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SENSORY AND CHEMICAL CHARACTERIZATION OF ENDEMIC LUMI-LUMI FISH CRACKERS (*Harpodon nehereus*) AS A LOCAL WISDOM PRODUCT

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ABSTRACT

Lumi-lumi fish (*Harpadon nehereus*) is an endemic fish commonly found in West Aceh, known for its high protein content and various minerals. Crackers are a food often consumed as a snack, a complement to dishes, or as an appetite stimulant, with a wide variety of consumers ranging from children to adults. However, the content of crackers made from tapioca is known to have a very low protein content of 0.5%. The addition of lumi-lumi fish is expected to increase the protein content of crackers. This study aims to identify the best formulation and analyse the nutritional content of Lumi-lumi fish crackers. The research method is arranged in a one-factorial Completely Randomised Design, which consists of 4 different levels of Lumi-lumi fish concentration treatment (P0: 0%, P2: 15%, P3: 20%, and P4: 25% Lumi-lumi fish)—then identified the expansion power of crackers between treatments. Next, a hedonic method sensory test was conducted to obtain the selected formulation through a scoring test. The chosen products were analysed for nutritional content in comparison to a control group, namely P0 (0% Lumi-lumi fish). Sixty untrained panellists conducted sensory testing. The results showed a significant effect on the cracker expansion power (P = 0.001), with the highest result obtained by treatment P3 at 58.54%. In the scoring test, the selected Lumi-lumi fish crackers were treatment P3. Then based on the results of nutritional content, it was found that the addition of 25% of Lumi-lumi fish meat was able to increase the nutritional content compared to the control treatment (PO), namely the ash content from 0.83 ± 0.39% to 1.36 ± 0.25%, fat content from 0.42 ± 0.08% to 5.81 ± 0.39%, protein content from 7.16 ± 0.55% to 8.58 ± 0.17% and fiber content from 1.47 ± 0.14% increased to 1.81 ± 0.21%. However, there was a decrease in carbohydrates from 90.11 ± 0.59% to 82.44 ± 0.54%. For the analysis of water content, it follows the rules of SNI 01-2713-2009. To produce Lumi-lumi fish crackers with the best organoleptic acceptance, it is recommended to use a concentration of Lumi-lumi fish of 25%.

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Introduction

West Aceh Regency has a 50.55 km coastline and a sea area of 80.88 km², boasting a diverse ecosystem and a variety of marine fish species (Rizal et al., 2018). Meulaboh City, located in the coastal area of West Aceh, is reported to have 35 species of fish, including the species with the Latin name Harpodon nehereus, commonly known as the Lumi-lumi fish (Zainuri et al., 2023).

The Nomei fish, or Lumi-lumi fish, can breed in various locations, including the seabed, mudflats, coastal areas, and estuaries, with a body length of 10 to 40 cm. Furthermore, Lumi-lumi fish are reported to reproduce year-round, making them potentially abundant (Setiawan et al., 2020). However, downstream products made from Lumi-lumi fish are not yet available in Meulaboh. Local communities typically process simple products, such as salted fish, to extend their shelf life.

Therefore, serious efforts are needed to develop innovative food products made from local Lumi-lumi fish, one of which is fish crackers. Lumi-lumi fish crackers were chosen because they exhibit good dry storage stability, possess desirable sensory properties, and are easy to prepare. Furthermore, crackers are commonly served as snacks, food accompaniments, or as appetite stimulants. Consumers are diverse, ranging from children to adults.

The innovative Lumi-lumi fish cracker also offers other nutritional advantages. According to a report by Rakhmawati et al. (2014), the low protein content of tapioca crackers is due to the low protein content of tapioca crackers, at 0.5%. It is hoped that adding Lumi-lumi fish to the cracker formulation will increase the protein content. According to previous research conducted by Safrida et al. (2022), steamed Lumi-lumi fish contains 13.32% crude protein and 7678.3 mg/mL of soluble protein that the body can absorb. Therefore, the results of this study offer a novel innovation in the form of a local snack typical of West Aceh, namely Lumi-lumi fish crackers, which are rich in protein.

Based on the background stated above, the research problem formulation in this study is how the addition of Lumi-lumi fish affects the sensory acceptability and nutritional content of Lumi-lumi fish crackers.

Method

Research Tools and Materials

The tools used to manufacture Lumi-lumi fish crackers include a scale, steamer, chopper (Philips), aluminium foil, cutter, and oven. Tools for chemical analysis of nutritional content include a scale (Radwag), Soxhlet apparatus, furnace (Furnace Carbolite, AAF11/3/21-201975), oven (Memmert), and Kjeldahl protein analyser (Memmert).

The main ingredients in this study were fresh Lumi-lumi fish obtained from the Bina Usaha Meulaboh Market. Additional ingredients included tapioca (Rose Brand), chicken egg white, ground shallots and garlic, ground pepper (Ladaku), salt (Jangkar), granulated sugar, water, and cooking oil (Sunco). The chemicals used included distilled water, concentrated H_2SO_4, HgO, NaOH, alcohol, hexane, K_2SO_4 , 0.02 N HCl, $CuSO_4$, K_2S, and petroleum ether to analyse the nutritional content of Lumi-lumi fish crackers.

Research Stages

This study employed a completely randomised design with one factor, namely Lumi-lumi fish concentration, consisting of four treatment levels: 0% Lumi-lumi fish (P0), 15% Lumi-lumi fish (P1), 20% Lumi-lumi fish (P2), and 25% Lumi-lumi fish (P3). This study encompassed the preparation of raw materials and the production of Lumi-lumi fish crackers.

Preparation of Cracker Ingredients

The main ingredient in this study was fresh Lumi-lumi fish obtained from the Bina Usaha Market in Meulaboh. Additional ingredients included tapioca (Rose Brand), chicken egg white, ground shallots and garlic, ground pepper (Ladaku), salt (Jangkar), granulated sugar, water, and cooking oil (Sunco).

Making Lumi-lumi fish crackers

Mixed tapioca and finely ground Lumi-lumi fish meat (according to the treatment), and add other supporting ingredients such as egg white, shallots, garlic, salt, sugar, ground pepper, and water. Stir until smooth. Pour the mixture into a 7x15cm aluminium foil mould, steam for 45 minutes, and then let it sit overnight (dry for 14 hours at 15°C in the refrigerator). After 14 hours, slice the dough into slices that are 2-3 mm thick. Dry the dough for 8 hours at 70°C, then fry the raw crackers until cooked through.

Data analysis

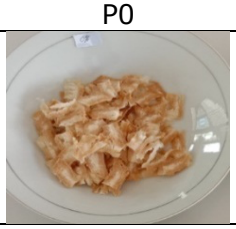
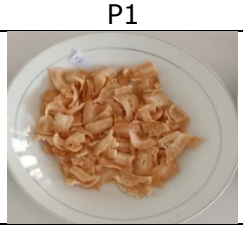
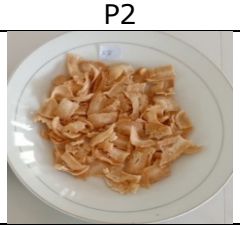
The analysis data were processed using Microsoft Excel 2010 and SPSS 22.0 (Chicago, IL, USA). Sensory test data were analysed using the Kruskal-Wallis test. Then, the data on the results of the cracker swelling power and proximate analysis were analysed using the One-Way ANOVA test, followed by Duncan's Multiple Range Test (DMRT) at a 5% significance level.

Measurement Methods

The measurement methods used in this study were sensory analysis, Cracker Expansion Power analysis, and proximate analysis. The sensory analysis used a hedonic test that adhered to the requirements of SNI 01-2346-2006. The test involved 60 untrained panellists. The criteria included being an adult (17-55 years), good health, no tuna fish allergies, understanding the main characteristics of cracker products, and willingness to provide written responses. The cracker expansion power test is referred to in Kusumaningrum (2009). Proximate analysis included moisture, ash, fat, protein, and fiber content using the AOAC method (2005). Determination of carbohydrate levels using the by-difference method referred to in Kusumaningrum AOAC (2016).

Results

In the study, a product formulation design was carried out, consisting of four treatments: P0 (0% Lumi-lumi fish), P1 (15% Lumi-lumi fish), P2 (20% Lumi-lumi fish), and P3 (25% Lumi-lumi fish). The results of the product formulation are presented in Figure 1.

	P0	P1	P2	P3
A				

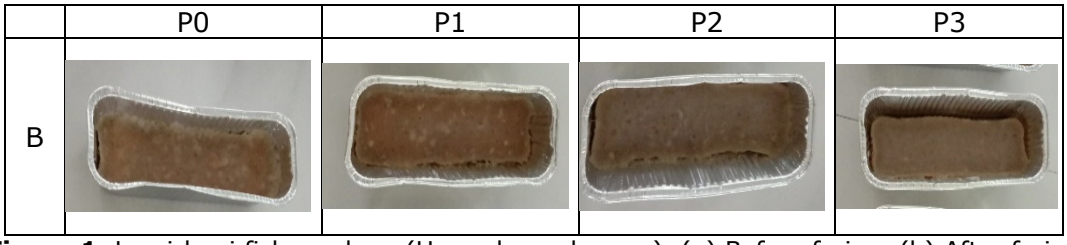


Figure 1. Lumi-lumi fish crackers (Harpodon nehereus). (a) Before frying. (b) After frying

The results of the cracker expansion ratio of Lumi-lumi fish can be seen in Table 1 below :

Table 1. Cracker expansion ratio of Lumi-lumi fish (*Harpodon nehereus*)

Treatments	Cracker Expansion Ratio (%)	P value
P0	32,01 ± 1,16[a]	
P1	45,88 ± 9,44[b]	0,001
P2	56,90 ± 3,20[c]	
P3	58,54 ± 1,68[c]	

Data were presented as mean ± standard deviation. Numbers accompanied by different letters in the same column indicate a significant difference of α0.05.

The hedonic test score of Lumi-lumi(Harpodon Nehereus) fish crackers is presented in Table 2. Then the results of the scoring test are presented in Figure 2. The scoring test aims to identify the selected product formulation.

Table 2. Hedonic test score of Lumi-lumi (*Harpodon nehereus*) Fish Cracker

Category	Treatments			
	P0	P1	P2	P3
Color	3.27 ± 0.78[a]	3,33 ± 0,80[a]	3,58 ± 0,67[b]	3,48 ± 0,81[b]
Aroma	3,43 ± 0,81[a]	3,23 ± 1,03[a]	3,33 ± 0,86[a]	3,60 ± 0,96[a]
Taste	3,33 ± 0,88[a]	3,13 ± 1,03[a]	3,70 ± 0,85[b]	3,73 ± 0,90[b]
Texture	3,28 ± 0,90[a]	3,52 ± 0,83[a]	3,80 ± 0,86[b]	3,90 ± 0,82[b]
Overall	3,43 ± 0,77[a]	3,38 ± 0,74[a]	3,78 ± 0,72[b]	4,03 ± 0,88[c]

Data were presented as mean ± standard deviation. Numbers accompanied by different letters in the same row indicate a significant difference of α0.05.

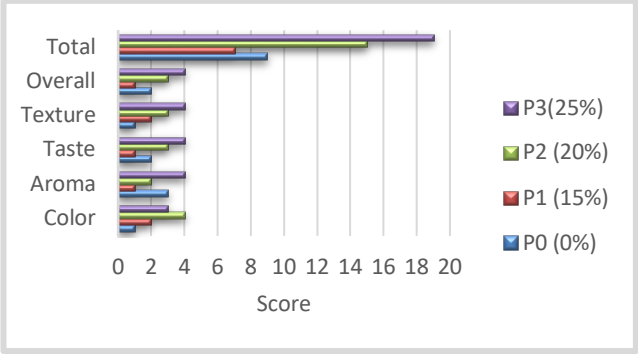


Figure 2. Sensory Characteristic Scores of Lumi-lumi Fish Crackers

Based on the scoring evaluation results, the highest score was obtained in the P3 treatment, which used a 25% concentration of Lumi-lumi fish (Fig. 2). Subsequently, a proximate analysis was conducted to assess the nutritional content of the P3 treatment, with the P0 treatment (0% Lumi-lumi fish) serving as the control. The results are presented in Table 3.

Table 3. Proximate composition of Lumi-lumi (*Harpodon nehereus*) fish crackers

Parameters (%)	Treatments	
	P0	P3
Moisture	7,31 ± 0,27[b]	5,66 ± 0,27[a]
Ash	0,83 ±0,40[a]	1,36 ± 0,25[a]
Lipid	0,42 ± 0,08[a]	5,81 ± 0,39[b]
Protein	7,16 ± 0,55[a]	8,58 ± 0,17[b]
Fiber	1,47 ± 0,15[a]	1,81 ± 0,21[a]
Carbohydrate	90,11 ± 0,60[b]	82,44 ± 0,54[a]

Data were presented as mean ± standard deviation. Numbers accompanied by different letters in the same row indicate a significant difference of α0.05.

Discussion

Cracker Expansion Ratio of Lumi-lumi Fish

The cracker expansion ratio of Lumi-lumi of this study showed that the highest expansion ratio was obtained in treatment P3 (25% Lumi-lumi fish), at 58.54 ± 1.68%, followed by P2 (20% Lumi-lumi fish), at 56.90 ± 3.20% (Table 1). Statistical tests showed no significant difference between the two treatments ($p>0.05$). Meanwhile, the lowest expansion power was achieved in P0 (0% Lumi-lumi fish), at 32.01 ± 1.16%, followed by P1 (15% Lumi-lumi fish) at 45.88 ± 9.44%. However, the statistical test results showed a significant difference between the two treatments ($p<0.05$). According to Nursholeh et al. (2022), this was due to the water content bound in the cavities of the Lumi-lumi fish crackers, resulting in higher expansion power in treatments P3 and P2 than in treatments P0 and P1.

Hedonic Test Score of Lumi-Lumi Fish Crackers

1. Organoleptic Color

The results of the color sensory test presented in Table 2 show that treatment P2 had the highest average value, at 3.58 ± 0.67% (fairly liked), followed by treatment P3 at 3.48 ± 0.81% (fairly liked). However, statistical tests for both treatments (P2 and P3) showed no significant difference ($p>0.05$). Meanwhile, treatment P0 (3.27 ± 0.78%) had the lowest organoleptic color acceptance, followed by treatment P1 (3.33 ± 0.80%), with no statistical difference between the two treatments

(p>0.05). The low color sensory acceptance in treatments P0 and P1 is suspected to be due to differences in the composition of fish and tapioca. Huda et al., (2009), in a study by Zzaman et al. (2017), found that the higher the amount of fish added to the cracker dough, the lower the L (Lightness) value because the fish has its own color pigment. This is demonstrated by the product results presented in Figure 1, where treatment P1 showed a darker color than P0 (without the addition of fish).

2. Organoleptic Aroma

The results of the sensory test for aroma attributes presented in Table 2 showed the highest average value for treatment P3 at 3.60 ± 0.96% (fairly liked), followed by treatment P0 at 3.43 ± 0.81% (fairly liked). Meanwhile, treatment P1 had the lowest organoleptic aroma acceptance at 3.23 ± 1.03% (fairly liked), followed by treatment P2 at 3.33 ± 0.86% (fairly liked). However, the statistical test results for the four treatments (P0, P1, P2, and P3) showed no significant difference (p>0.05). This is suspected to be because of the volatile content of the spices added to the fish cracker mixture. This is supported by Apriliani's (2014) statement that people utilize spices such as garlic, which contains allicin, a biosynthetic product as an essential oil called allinase in shallots, and the essential oil content containing piperine compounds in pepper plays a role in aroma and taste. The aroma of Lumi-lumi fish cracker products is also influenced by the addition of fish meat concentration. According to Natalia et al. (2019), fish meat has a distinctive aroma resulting from the breakdown of protein in fish into amino acids, especially glutamic acid, which then gives fish crackers a delicious taste and aroma.

3. Taste Organoleptic

The sensory test results for taste attributes showed the highest average value for treatment P3 at 3.73 ± 0.90% (fairly liked), followed by treatment P2 at 3.70 ± 0.85% (fairly liked), but statistically there was no significant difference between the two (p>0.05) (Table 2). Meanwhile, the lowest taste organoleptic acceptance was for treatment P1 at 3.13 ± 1.03% (fairly liked), followed by treatment P0 at 3.33 ± 0.88% (fairly liked), with statistically no significant difference between the two (p>0.05). Based on the taste organoleptic results, it is suspected that the lower concentration of fish meat used in treatment P1 reduced the deliciousness of the crackers. The same was true for treatment P0 without the addition of fish meat. According to Fauzi et al. (2022), the protein content in fish breaks down into amino acids, especially glutamic acid, which gives crackers their umami flavor.

4. Organoleptic Texture

The results of the sensory test for texture attributes can be seen in Table 2, which shows that treatment P3 had the highest average value, at 3.90 ± 0.82% (liked), followed by P2 at 3.80 ± 0.86% (liked). However, statistical tests showed no significant difference between the two treatments (P3 and P2). The lowest organoleptic texture acceptance was achieved by treatment P0 (3.28 ± 0.90%), followed by P1 (3.52 ± 0.83%) (quite liked), with statistical tests showing no significant difference between the two treatments (p>0.05).

The high and low organoleptic textures in the four treatments (P0, P1, P2, and P3) are likely due to differences in the tapioca composition added to the cracker dough. Yunita and Silitonga (2014) reported that tapioca has the ability to absorb 2-3 times its original weight in water, resulting in an increase in water content. High water content can reduce the texture of the product.

Scoring

A scoring test was conducted to determine the selected products, which were then analyzed for nutritional content using a control group, P0. The results of the scoring test can be seen in Fig. 2. The highest score was obtained from treatment P3, with a score of 19, followed by treatment P2, with a score of 15. The lowest score was obtained from treatment P1, with a score of 7, followed by treatment P0, with a score of 9.

Proximate Composition of Lumi-Lumi Fish Crackers

Proximate composition of Lumi-lumi (*Harpodon nehereus*) fish crackers were presented in Table 3. The results of the water content analysis showed that the lowest water content was obtained from P3, at 5.66 ± 0.27%. Meanwhile, the highest water content was obtained from P0, at 7.31 ± 0.27. The statistical test showed a significant difference between the two groups (p<0.05). The high tapioca content is thought to have increased the water content of Lumi-lumi crackers. This is consistent with Yunita and Silitonga's (2014) statement that tapioca is known as a water binder due to its ability to retain water during processing and heating. Tapioca can absorb two to three times its original weight.

The highest ash content in the lumi-lumi fish crackers was found in treatment P3, at 1.36 ± 0.25, and the lowest ash content was found in treatment P0, at 0.83 ± 0.39%. However, the statistical test results for the two were not significantly different (p>0.05). The average ash content in this study was lower than that of the catfish crackers in the study by Zulisyanto et al. (2016), at 1.66 ± 0.22. The ash content obtained in this study was higher than the SNI 01-2713-2009 guideline, which states a maximum ash content of 0.2%. The increase in ash content in the lumi-lumi fish crackers treated with P3 was due to the addition of fish meat.

The highest fat content in the lumi-lumi fish cracker study was P3, at 5.81 ± 0.39%, and the lowest fat content was P0, at 0.42 ± 0.08%. The statistical test results for both were significantly different (p<0.05). The low-fat content in P0 (without fish) is thought to be due to the low-fat content of tapioca.

The highest fiber content in the lumi-lumi fish crackers was P3, at 1.81 ± 0.21%, and the lowest fiber content was P0, at 1.47 ± 0.15%. However, the statistical test results for both were not significantly different (p>0.05). The fiber content results in this

study did not comply with the SNI 01-2713-1999 guidelines, which stipulate a maximum of 1% fiber content.

Lumi-lumi fish crackers with the highest carbohydrate content were treatment P0, namely, 90.11 ± 0.60% and the lowest treatment was P3, namely, 82.44 ± 0.54%. The high carbohydrate content in treatment P0 is thought to be due to the use of a higher percentage of tapioca, tapioca is reported to contain 86.9% carbohydrates per 100 grams (Natalia 2019). The high carbohydrate content will significantly influence the determination of the reduction in nutritional content such as protein, fat, water, and ash (Sufiat et al., 2022).

Conclusion

Treatment P3 (25% lumi-lumi fish) had the best formulation of lumi-lumi fish crackers and received the highest score of 19 for aroma, taste, and texture in the organoleptic test. Furthermore, treatment P3 had the highest expansion power test (58.54 ± 1.68), followed by P2 (20%) at 56.90 ± 3.20, and P0 (0%) at 32.01 ± 1.16. P3's nutritional content was significantly higher than that of the control (P0), specifically in the following areas: protein (8.58 ± 0.17 vs 7.16 ± 0.55), fat (5.81 ± 0.39 vs 0.42 ± 0.08), ash (1.36 ± 0.25 vs 0.83 ± 0.39), and crude fiber (1.81 ± 0.21 vs 1.47 ± 0.14). Meanwhile, moisture and carbohydrate content decreased in P3, such as carbohydrate (82.44 ± 0.54 vs 90.11 ± 0.59) and moisture (5,66 ± 0,27 vs 7.31 ± 0.27). Indicating that the addition of lumi-lumi fish tends to increase nutritional value and improve the sensory quality of the product. With its relatively high protein content and consumer-favored characteristics, P3 lumi-lumi fish crackers have the potential to become a local snack typical of West Aceh with economic value and can be developed on a home-based scale. A 25% concentration of lumi-lumi fish is advised to produce crackers with the highest nutritional value and acceptability. To determine the shelf life of lumi-lumi fish crackers for wider commercialization, more research is required.

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