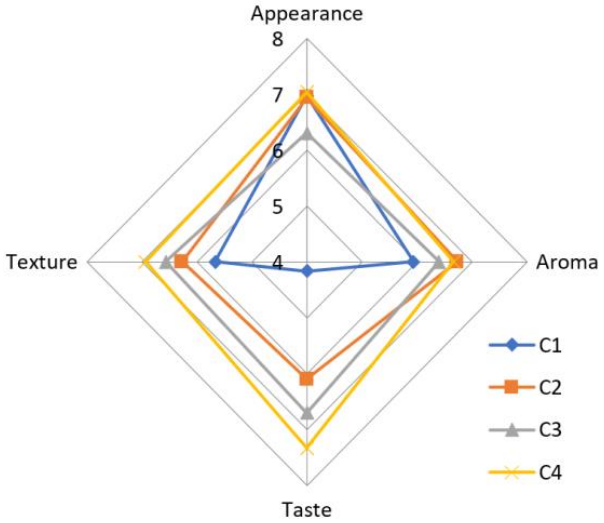

Figure 4. Spider web analysis of treatment hedonic score in each parameter (C_1= Rhizophora flour 100% wheat flour 0%, C_2 = Rhizophora flour 75% wheat flour 25%, C_3 = Rhizophora flour 50% wheat flour 50%, C_4 = Rhizophora flour 25% wheat flour 75%)

Spider web analysis shows that respondents tend to give similar scores in appearance parameters. This result also confirms that the addition of wheat flour does not significantly impact the appearance of Rhizophora cookies. Apart from the C1 treatment (100% Rhizophora flour), respondents gave scores above the threshold value in all other samples. This indicates the overall acceptance of the respondent as the representative of the consumer (C. Zhang et al., 2020). This result also shows the potency of developing cookie products using Rhizophora flour as the ingredient.

CONCLUSION

The potency of Rhizophora flour from its propagule as ingredients of cookies product is confirmed based on sensory evaluation using 9-point hedonic scale and ANOVA-RBCD statistical approach method. However, wheat flour is still needed to be added in the formulation in concentration up to 50% to give better taste, aroma and texture of the Rhizophora cookies.

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