

INNOVATION MACARONI PASTA OF BASED LUMI-LUMI FISH- ENDEMIC AND EFFECT OF BOILING METHOD PROCESS ON NUTRITIONAL CONTENT

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ABSTRACT

Meulaboh is located in the western part of Sumatra Island, West Aceh Regency, Aceh Province. Coastal areas in the Meulaboh have an endemic type of fish, lumi-lumi (*Harpodon nehereus*), which is known to contain various micronutrients and proteins. The study aimed to identify the best macaroni formulation based on good sensory acceptability, micronutrient content, nutritional value, and protein. The treatment used was a different concentration of Lumi-lumi fish meat on macaroni dough, namely: P1(15%), P2(20%), and P3(25%). The best macaroni formulation was determined using scoring analysis based on sensory parameters. The participants consisted of 30 untrained panelists. Then the best products were tested for changes in nutritional content, soluble protein, and minerals, before and after boiling for 15 minutes using a paired t-test with alpha 5%. The study showed that the selected formulation was P1(15%), with the highest total score of 18. The results show the boiling process significantly increases the moisture, ash, and fat content, namely 71.70%, 1.67%, and 4.73%, respectively on the P1 (15%) product. Meanwhile, it reduces the crude protein, fiber, carbohydrate, and soluble protein content by 8.41%, 1.63%, 11.86%, and 16.8 ug/L. Then, it also reduces a number of minerals, namely calcium, magnesium, copper, zinc, and selenium. In conclusion, the macaroni formulation P1 is better based on consumer acceptance with color value 4.71 (slightly-liked), aroma 4.28 (indifferent), taste 4.21 (indifferent), hardness 4.71 (slightly-liked), elasticity 4.82 (slightly-liked), and overall acceptance 4.51 (slightly-liked).

Kata kunci: *Harpodon nehereus*, Lumi-lumi, Macaroni, Nutrition, Sensory

Meulaboh terletak di sebelah Barat Laut Pulau Sumatra, Kabupaten Aceh Barat, Provinsi Aceh. Perairan di wilayah meulaboh memiliki jenis ikan endemik lumi-lumi (*Harpodon nehereus*) yang diketahui mengandung berbagai mikronutrien dan protein. Tujuan penelitian yaitu mengidentifikasi formulasi makaroni terbaik berdasarkan daya terima sensori yang baik, dengan kandungan mikronutrien, nilai gizi, dan protein. Perlakuan penelitian yaitu konsentrasi daging ikan Lumi-lumi yang berbeda pada adonan makaroni meliputi: P1(15%), P2(20%), dan P3(25%). Formulasi makaroni terbaik ditentukan dengan analisis skoring berdasarkan parameter sensori. Peserta terdiri dari 30 panelis tidak terlatih. Kemudian produk terbaik diuji perubahan kandungan gizi, protein terlarut, dan mineral, sebelum dan setelah perebusan selama 15 menit menggunakan uji t berpasangan alpha 5%. Hasil penelitian menunjukkan formulasi terbaik adalah P1(15%) dengan total skoring tertinggi yaitu 18 skor. Kemudian proses perebusan meningkatkan kadar air, abu, dan lemak secara signifikan yaitu masing-masing sebesar 71,70%, 1,67%, dan 4,73% pada produk P1 (15%). Sementara proses perebusan menurunkan kandungan protein kasar, serat, karbohidrat, dan protein larut sebesar 8,41%, 1,63%, 11,86%, dan 16,8 ug/L. Kemudian, juga mengurangi sejumlah mineral yaitu kalsium, magnesium, tembaga, seng, dan selenium. Kesimpulannya formulasi makaroni P1 lebih baik berdasarkan penerimaan konsumen dengan nilai warna 4.71 (agak-suka), aroma 4.28 (normal), rasa 4.21 (normal), kekerasan 4.71 (agak-suka), kekenyalan 4.82 (agak-suka), dan penerimaan keseluruhan 4.51 (agak-suka).

Kata kunci: *Harpodon nehereus*, Lumi-lumi, Makaroni, Nutrisi, Sensori

INTRODUCTION

Lumi-lumi (*Harpodon nehereus*) or known as Bombay duck fish is a type of demersal fish that specifically breeds in the waters of western Aceh, especially the city of Meulaboh. The abundant availability of Lumi-lumi makes Lumi-lumi as characteristic of the Meulaboh city, although production data on fishing has yet to be available in Aceh. Lumi-Lumi is reported to be able to reproduce throughout

the year and can live well in mud, beaches, and river estuaries (Nugroho and Rahayu, 2011), which means that their potential availability is quite large.

Coastal communities use Lumi-lumi as traditional food or preserve it through dry salting techniques. The reason is that Lumi-lumi often doesn't sell well in the market even though the price is relatively low. Lumi-lumi has a soft texture and fishy smell, and the water content is relatively high, reaching 90%, making Lumi-lumi fish less attractive.

MATERIAL AND METHODS

Material

The research material was lumi-lumi fish (*Harpadon nehereus*) obtained from the primary market, Meulaboh, West Aceh. Other raw materials are wheat flour (Cakra Kembar), salt (Dolphin), shallots, garlic, pepper (Ladaku), and eggs. Then, chemicals are used to analyze mineral content, nutritional value, and soluble protein. The tools used include a pasta machine (Oxone, OX 356, Indonesia), scales (Radwag), oven (Memmert), Kjeldahl (Memmert), furnace (Furnace Carbolite, AAF11/3/21-201975), Spectrophotometer (Shimadzu), and Atomic Absorption Spectrophotometry (Thermo Fisher Scientific).

Methods

This study was conducted in four locations: The Culinary Laboratory, Public Health Faculty, Universitas Teuku Umar; the Analysis of Food and Agricultural Products Laboratory, Faculty of Agriculture, Universitas Syiah Kuala; the Instrumentation and Research Laboratory, Faculty of Mathematics and Natural Sciences, Universitas Syiah Kuala; and Saraswanti Indo Genetech Laboratory, Bogor, from November 2021 to January 2022. Table 1 describes the recipe formulations of macaroni with fish meat lumi-lumi

Table 1. Recipe Formulation of macaroni with fish meat lumi-lumi (*Harpadon nehereus*)

| Ingredients | Treatments | | |
|---------------------|------------|----------|----------|
| | P1 (15%) | P2 (20%) | P3 (25%) |
| Wheat flour (g) | 425 | 400 | 375 |
| Meat Fish (g) | 75 | 100 | 125 |
| Egg (mL) | 45 | 38 | 33 |
| Garlic puree (g) | 15 | 15 | 15 |
| Shallot puree (g) | 15 | 15 | 15 |
| Salt (g) | 5 | 5 | 5 |
| White pepper (g) | 1.5 | 1.5 | 1.5 |
| Carrot extract (mL) | 29 | 29 | 29 |

Sensory Analysis

Sensory analysis used a hedonic test on a scale of 1-7, referring to the method of Kusumawati, *et. al.*, (2022) with value scores of 1= strongly disliked, 2 =moderately disliked, 3= slightly disliked, 4= indifferent, 5= slightly liked, 6= moderately liked, 7= Strongly liked—the test parameters namely color, aroma, taste, hardness, elasticity, and overall acceptance. The number of panelists consisted of 30 untrained panelists.

Scoring Analysis

The scoring analysis aimed to identify the best macaroni product of three formulations. Scoring was determined: the higher the score, namely 3, the higher the value of the macaroni product. The scoring assessment was based on cooking quality tests and sensory tests. The scoring method refers to Kusumawati, *et. al.*, (2022). The selected products were then identified for their nutritional content and the effect of boiling treatment on the nutritional content of Lumi-lumi macaroni was identified.

Proximate Analysis

Testing the nutritional value of fish includes proximate tests, including tests for moisture, ash, fat, protein, and fiber content using the AOAC method (2005). Determination of carbohydrate levels using the by-difference method.

Soluble Protein Analysis

Soluble protein analysis uses the Lowry method, which refers to the procedure of Safrida *et. al.*, (2023); the determination of soluble protein consists of preparing a standard solution, Lowry A reagent, and Lowry B reagent.

Mineral Analysis

Determination of the mineral Se content used the ICP-MS method, while the minerals Ca, Mg, Cu, Fe, and Zn followed the AOAC (2005) procedure, starting with wet ashing. A sample of 1 g was added with 10 mL of HNO and 3 mL of 60% HClO₄, then heated slowly over the digestion apparatus until the solution turned clear and the foam that formed stopped. If the solution is black, continue heating and add another 10 mL of HNO₃. Next, filter with Whatman no. 1 and add up to 50 mL. An Atomic Absorption Spectrophotometer (AAS) analyzed the filtrate for minerals.

Data Analysis

Data were processed using SPSS 22.0 software (Chicago, IL, USA). Analysis of cooking quality and sensory tests used the one-way ANOVA test followed by the Duncan Multiple Range Test (DMRT) at a significance level of 5%. It then tested the nutritional content, soluble protein, and minerals using a paired t-test with an alpha of 5% to identify the effect of cooking treatment on selected raw macaroni.

RESULT AND DISCUSSION

The analysis results of variance in assessing the taste of macaroni, the more Lumi-lumi fish was added, the more its acceptance color decreased (Table 2). The macaroni color values for each treatment, P1, and P2, were 4.71 and 4.69, meaning somewhat liked, and P3 obtained 3.38, namely somewhat disliked.

The significant decrease in treatment P1 to P3 ($P < 0.05$) and P2 to P3 ($P < 0.05$) was allegedly because the calcium content in Lumi-lumi fish affected the color of the product produced. This statement is strengthened by Fitriani (2018), who states that the high calcium content in fish causes a color change in the solution, namely a cloudy color. As a result, the color appearance of the food product produced is darker. The color of Lumi-lumi fish macaroni paste can be seen in Figure 1.

In Figure 1, the P3 formulation with the addition of 25% fish has a darker color than others. The previous studies showed that the calcium content in Lumi-lumi fish was 517.2 mg/100 g (Safrida, *et. al.*, 2023). The decrease in color assessment was also followed by a reduction in the aroma and taste of macaroni, along with adding Lumi-lumi fish.



Figure 1. Raw Macaroni. Fish Meat Composition (P1) 15%; (P2) 20% ; (P3) 25%

The aroma of macaroni in P3 was significantly ($P < 0.05$) lower than P2 and P1, namely 3.74, 4.23, and 4.28, respectively, as well as the taste assessment, namely P3 was significantly ($P < 0.05$) lower than P2, and P1 is 3.91, 4.14, and 4.21 respectively (Table 2). However, the amount of fish added to the three product treatments was still acceptable to the panelists. The decrease in the assessment of aroma and taste preferences in the P3 treatment was thought to be because Lumi-lumi fish had a fishy aroma, thus affecting the sensory taste of the product. According to Fitriani's statement (2018), adding fish meat to pasta products can affect the decreased acceptance of the product's aroma, color, and taste.

Regarding the hardness value, there was a decrease in favorable acceptance, along with the addition of lumi-lumi fish. Macaroni in treatment P3 produced a significantly ($P < 0.05$) lower preference for hardness than treatment P1. The decline in acceptance is likely due to the texture of the macaroni being somewhat fragile after the cooking process. The same research was also reported by Nawaz, *et al.*, (2020), along with the increase in the addition of fish meat to noodle formulations, which decreased product hardness. Then, a decrease in the rugged texture of the product due to the addition of increased fish meat was also reported by Nawaz, *et al.*, (2019).

Table 2. Hedonic test score result of Fish Lumi-lumi Macaroni

| Category | Treatments | | |
|--------------------|-------------------------|--------------------------|-------------------------|
| | P1 | P2 | P3 |
| Color | 4.71 ^b ±1.05 | 4.69 ^b ±1.53 | 3.38 ^a ±1.41 |
| Aroma | 4.28 ^b ±1.24 | 4.23 ^b ±1.41 | 3.74 ^a ±1.51 |
| Taste | 4.21 ^a ±1.29 | 4.14 ^a ±1.39 | 3.91 ^a ±1.40 |
| Hardness | 4.71 ^c ±1.26 | 4.40 ^{ab} ±1.53 | 4.12 ^a ±1.53 |
| Elasticity | 4.82 ^c ±1.28 | 4.36 ^b ±1.34 | 3.94 ^a ±1.31 |
| Overall acceptance | 4.51 ^b ±1.09 | 4.27 ^b ±1.45 | 3.79 ^a ±1.34 |

All data were presented as mean ± standard deviation. n = 3 (triplo). Different superscripts on the same column and row showed a significant difference at the 5% test level.

The hardness level depends on the integrity of the matrix formed by gluten protein during cooking (Larrosa, *et al.*, 2016). Components such as lipids, fats, and other added ingredients affect the formation of a weak dough structure; in this case, the decrease in hardness is associated with the components resulting from adding fish. Fish contains lipids as well as myofibril proteins, which can disrupt the matrix formed by starch and gluten (Kowalczewski, *et al.*, 2019; Ainsa, *et al.*, 2021), which causes a decrease in the hardness level of macaroni as the increased addition of 20% and 25% fish compositions.

The decrease in preference for hardness due to the addition of fish also impacted the preference value for elasticity. Macaroni made with 15% fish (P1) was slightly preferred compared to other treatments with a statistically significant test ($P < 0.05$) higher than treatments P2 and P3. It is likely because the macaroni texture in formulations P2 and P3 is more fragile, causing a reduction in elasticity. Therefore, the overall acceptance of P1 treatment is higher than other treatments.

Scoring of Lumi-lumi macaroni

The selection of macaroni products was based on the highest total score of the sensory parameters of the hedonic method of three formulations. The score is determined from 1-3; the higher the score (3), the macaroni product gets a higher or better score on that parameter. Scores based on the macaroni's sensory characteristics are presented in Figure 2. Based on the scoring test in Figure 2, macaroni, with a fish percentage of 15% (P1), has a total score value higher than other treatments, namely 18 scoring parameters for sensory characteristics of macaroni. Thus, the selected macaroni product was treatment P1.

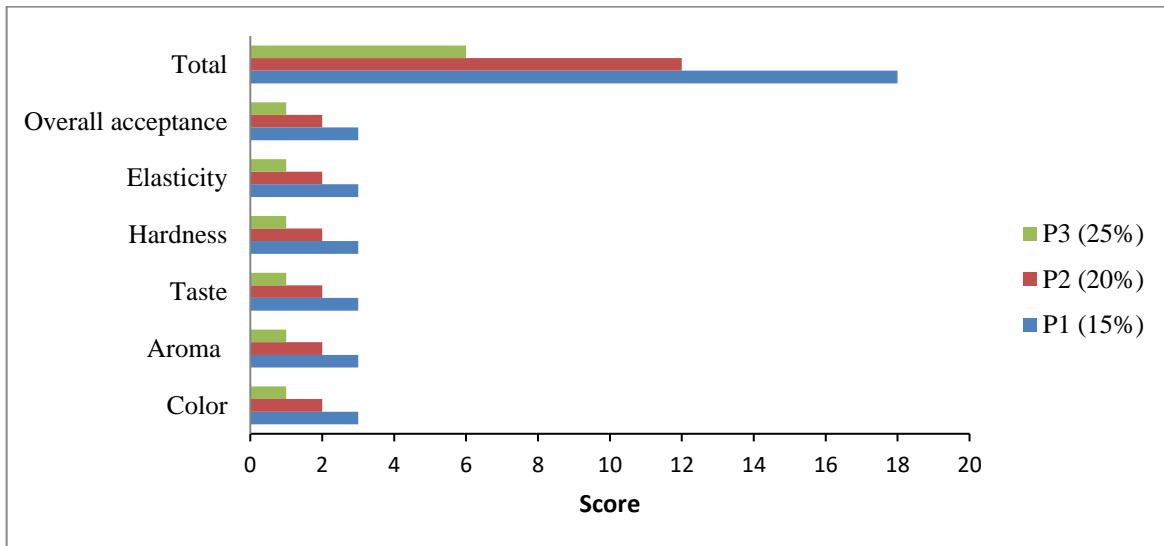


Figure 2. Macaroni sensory characteristics scores

Proximate Composition and Soluble Protein of Selected Macaroni

The proximate composition and soluble protein content of raw and cooked selected macaroni are presented in Table 3. The results show that the boiling method significantly influences the macaroni's proximate composition of moisture, ash, fat, fiber, and carbohydrates. The increased moisture of cooked macaroni significantly, namely 71.70 ± 3.10 , was suspected during the boiling process; the hydroxyl groups in the starch granules absorb and trap the water, so it cannot move freely (Sumardana, *et. al.*, 2017). Apart from that, macaroni's protein and fiber content also affect the ability to absorb water (Patty, *et. al.*, 2023). The results of the moisture of raw (dry) macaroni showed that the product meets the requirements of SNI 01-3777-1995, namely not exceeding a maximum moisture of 12.5%.

Table 3. Proximate Composition and Soluble Protein of Macaroni

| | Raw | Cooked |
|------------------------|--------------------|--------------------|
| Moisture (%) | 1.75 ± 1.14^a | 71.70 ± 3.10^b |
| Ash (%) | 0.12 ± 0.02^a | 1.67 ± 0.35^b |
| Lipid (%) | 1.01 ± 0.37^a | 4.73 ± 0.41^b |
| Protein (%) | 11.60 ± 0.50^a | 8.41 ± 0.50^a |
| Fiber (%) | 3.07 ± 0.44^b | 1.63 ± 0.14^a |
| Carbohydrate (%) | 82.45 ± 1.36^b | 11.86 ± 3.79^a |
| Soluble Protein (ug/L) | 23.01 ± 3.24^a | 16.8 ± 2.51^a |

All data were presented as mean \pm standard deviation. n = 3 (triplo). Different superscripts on the same column and row showed a significant difference at the 5% test level.

In the ash and fat analysis results, boiling the Lumi-lumi macaroni for 15 minutes increased the ash and fat content significantly, 1.67% and 4.73%, respectively. These changes were similar to those reported by Tenyang, *et. al.*, (2022), *Polypterus bichir bichir* fish cooked by boiling causes an increase in ash and lipid levels of up to 16% and 28%. According to Ardiansyah (2018), the increase in ash content is due to stable water bonds in macaroni products and reduced water loss during cooking, so the percentage of ash content is more significant than that.

In the results of crude protein analysis, the boiling process caused an insignificant decrease in protein content from 11.6% of raw macaroni to 8.41% of cooked macaroni. The same thing was also reported by several other researchers (Tukura, *et. al.*, 2017; Tan, *et. al.*, 2018). This decrease is due to the separation of water-soluble nitrogen compounds during the boiling process (Syukri, *et. al.*, 2022). Sarcoplasmic proteins, especially myogenic in fish muscle, are water-soluble, making it possible for the protein to degrade during boiling (Gultom, *et. al.*, 2015). These results are also linear with the results obtained for the dissolved protein content; boiling macaroni can reduce protein by 6.21 ug/mL. The decrease in protein is thought to be due to protein denaturation during processing. The decrease in protein

during boiling was also found by Ciptawati et al. (2021); there was a decrease in soluble protein content in the processing of boiled catfish by 99.58 mg/L.

The research results also showed a significant decrease in the crude fiber content of boiled macaroni, namely from 3.07% raw macaroni to 1.63% cooked macaroni. The decrease in crude fiber content is due to the dissolution of water-soluble fractions, such as oligosaccharides, starch gelatinization, and dietary fiber fractions (Sobota and Zarzycki, 2012). Meanwhile, the low carbohydrate content in cooked macaroni is 11.86% due to the high water content during the boiling process.

Mineral in Selected Lumi-lumi Macaroni

The decrease in macro and micro mineral content presented in Table 4 was thought to be caused by some of the minerals being carried away with the water vapor that comes out during the macaroni boiling process. It was reinforced by the statement of Syukri et al. (2022) that during the boiling process, the mineral particles that bind the water were broken. Then, the minerals were carried away with the water vapor calcium minerals. In addition, several minerals such as magnesium, zinc, copper, and selenium are also reported to decrease during the boiling process (Lewu, *et. al.*, 2010; Karimian-Khosroshahi, *et. al.*, 2016; Vicente-Zurdo, *et. al.*, 2019). It is why some minerals, such as calcium, magnesium, zinc, copper, and selenium, decrease during boiling.

Table 4. Macro and Micro Mineral Content of Lumi-lumi Fish Macaroni

| Mikronutrien | Raw macaroni | Cooked macaroni |
|-------------------------------|-------------------------|-------------------------|
| Macro minerals (mg/Kg) | | |
| Calcium (Ca) | 46.45±5.17 ^a | 42.34±3.25 ^a |
| Magnesium (Mg) | 48.68±2.91 ^b | 30.27±4.71 ^a |
| Micro minerals (mg/Kg) | | |
| Iron (Fe) | 0.81±0.14 ^a | 0.83±0.25 ^a |
| Copper (Cu) | 0.29±0.10 ^a | 0.17±0.02 ^a |
| Zinc (Zn) | 0.41±0.00 ^b | 0.30±0.04 ^a |
| Selenium (Se) | 0.24±0.02 ^a | 0.09±0.02 ^a |

All data were presented as mean ± standard deviation. n = 3 (triplo). Different superscripts on the same column and row showed a significant difference at the 5% test level

In this study (Table 4), magnesium and zinc were the mineral content that experienced a significant decrease in cooked macaroni. Fe minerals do not decrease while boiling macaroni (cooked macaroni). It is the same thing reported by research by Karimian-Khosroshahi (2016), namely that the boiling process does not cause a loss of Fe minerals in trout.

CONCLUSION

This experimental study identified selected macaroni formulations with the addition of Lumi-lumi fish. Three macaroni formulations were tested for scoring based on sensory parameters. The highest total scoring was formulation P1. The test results of P1 formulation favored the color, aroma, taste, and the overall acceptability assessment of the product was higher. Then, in the process of boiling product P1, the water, ash and fat content increases, but reduces the amount of crude protein, fiber, soluble protein and various essential minerals, namely calcium, magnesium, copper, zinc and selenium, but does not reduce the iron mineral. For future research, it is necessary to develop macaroni formulations by adding a variety of spices to increase consumer acceptance of the product, as well as continuing to identify its nutritional content.

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