

Prospect of processing *lindur* fruit (*Bruguiera sexangula*) biscuits as a culinary product to support the development of mangrove-based nature tourism

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Abstract

Indonesia is a country with a mangrove forest area of 8.6 million hectares. Diverse forms of ecotourism based on mangroves have also begun to flourish. However, only a few coastal communities know that mangrove fruit can be consumed or processed into various types of food for humans, including the prospect of being developed into a unique culinary product for mangrove-based ecotourism. This research examined the production of biscuits from *lindur* fruit (*Bruguiera sexangula*) and the development prospects as one of the supporting culinary products in the mangrove beach tourism object of Kampung Nipah, North Sumatra Province. Appropriate methods were used to examine the process of making flour from mangrove fruit biscuits, testing the level of consumer acceptance through organoleptic tests and preferences for the taste treatment of *lindur* fruit. The results showed that 1 kg of *lindur* fruit produced 310 g of flour (31% yield), and with other supporting ingredients, it could produce 750 g. The sweet taste had the highest score at 4.46 (like), color at 3.99 (slightly like), and aroma at 3.1 (somewhat like). In all aspects, it was found that the highest consumer preference was given to biscuits with a sweet-taste treatment, followed by salty and original flavors. Consumer preferences for flavoring treatment differ significantly in aroma and taste. Additionally, the market potential is quite promising because it gives a positive response, when about 96.25% of visitors were willing to buy the product. This willingness to buy does not have a significant correlation with visitor characteristics on aspects of visitor age, education level, and occupation.

1. Introduction

Kuswana *et al.* (2020) reported that Indonesia is one of the largest countries with mangrove forests, covering an area of 3.2 million hectares, 22.6% of the world's total mangrove forests. The function of the mangrove forest is not only to prevent abrasion, but it is also beneficial for the socio-economic life of the community. Therefore, to maintain a balance between the ecological and economic sustainability of mangrove forests, the current policy of the Indonesian government is to prioritize the utilization of non-timber forest products (NTFPs) and environmental services (nature tourism) and reduce the utilization of wood. However, the utilization of NTFPs has not been optimal, even though several species known to the public can be processed into human food. The business of processing mangroves into food products has not been widely developed and is in demand by coastal

communities. Many people do not know that mangrove fruit can be consumed. Knowledge of the potential and benefits of a food source is still very limited (Ledheng *et al.*, 2022). Government supervision in maintaining mangrove forests by their functions is still weak (Ilman, 2011; Dharmawan *et al.*, 2016; Arifanti *et al.*, 2021; Rudianto, 2021). If a mangrove management model that is of high economic value but sustainable is not developed, mangrove degradation will continue. Therefore, the prospect of utilizing mangrove fruit for culinary products integrated with the development of nature tourism is expected to be an alternative solution that must be researched.

Kuswana *et al.* (2020) reported that Indonesia is one of the largest countries with 3.2 million hectares of mangrove forests, 22.6% of the world's total mangrove forests. The function of mangrove forests is not only to

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Sei Nagalawan Village is located on the east coast of Sumatra Island, in Serdang Bedagai Regency, North Sumatra, Indonesia. The main ecosystem on the coast is the mangrove with a small proportion of sand beach forest. Most of the mangrove forest ecosystem in this area has been converted into ponds. The condition of damage and loss occur in this area and on most of the east coast of North Sumatra (Harahap and Absah, 2020a). One side of the mangrove ecosystem has been managed and developed as a tourism object in Kampung Nipah with a group approach (Purwoko *et al.*, 2021; Harahap and Absah 2020b).

The ecosystem is the mainstay of the appeal with various tourist attractions, including educational tourism (Harahap and Absah 2020b). As a unique educational and culinary attraction, several Sei Nagalawan Village mangrove plants have also been used by the surrounding community in processed food and beverage products. The fruits processed and marketed as mangrove-based food products, as reported by Harahap and Absah (2020c), and Sitomorang (2018), include *perepat/pedada* (*Sonneratia caseolaris*), *jeruju* (*Acanthus ilicifolius*) and *fire fruit* (*Avicennia caseolaris*). This mangrove fruit has high nutritional value but is not too sweet according to Sabana (2015) and tends to be sour according to Pramanick *et al.* (2021).

One of the potentials for tourism is *lindur* fruit. This species grows naturally or is planted as a conservation effort and tourist attraction. Seedlings are also used as an

educational tourism attraction for school children and the public (Riyadi *et al.*, 2021; Purwoko *et al.*, 2023). The potential of *lindur* fruit has not been utilized properly by the Muara Baimbai Cooperative as a tourism object manager. Therefore, this research aimed to analyze the processing and yield, consumer preferences for various flavoring treatments, and the prospect of processing *lindur* biscuits as souvenirs from mangroves to support the development of nature tourism in the Mangrove Coast of Kampung Nipah.

2. Materials and methods

2.1 Research location

This research was conducted at the Mangrove Beach tourism object, Kampung Nipah, Serdang Bedagai Regency, North Sumatra Province (Figure 1).

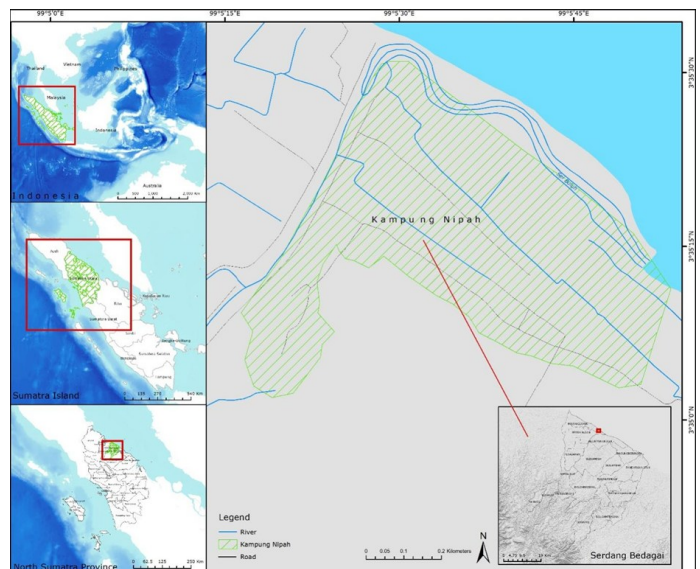


Figure 1. Map of research location.

2.2 Materials and equipment

The materials were *lindur* fruit or ‘Crocodile Eye’ mangrove, harvested from Sei Nagalawan Village’s mangrove forest and processed into flour. Additional materials were yeast, water, powdered sugar, baking soda, wheat flour, vanilla, and fine salt. The equipment used for making biscuits was digital scales, mixers, and toaster ovens.

2.3 Production of mangrove fruit flour

The ripe *lindur* fruit was sorted and peeled to separate the peel from the fruit flesh. Fresh fruit was soaked in clean water and charcoal (30%) for 2 days to reduce the tannin content. The higher the proportion of charcoal, the lower the tannin content (Min *et al.*, 2018). The soaking water was changed every 6 hrs to speed up, reducing the tannin content, and it was boiled at 100°C for 30 mins. Subsequently, it was sliced using a knife and dried under the sunlight, as marked by a rustling

sound when the fruit slices were broken. The dried fruit slices were ground using a flour milling machine and sieved with an 80-mesh sieve to obtain flour.

2.4 Production of biscuits from lindur fruit flour

The biscuits made from *lindur* fruit flour consisted of three taste treatment flavours: original, sweet and salty. The dry ingredients in the form of *lindur* fruit flour (310 g), salt (40 g), yeast (40 g), and baking soda (20 g) were mixed using a low-speed mixer until homogeneous. Meanwhile, the shortening (900 g) was stirred using a high-speed mixer for 5 mins until the cream was formed. The mixture of dry ingredients was put into the cream mixture and water (150 mL). The solution was stirred again using a mixer at medium speed until a smooth dough was formed. The dough was allowed to stand for 30 mins at room temperature (29°C). Therefore, fermentation occurred, and the dough experienced a slight expansion.

The fermented dough was divided into 3 parts and treated differently. The first dough uses 300 g of sugar and stirs homogeneously to produce biscuits with a sweet taste. The second dough uses 300 g of grated cheese and stirs until smooth to produce biscuits with a salty taste. The third is not given additionally to producing biscuits with the original taste.

Each of the three types of dough was made into a 3 mm thick sheet and moulded into the desired biscuit shape. On the surface, the topping dough is spread in the form of 33.7 g flour and 11.8 g shortening, which has been beaten with a high-speed mixer for 5 mins. It was baked in an oven at 165°C for 15 mins, and the resulting biscuits were cooled at room temperature before being packaged in airtight polyethylene plastic.

2.5 Organoleptic test of lindur fruit flour biscuit products

The packaged biscuits were organoleptically tested to determine consumer acceptance, and the population was tourists who visited the mangrove tourism object of Kampung Nipah. The samples were taken using the accidental sampling method, determining the sample by chance. Respondents were taken from incidental visitors considered to match the characteristics of the specified sample. The number of samples was calculated by the Slovin formula, as used by Semariyani and Singapurwa (2020), Risano *et al.* (2021), Tampi *et al.* (2022) and Lodhi *et al.* (2022), as follows:

$$n = \frac{N}{1 + Ne^2} \quad (1)$$

Where n is the sample size, N is the population size and e is the inaccuracy/error limit.

The total population of visitors to mangrove tourism objects of 23,500 people per year Muara Baimbai Cooperative (2018), a rounded sample of 80 was obtained.

The organoleptic and hedonic tests were carried out with a scale ranging from 1 (very dislike) to 5 (very like). The panelists used were untrained, 80 visitors to the Kampung Nipah mangrove tourism object. The organoleptic test parameters assessed were taste, aroma, texture, and color (Fiorentini *et al.*, 2000; Dias *et al.*, 2020).

2.6 Consumer preference test on flavor treatment

The ranking and the significance test of differences were conducted using the Friedman Test to determine consumers' preferences for flavoring treatment. The same test method was also used (Hernandez *et al.*, 2016). Friedman test, according to (Lowry, 2000; Hollander *et al.*, 2014), was conducted with the following steps and formula:

$$x_r^2 = \frac{12}{nk(k+1)} \sum_{j=1}^k R_j^2 - 3n(k+1) \quad (2)$$

Where, R_j is the number of ratings observed on the j^{th} treatment, $J = 1, 2, \dots, k$, where are the units observation into a number (k) treatments and (b) blocks. The biscuits were given sweet and salty flavors with a control in the form of original biscuits. The sweetness and salty treatment was carried out by adding sugar and cheese to the dough.

2.7 Market prospect analysis

Marketing is an important aspect of the entire series of company businesses. At the theoretical level, marketing strategy is known as the mix, which combines four elements of price, product, place, and promotion strategies (Dominici, 2009; Išoraitė 2016; Abedian *et al.*, 2022). The economic value of mangrove tourism in Sei Nagalawan Village can be seen from various criteria and those that are asked of visitors. Visitors' questions include the willingness to buy mangrove biscuit products, the desired price range, and the number of products to buy in a single purchase.

The data collected included primary and secondary data. Types of primary data collected from visitors include characteristics such as gender, age, education, occupation, and origin, organoleptic data including taste, color, and aroma, and consumer acceptance data, such as the willingness to buy, the relationship between visitors' characteristics with a willingness to buy, and the ability to purchase prices. This data was obtained by giving questionnaires to 80 visitors as respondents. Primary data related to the process and yield of biscuits from

mangroves was carried out by conducting experiments and in-depth interviews with informants. They include mothers of the Muara Tanjung Women's Group, who manage the mangrove tourism object of Kampung Nipah, especially in the culinary service section. Visitor characteristics data is also collected to determine the relationship between visitor characteristics and willingness to pay. Analysis of this relationship is performed by statistical test of correlation (Hollander *et al.*, 2014).

3. Results and discussion

3.1 Description of research location

Mangrove tourism objects are located on the east coast of Sumatra Island, in Serdang Bedagai Regency, North Sumatra Province. This area consists of rice fields and livestock producers but also has a coastline, hence some of the residents work as fishermen. Geographically, Sei Nagalawan Mangrove Beach is located at the coordinates of 03° 35' 29.52" - 03° 35' 24.46" North Latitude and 99° 5' 28.59" - 99° 5' 39.09" East Longitude.

The mangrove beach tourism is about a 1-1.5 h (57.8 km) drive from Medan City, the center of population density in North Sumatra Province. Several small towns also surround this tourist attraction as a buffer population. It has good accessibility, and the road conditions are quite nice. Hence visitors can use private vehicles such as motorbikes, cars, or buses.

3.2 Lindur fruit flour

The results showed that *lindur* fruit could be processed into flour, yielding 31.1%. The flour is brown, as indicated in Figure 2. Due to the high tannin content of 4.56 mg/L as a barrier to its use in food products (Subandriyo and Setianingsih 2016). Tannins can be reduced by modifying the flour processing process by soaking in water with charcoal and boiling at a temperature of 100°C for 30 mins (Sharma *et al.*, 2016). Soaking for 2 days and changing the water every 24 hrs was able to reduce the level to 0.063%, and the HCN level to 2,093 ppm, these results met SNI standards. 01-2997-1996 and Acceptable Daily Intake (ADI) as food ingredients (Pujirahayu *et al.*, 2022).

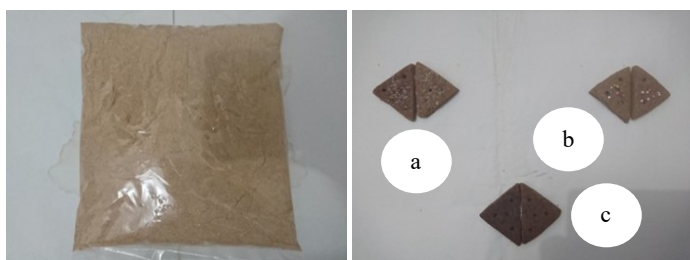


Figure 2. (i) *Lindur* fruit flour and (ii) *Lindur* fruit biscuits taste sweet (a), sour (b), and original (c).

3.3 Organoleptic test on biscuits from lindur fruit

The organoleptic test measures the impression statement on the quality of a product and can be applied during product comparisons. The preference test asks the panelists to pick one of the other options (Boggs and Hanson, 1949; Setyaningsih *et al.*, 2014). Table 1 describes the organoleptic test results of biscuits from 3 flavor treatments.

Table 1. Organoleptic test on the biscuit fruit flour of *lindur* fruit.

No	Flavor	Color	Aroma	Taste
1	Sweet	3.99	3.14	4.46
2	Salty	3.98	3.13	4.34
3	Original	3.96	2.93	3.26
	Average	3.98	3.07	4.02

Description: 1 = Very dislike, 2 = Dislike, 3 = Quite Like, 4 = Like 5 = Very like

3.3.1 Color

All three treatments produce different biscuit colors. The sugar (sweet) treatment produces biscuits with a medium brown color (color code 4F4138), the cheese (salty) treatment produces biscuits with a dark brown color (color code 382E28), and the original treatment produces biscuits with a light brown color (color code 856D5D). The color was formed from the baking process, baking biscuits in the oven will produce a brown color on the surface due to the Maillard reaction (Manley, 2000). Baking at high temperatures and for too long will cause low moisture and darken the color. The effect of roasting temperature is also related to caramelization reaction. Reaction involving simple sugars that can form caramel brown color and flavor components (Hui *et al.*, 2006). Color has an important meaning and role in the attractiveness of identification and quality parameters (Ke *et al.*, 2015).

Based on the scoring test in terms of color from 3 samples of biscuits given to visitors, the sweet taste had the highest average score of 3.99 (like category). At the same time, the lowest was the color of the original taste, which was 3.96 (like category). Overall, the score for the color aspect was 3.98, meaning that visitors like the color.

3.3.2 Aroma

The aroma of food products can be influenced by the ingredients used in the processing. High temperatures in production cause volatile compounds to be lost due to evaporation. The increase in temperature causes the transfer of dough moisture through the capillary and diffusion processes. Surface hardening also forms a distinctive aroma with the evaporation of water

(Rajkumar et al., 2017).

Aroma is a difficult smell to measure, giving rise to different opinions in assessing quality (Marsili, 1997). Differences of opinion are caused because each person has a different sense of smell. Even though they can distinguish aromas, everyone has different preferences. Based on the score of 80 visitors from 3 samples, the most preferred flavor variant in the aroma was biscuits with a sweet taste with a score of 3.14 (quite like). In contrast, the lowest score in terms of aroma was obtained in the original flavor variant with a score of 2.93 (quite like). The overall score for the aroma aspect is 3.07, meaning that visitors to the Kampung Nipah Mangrove Beach tourism object like the biscuit smell. They give an assessment based on the level of aroma contained in the biscuit product. A strong aroma is important because it can increase tourist interest in buying these biscuits. Visitor ratings are lower than other aspects because they still smell the distinctive aroma of plant sap from the raw material in the form of *lindur* fruit. This is because the *lindur* fruit contains steroids, flavonoids, and tannins (Jacob et al., 2013).

3.3.3 Taste

Taste is the main factor influencing consumer preference. The resulting taste is influenced by the food ingredients' components and processes (Saragih, 2014). Taste is a decisive factor in the consumers' final decision to reject or accept food. Generally, food ingredients combine various flavors in an integrated manner, giving rise to a complete taste image. Taste is influenced by several factors, that is chemical compounds, temperature, concentration, and interaction with other flavor components (Regueiro et al, 2017).

Based on Table 1, the taste with the highest average score is sweetness, which is 4.46 (like). This proves that visitors like sweet-tasting food compared to other flavors, and the lowest average score is original at 3.26 (quite like). The overall score for the taste aspect is 4.02, implying that visitors to the Kampung Nipah Mangrove Beach tourism object like the taste of the biscuits. The additional ingredients provide a taste effect visitors like. Likewise, Triratnawati (2017) and Shen et al. (2021) explain that the taste caused by food products could come from substances added during the process. Tannin from *B. gymnorrhiza* is lost because it is decreased and considered to have disappeared, hence there is no astringent taste (bitter/sour) (Rina et al., 2021). However, the taste score is not optimal, and there may still be a residual astringent taste caused by tannins. Winarno (1997); Taladrid et al., (2019); Fracassetti (2019) and Sáenz-Navajas (2020) explain that the presence of tannins in food could also determine the

taste.

The processed mangrove biscuit products have a soft texture, distinctive aroma, and attractive color. Visitors are curious about mangrove plants that can be made into delicious processed products. Based on Table 1, the market potential of *Lindur* mangrove biscuits with a sweet taste is more likely to be produced and marketed commercially. This is because visitors are more interested in salty and original flavored biscuits.

3.4 Comparative analysis between flavor treatment

The Friedman Rank Test was carried out to compare original, sweet, and salty treatments in each aspect (MacFarland and Yates, 2016; López-Vázquez and Hochsztain, 2019). To determine the degree of significance of the difference, a Spreadman Test was carried out.

3.4.1 Taste

Table 2 shows that sweetness ranks the highest in the three aspects of color (2.01), aroma (2.11), and taste (2.5). The next rank is salty taste, and the lowest is original. This shows that visitors prefer sweet taste to the salty and original taste. Likewise, Valentin et al. (2006); Ashton et al. (2014); Schaefer and Garbow (2021) explain that sweetness in food tends to be preferred or selected. Consumer preferences for sweetness compared to other flavors are also reported by many studies. Younger people like sweet taste and saltiness more than adults (Hoffman et al., 2016). There were differences in preferences for different races and sexes in the younger age group, but there was no difference in adults. Furthermore, sweet taste was preferred in children who are taller in infancy. Sweet and salty tastes correlate with children's intake worldwide.

Table 2. Rank test.

No	Flavor	Mean rank		
		Color	Aroma	Taste
1	Sweet	2.01	2.11	2.50
2	Salty	2.00	2.09	2.36
3	Original	1.99	1.79	1.14

Children like sweet and dislike bitter tastes (Mennella and Bobowski, 2015). It reflects the basic biology of children, where they like sweet tastes from birth, which attracts them to breast milk. Children's level of preference for sweet tastes is higher than adults. The level of preference decreases with age toward adulthood. People like a sour taste when consuming fruit products, but a sweet taste is liked by people when eating snacks (Sijtsema et al., 2012). This also follows that most commercial biscuits are produced with a sweet taste, and few provide a salty option.

Consumer preferences for giving sweetness were strengthened by the Friedman Test (Table 3), which resulted in a significant difference between the control and the treatment of giving sweet and salty flavors in terms of aroma and taste with a significance close to 0. Therefore, providing consumers with their preferred flavor significantly impacts their preferences and propensity to consume mangrove biscuits. Fracassetti *et al.* (2019) also investigated the same result where consumers prefer a sweeter taste.

Table 3. Friedman statistic test.

	Color	Aroma	Taste
N	80	80	80
Chi-Square	0.421	28.737	130.353
df	2	2	2
Asymp. Sig.	0.810	0.000	0.000

3.4.2 Color

In the aspect of color, there was no significant difference between the control and the treatment with sugar and butter. This shows that in this case, the consumer does not mind the color too much in the processing process. This result is also possible because the color difference is only obtained from the effect of adding sugar and butter. The recipe formula affects the color of the dough (Hesso *et al.*, 2015). For more detailed results related to the color aspect, research should be carried out by giving a more striking color difference treatment. The attitude of visitors to Mangrove Beach who do not question color differences, where the color of biscuits significantly impacts consumer perceptions. Therefore, the effect of the recipe modifications on consumer perceptions was determined.

3.4.3 Aroma

There is a significant difference in aroma between the control and treatment samples. Sugar-flavored biscuits are preferred, followed by biscuits with butter and no additives. The addition of sugar to the ingredients produces a more fragrant and attractive aroma to consumers (Manley, 2011; Liu *et al.*, 2021).

3.5 Market potential analysis of lindur fruit biscuit

Market potential analysis of biscuit products processed by *lindur* fruit can be found by asking for opinions from beach visitors in Sei Nagalawan Village who are willing to taste mangrove food products.

3.5.1 Visitor characteristics

3.5.1.1 Age

Age is closely related to the ability to carry out activities, and in this research, this characteristic

provides an overview of the visitors' condition. The oldest was 24-32, with an average of 28.23 years. As a comparison, the visitors' age at the same location was 20-50. In adjacent locations at Romantic Beach, reported that most visitors came from the 17-25-year-old group, which was 52%, followed by the 26-35 years age group at 42.26%. The age group between 24-32 is more like a tourist attraction. Therefore, the age range of visitors to Kampung Nipah tourism is young. The characteristics of youth tourism should be recognized to determine the preferences regarding the attractiveness and desired tourist attractions, including souvenirs and culinary delights.

3.5.1.2 Education level

Education level plays an important role in showing an individual mindset. This parameter shows the education level taken by visitors. The majority graduated from senior/vocational high school with a frequency of 50%, followed by universities at 43.75%. Tourists in beach tourism objects had a senior high school education at 56%, followed by a university education at 39%. Therefore, visitors to Kampung Nipah tourism averagely belong to the educated group.

3.5.1.3 Occupation

Occupation shows the level of success and prosperity in purchasing power, preferences, or other travel demands. This research comprises 47.5% self-employed, 26.25% employees, and 8.75% college students. Similar results were that most tourists who came to Kampung Nipah worked as laborers (35%), then traders (23%) (Drumm and Moore, 2005; Fandeli, 2000). The number of visitors who come from working circles follows the statement that tourists can be categorized in several ways (Coenen *et al.*, 2013). These include traveling with physical motivation to recover physically and mentally from the tension and boredom of everyday life by finding a return or maintaining physical and mental well-being.

3.5.2 Availability of raw materials

Lindur fruit raw materials in Nipah Village mangrove tourism objects are easy to obtain. In this location itself, there is *lindur* at the tree level with a density of 3.7 ind/ha (Purwoko, *et al.*, 2023). This amount is indeed small and will not be enough if processed and marketed to visitors reaching 23,500 people per year (Muara Baimbai Cooperative, 2018), but this type of tree is found in many mangrove ecosystems around this area and can be harvested if needed. In addition, *Lindur* is relatively easy to grow as an enrichment planting and can already begin to bear fruit at the age of 2 years and can bear fruit throughout the year

(Sulistyawati et al., 2012). Thus, the provision of raw materials is not a problem.

3.5.3 Willingness to buy

Based on a survey conducted on visitors to Kampung Nipah, 96.25% stated that they were willing to buy mangrove biscuit products (*lindur*), while 3.75% were not. Likewise, 75%, 18.75%, and 2.5% of visitors were willing to buy 1, 2, and 3 biscuit jars for 1 purchase, while the rest were not willing to buy. Therefore, this mangrove biscuit has very good prospects of being marketed as one of the culinary products processed by mangroves. This is supported by the taste aspect, where *Lindur* biscuits have a savory and delicious taste, a crunchy texture, and are not hard (Rina et al., 2021).

3.5.4 The relationship between visitor features and purchase approval

The visitor characteristics do not have a significant correlation with the willingness to buy on the aspects of the visitor's age, educational level, and occupation (Tables 4, 5, and 6). This is empirically thought to be due to i) food products by *lindur* fruit are still not widely known by the wider community and ii) the price of the product is relatively low, so it is still affordable for all groups of visitors. In this case, the price of this product is relatively affordable for various age groups, education levels and visitor occupations. However, this still requires further research.

3.5.5 Selling price

The price desired by visitors to Kampung Nipah for the *Lindur* mangrove biscuits was very diverse, starting from IDR 10,000 to IDR 40,000 per package of 0.5 kg. The average desired price was IDR22,662 per pack, or IDR45,324/kg biscuit, which is equivalent to 3 USD/kg. This is still relatively low compared to the raw material in the form of *lindur* fruit flour, sold in the IDR15,000-IDR25,000/package of 2 ounces. *Bruguiera* flour can have a higher price due to a more complicated process and natural ingredients. Theodora et al. (2016) compared to the selling price of other processed mangrove products, such as *jeruju* crackers which reached IDR5,000/pack, equivalent to IDR50,000/kg or 3.33 USD/kg (Basyuni et al. 2021). In addition, the production of *lindur* biscuits is also more complicated, due to the difficulty of obtaining *Lindur* fruit and the length of time it takes to process *Lindur* fruit into flour. Meanwhile, market socialization and education will be continued by tourist attraction managers, increasing visitors' willingness to purchase *lindur* biscuits at higher prices.

Biscuit processing from mangroves is a very good

Table 4. Correlation test results of visitor age and willingness to buy

Correlations			
		Visitor Age	Willingness to Buy
Visitor Age	Pearson Correlation	1	0.049
	Sig. (2-tailed)		0.668
	N	80	80
Willingness to Buy	Pearson Correlation	0.049	1
	Sig. (2-tailed)	0.668	
	N	80	80

Table 5. Correlation test results of visitors' education level and willingness to buy.

Correlations			
		Visitor education level	Willingness to Buy
Visitor education level	Pearson Correlation	1	0.001
	Sig. (2-tailed)		0.992
	N	80	80
Willingness to Buy	Pearson Correlation	0.001	1
	Sig. (2-tailed)	0.992	
	N	80	80

Table 6. Correlation test results of visitor work and purchase intentions.

Correlations			
		Visitor jobs	Willingness to Buy
Visitor jobs	Pearson Correlation	1	-0.011
	Sig. (2-tailed)		0.920
	N	80	80
Willingness to Buy	Pearson Correlation	-0.011	1
	Sig. (2-tailed)	0.920	
	N	80	80

effort to add value to the plants. This species of *Bruguiera* sp is also rich in important minerals such as calcium, iron, and magnesium from Rout (2022) and can help provide adequate nutrition for the community. The addition of culinary products made from mangroves in tourism objects can increase the income of people. Other forms of tourism package development based on the manufacture can also be developed by offering environmental tour packages and culinary education. This will be even better when it is supported by social capital in the form of a group of women fishermen who are already solid, organized, and active in managing resources with natural tourism activities (Matsue et al., 2014). The increasing economic benefits of the

mangrove ecosystem allow the community to maintain the preservation of mangrove forests in tourist sites.

4. Conclusion

Lindur fruit can be processed into biscuits, where every 1 kg can produce 310 g of flour, while other ingredients can produce 750 g of biscuits. The organoleptic test on the resulting biscuits on aspects of color, aroma, and taste produced scores consecutively like (score of 3.98), quite like (score of 3.07), and like (score of 4.02). The sweet taste variant obtained from adding sugar had the highest score of 4.46 (between like and very like). Friedman's test shows that in all aspects (color, aroma, and taste), the highest consumer preference is given to biscuits with a sweet taste treatment, followed by salty and original flavors. According to the different tests, consumer preferences in the flavoring treatment differed significantly in the aroma and taste aspects but not in color. The market potential of *Lindur* biscuit products as an alternative culinary and souvenirs at the Mangrove Beach tourism object in Kampung Nipah is quite promising because 96.25% of visitors were willing to buy. About 75% of visitors are willing to buy 1 pack, while the rest are more than 1 pack at size 0.5 kg. The willingness to buy has no significant correlation with visitor characteristics on aspects of visitor age, education level, and employment. The average price based on the willingness to buy the mangrove biscuits is IDR22,662/pack of 0.5 kg or IDR45,324/kg biscuit, which is equivalent to 3 USD/kg.

Conflict of interest

The authors declare no conflict of interest.

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