Comparative Study of Fatty Acid Composition and Sensory Acceptance of Indonesian Shortfin Eel (*Anguilla bicolor*) and Farmed Atlantic Salmon (*Salmo salar*)

Reynetha D.S. Rawendra*, Diana Lo, Ardelia Vinta Dikwatama

Food Technology Department, Faculty of Engineering, Bina Nusantara University, Jakarta, Indonesia 11480

*Corresponding author: reynetha.rawendra@binus.ac.id

Abstract. The aim of this study was to examine the fatty acid composition and sensory acceptance of Indonesian shortfin eels meat (*Anguilla bicolor*) in two consumable sizes (small and large) as compared to farmed Atlantic salmon meat (*Salmo salar*) that are commonly consumed by Indonesian consumers as a source of nutrient and omega-3. Fatty acid analysis was carried out by fat extraction and gas chromatography. Data obtained was analyzed by ANOVA. Results revealed that the highest total fat content was found in small eels (23.75 / 100 gr), followed by large eels (18.52 / 100 gr) and salmon (15.98 / 100 gr). Meanwhile, the highest total fatty acid content was found in salmon (88.07% w/w), followed by large eel (81.88% w/w) and the small eels (75.68% w/w). Saturated fatty acid (SFA) was found more abundant in eels of both sizes whereas salmon contains a higher amount of monounsaturated fatty acid (MUFA) and polyunsaturated fatty acid (PUFA). Both small eel and large eel contain 25 types of fatty acids, while salmon contains 24 types of fatty acids with heneicosanoic acid being the fatty acid absent in salmon. Sensory evaluation using hedonic scale demonstrated panelists' preferences for texture (firmness, juiciness), aroma, taste, and overall of boiled salmon were not significantly different from boiled eel. The panelists' preference for the aroma, taste, and overall of boiled eel with dipping sauce was also not significantly different from steamed salmon with dipping sauce. In conclusion, our study suggests that Indonesian shortfin eels present a commensurable if not greater fatty acid composition and palatability compared to Salmon.

1. Introduction

As the world’s largest archipelagic state, Indonesia possesses enormous opportunity in its fishery and marine resources both economically, and nutritionally. Fish products are fat-producing food ingredients that are essentially required as a source of energy and a solvent for fat soluble vitamins (A, D, E, and K). The main constituent of fats or oils are fatty acids [1]. To date, few studies have systematically appraised the evidence of health benefits from consuming essential fatty acids. Essential fatty acids are obtained by the body from food because the body's ability to synthesize these fatty acids is very limited [2]. Fishery and marine commodities contain essential fatty acids such as Omega-3 and Omega-6. Examples of Omega-3s are pentaoenic fatty acid (EPA) and docosahexaetanoic acid (DHA) which are abundant in salmon, tuna, sardines and mackerel. Examples of Omega-6 are linoleic acid and arachidonic acid (ARA) [3], which are found in various types of oils such as corn oil, sunflower oil, soybean oil [4].
One of the potential fishery commodities that has not been widely studied is Indonesian shortfin eel also known as unagi in Japan or sidat in Indonesia, commonly used in Japanese cuisine. Eel is a snake-like catadromous fish which lives in fresh, tropical and subtropical waters, and will immigrate to marine waters to spawn. Eels live in freshwater at a temperature of 12-31 °C from the larval to adult phase and will migrate to the sea to reproduce, then the spawned larvae will be carried to the coast and into freshwater through river estuaries. Eel in both seed size and consumption size is quite abundant in Indonesia’s fresh waters, especially in river estuaries on the southern coast of Java, the west coast of Sumatra, and the coast in Sulawesi. The Indonesian shortfin eel has high economic value and is in great demand due to its increasing popularity in developed countries such as Japan and Korea. Japan is the largest eel consuming country, with an average consumption of 120,000 tons per year and in 2012 there was an increase in consumption of up to 150,000 tons [5]. However, its potential as an export commodity has not reached maximum potential due to lack of reliable information on nutritional value.

Atlantic farmed salmon are no stranger to Indonesian consumers due to its nutrient density, availability and affordability. Salmon is commonly used in Japanese cuisine which is often served raw or known as sashimi, made into sushi or cooked by grilling or made into a soup. Salmon is the third most frequently consumed marine resource after shrimp and tuna. Salmon is well known for its excellent nutritional content such as proteins, lipids, vitamins and minerals [6]. The protein content of salmon is recognizably high when compared to other fisheries products and contains more omega-3 (n-3) long chain polyunsaturated fatty acids (LC-PUFA) that are absent in other terrestrial animals and plants. Unsaturated fatty acids are essential fatty acids that are able to lower cholesterol and triglyceride levels in the blood, thereby reducing the risk of cardiovascular disease. Salmon also contains vitamins A, D, E, B6, and B12, as well as niacin and riboflavin [7]. The life of salmon is in contrast to eel. Salmon can adapt to live in cold oceans, fast flowing rivers, cold deep lakes, as well as extreme water temperatures or climates, such as waters affected by glasters, volcanoes, and earthquakes. Salmon develops during its mobility, such as moving freely in rivers and wide oceans and the ability to adapt to extreme climate change. This has resulted in several species producing hundreds of genetically different types of race, subspecies, color, characteristics, and other attributes [8]. Norway is the global leader in salmon aquaculture, producing more salmon than the United Kingdom, Chile, Canada, and the Faroe Islands combined. However, salmon is not commonly cultivated in Indonesian waters, neither wild nor farmed.

In this study, comparison of total fat, fatty acid profile and sensory properties between shortfin eel and salmon was conducted to address the lack of information and to maximize the utilization and consumption of Indonesian shortfin eel. Previous study by Saleh et al., 1993, revealed that 100 grams of eel contain protein ranging from 17.5 to 21.5%, water 71.5-75.9%, fat from 3.3 to 9.5% and ash from 1.0 to 1.6%. One of the studies related to fatty acids in eel was conducted by Jamaluddin et al. [9] in the form of a comparative study of the fatty acid composition of yellow eel fish (Anguilla marmorata) with different habitats, namely the Palu River and Poso Lake. However, further information on the nutrient density and sensory acceptance of eel meat compared to salmon has not been examined.

2. Materials and Methods

2.1. Fatty Acid Analysis

Materials needed in this research are raw meat from eel (Anguilla bicolor) in two different consumable sizes, namely small size weighing 150-250 grams with ages of 4-5 months, and large sizes weighing 800 - 1000 gr with the age of 8 months old cultivated from the freshwaters of Pelabuhan Ratu, West Java. Norwegian salmon meat (Salmo salar) was purchased from a local supermarket in Tangerang, Indonesia. For Gas Chromatography, NaOH solution in methanol (0.5 N), 20% BF3 solution, saturated NaCl solution, anhydrous Na2SO4, and 40-60 °C hexane or petroleum ether or other fatty solvents.

The instruments used in this study were the Shimadzu type 2010 plus gas chromatography device, a 10μL syringe, a water bath, a Teflon-covered tube, analytical balance, micro pipette, filter paper, 100 ml fat flask, Soxhlet tool, electric heating, and fat free cotton.
Fat extraction was carried out using the Soxhlet method (SNI 01-2891-1992). The analysis of the fatty acid profile was carried out using the GC-MS method. Eel and salmon oil is prepared first by the transesterification process into Fatty Acid Methyl Ester (FAME) according to the standards in AOAC (2005). Furthermore, the FAME sample is injected into a gas chromatography system, using helium mobile phase and column stationary phase with programmed temperature separation. The two analysis data were then processed and evaluated. The data from the analysis of the fatty acid profile is the result of three repetitions and then the mean and standard deviation are determined and then processed statistically with analysis of variance or analysis of variance (ANOVA) with a confidence level of 5%. If there is a significant difference in the sample being tested, then proceed with the Duncan Multiple Range Test (DMRT) to determine the variables that cause the difference.

2.2. Sensory Evaluation

Organoleptic tests on eel and salmon meat were carried out using the hedonic test method or preference test (SNI 01-2346-2006) using 36 untrained panelists. This hedonic test is divided into 2 types, namely Profile of boiled eel and salmon meat. In this study, panelists were served boiled eel and boiled salmon. Then the panelists were asked to taste the two fish meat and give an assessment of their preference for five parameters, namely texture (firmness and juiciness), aroma, taste, and overall. The second type is hedonic preference of boiled eel and salmon with dipping sauce. In this study, panelists were asked to give an assessment of their preferences for eel and boiled salmon which is consumed with dipping sauce. The preference rating includes three parameters, namely aroma, taste, and overall. Grading starts from score 1-7, where: 1 = very dislikes, 2 = dislikes, 3 = slightly dislikes, 4 = neutral, 5 = rather likes, 6 = likes, and 7 = very likes.

3. Results and Discussion

The total fat content of small and large eels (Anguilla bicolor) and salmon (Salmo salar) differed significantly (Table 1). Small eels had the highest total fat content (23.75 g / 100g) followed by large eels (18.52 g / 100g), while salmon has the smallest total fat content (15.98 g / 100g). The difference in total fat in large eel and small eel is caused by differences in fish body size. According to Goel et al. [10], the fat content of fish will increase correspondingly to its body size. The larger the size, the utilization of feed will increase due to the greater energy needed for fish growth. The difference in total fat in eel and salmon is caused by the different spawning methods between the two fish. According to Skjærven et al. [11], differences in swimming flow during immigration for spawning can distinguish the total fat between the two fish. The correlation between the total fat content of salmon and eel with the difference in the way the two fish spawn lies in the amount of energy used from fat by the two different fish resulting in the difference of total fat.

| Parameter | Small size | Large size | Salmon |
|-----------|------------|------------|--------|
| Anguilla bicolor | 23.75<sup>a</sup> | 18.52<sup>b</sup> | 15.98<sup>c</sup> |

<sup>a</sup>-<sup>c</sup>Value with different letter indicate significantly difference (p<0.05)

Fatty acid analysis of small and large eel meat using gas chromatography identified 25 types of fatty acid components, consisting of 10 saturated fatty acids or SFA (Table 2), 6 monounsaturated fatty acids or MUFA (Table 3), and 9 polyunsaturated fatty acids or PUFA (Table 4). Meanwhile, 24 types of fatty acid components were identified in salmon meat consisting of 9 SFA, 6 MUFA, and 9 PUFA. The one fatty acid that is found in small eels and large eels but not in salmon meat is heneicosanoic acid. Heneicosanoic acid is a type of saturated fatty acid that has a long chain, which is usually found in human milk fat [12]. Heneicosanoic acid can also be synthesized endogenously or from within the body, for
example from propionic acid (3: 0) which comes from the intestine. A number of studies have shown an inverse relationship between the concentration of heneicosanoic acid in human plasma phospholipids or red blood cells and the reduced risk of type 2 diabetes and cardiovascular disease [13].

### Table 2. Saturated fatty acid profile of Anguilla bicolor compared to Salmon

| Saturated Fatty Acid                  | Small size Anguilla bicolor | Large size Anguilla bicolor | Salmon (Salma Salar) |
|---------------------------------------|----------------------------|-----------------------------|----------------------|
| Lauric Acid, C12                       | 0.14±0.04^a                | 0.09±0.00^a                 | 0.09±0.03^a          |
| Myristic Acid, C14                      | 3.27±0.16^a                | 3.43±0.04^a                 | 2.21±0.12^b          |
| Pentadecanoic Acid, C15                | 0.28±0.01^a                | 0.35±0.01^b                 | 0.15±0.01^c          |
| Palmitic Acid, C16                      | 16.89±0.35^a               | 18.27±0.13^b                | 11.64±0.31^c         |
| Heptadecanoic Acid, C17                | 0.33±0.01^a                | 0.41±0.01^b                 | 0.18±0.02^c          |
| Stearic Acid, C18                       | 2.66±0.03^a                | 3.12±0.03^b                 | 3.34±0.07^c          |
| Arachidic Acid, C20                     | 0.12±0.01^a                | 0.14±0.00^b                 | 0.16±0.01^c          |
| Heneicosanoic Acid, C21                | 0.02±0.00                   | 0.02±0.00                   | ND                   |
| Behenic Acid, C22                       | 0.04±0.00^a                | 0.06±0.02^b                 | 0.07±0.00^b          |
| Lignoceric Acid, C24                    | 0.02±0.00^a                | 0.03±0.01^b                 | 0.05±0.01^c          |
| Total saturated fatty acid              | 23.77                      | 25.93                       | 17.88                |

**Mean±Standard deviation with different superscript shows significant different observed by Analysis of Variance with Duncan Multiple Range Test at p<0.05**

Results of the analysis showed that there were 6 SFA which showed significant differences in both small eel, large eel and salmon meat, namely pentadecanoic acid, palmitic acid, heptadecanoic acid, stearic acid, arachidic acid and lignoceric acid. The highest SFA content of the two types of fish is palmitic acid, where large eels have the highest average content (18.27% w/w), followed by small eels (16.89% w/w) and the lowest is in salmon meat (11.64% w/w). According to Hooper *et al.* [4], palmitic acid is thought to be the dominant fatty acid in freshwater fish and can generally convert fish fat to semi-solid or solid at room temperature. Lauric acid in the three types of fish did not show any significant difference, in contrast to behenic acid which showed a significant difference between small eels (0.04% w/w) large eels (0.06% w/w) and salmon (0.07% w/w). The myristic acid in small eels (3.27% w/w) and large eels (3.43% w/w) was not significantly different, but there was a significant difference if myristic acid in both eels was compared to salmon (2.11% w/w). The highest total SFA was found in large eels (25.93% w/w), followed by small eels (23.77% w/w) and the lowest was in salmon (17.88% w/w).

### Table 3. Monounsaturated fatty acid profile of Anguilla bicolor compared to Salmon

| Monounsaturated fatty acid                  | Small size Anguilla bicolor | Large size Anguilla bicolor | Salmon Salma salar |
|---------------------------------------------|----------------------------|-----------------------------|---------------------|
| Myristoleic Acid, C14:1                    | 0.06±0.00^a                | 0.07±0.00^a                 | 0.05±0.00^a         |
| Palmitoleic Acid, C16:1                    | 3.75±0.07^a                | 4.32±0.05^b                 | 4.44±0.11^b         |
| Cis-10-Heptadecanoic Acid, C17:1           | 0.27±0.01^a                | 0.26±0.11^a                 | 0.22±0.07^a         |
| Oleic Acid, C18:1 In9c                     | 26.84±0.20^a               | 29.11±0.28^b                | 34.64±0.20^c        |
| Cis-11-Eicosenoic Acid, C20:1              | 1.06±0.01^a                | 1.36±0.01^b                 | 2.11±0.04^c         |
| Nervonic Acid, C24:1                       | 0.03±0.00^a                | 0.05±0.00^b                 | 0.25±0.01^c         |
| Total monounsaturated fatty acid            | 32.01                      | 35.17                       | 41.71               |

**Mean±Standard deviation with different superscript shows significant different observed by Analysis of Variance with Duncan Multiple Range Test at p<0.05**

There are 6 MUFA whose values are significantly different both in small eel, large eel and salmon, namely palmitoleic acid (palmitoleic acid), oleic acid (oleic acid), and cis-11-eikosenoic acid (cis-11-
eicosenoic acid), and nervonic acid (nervonic acid). Oleic acid is a MUFA with the highest levels and significantly different from both eels (small and large) and salmon, namely 26.84% w/w (small eels), 29.11% w/w (large eels), and 34.64% w/w (salmon). Similar to the yield of oleic acid, there was a significant difference in cis-11-eicosenoic acid in the three types of fish. Myristoleic acid was not significantly different, both in small eels, large eels, and salmon. Palmitoleic acid of small eels (3.75% w/w) was significantly different if palmitoleic acid was compared to large eels (4.32% w/w) and salmon (4.44% w/w). Salmon has the highest total MUFA (41.71% w/w) when compared to large eel (35.17% w/w) and small eel (32.01% w/w).

Table 4. Polyunsaturated fatty acid profile of *Anguilla bicolor* compared to Salmon

| Polyunsaturated fatty acid | Small size *Anguilla bicolor* | Large size *Anguilla bicolor* | Salmon *Salmo salar* |
|----------------------------|-------------------------------|-------------------------------|---------------------|
| Linoleic Acid, C18:2n6c    | 8.24±0.09a                    | 7.60±0.10a                    | 13.73±0.04c         |
| γ-Linolenic Acid, C18:3n6  | 0.35±0.01c                     | 0.36±0.01c                     | 0.20±0.02a          |
| Linolenic Acid, C18:3n3    | 1.22±0.04a                     | 1.42±0.04b                     | 3.27±0.05c          |
| Cis-11,14-Eicosadienoic Acid, C20:2 | 0.64±0.01c | 0.69±0.01a | 1.27±0.10b |
| Cis-8,11,14-Eicosatrienoic Acid, C20:3n6 | 0.49±0.01a | 0.47±0.01b | 0.45±0.02b |
| Arachidonic Acid, C20:4n6  | 0.84±0.01a                     | 0.95±0.03b                     | 0.51±0.02c          |
| Cis-5,8,11,14,17-Eicosapentaenoic Acid, C20:5n3 | 2.00±0.03a | 2.25±0.03b | 3.57±0.04c |
| Cis-13,16-Docosadienoic Acid, C22:2 | 0.03±0.06a | 0.04±0.00a | 0.12±0.03b |
| Cis-4,7,10,13,16,19-Docosahexaenoic Acid, C22:6n3 | 6.08±0.03a | 6.99±0.07b | 5.39±0.09c |

Total polyunsaturated fatty acid 19.90 20.78 28.50

*Mean±Standard deviation with different superscript shows significant different observed by Analysis of Variance with Duncan Multiple Range Test at p<0.05*

Small eels, large eels, and salmon contain nine PUFAs whose values are significantly different, namely linoleic acid (LA), linolenic acid (ALA), arachidonic acid (ARA), and eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA). From the analysis of PUFA, it was found that both eel and salmon had high levels of essential fatty acids, including linolenic ALA, EPA, and DHA which are included in omega-3 fatty acids and ALA, γ-ALA, EPA, and ARA which are included in omega-6 fatty acids. However, when compared between eels, salmon has a higher content of essential fatty acids. Linoleic acid (LA), which is one of the omega-6 fatty acids and was found to have the highest content and was significantly different in both small eels (8.24% w/w), large eels (7.60% w/w) and salmon (13.73% w/w). According to denHartigh [14], LA plays a role in growth, maintenance of cell membranes, regulation of cholesterol metabolism, lowers blood pressure, inhibits hepatic lipogenesis, lipid transport and so on. However, according to Jandacek [15], LA deficiency can cause dermatitis, decreased reproductive capacity, growth problems, liver degeneration, and susceptibility to infection. Another essential fatty acid which is high in content and significantly different from large eels, small eels and salmon is docosahexaenoic acid or better known as DHA. DHA content of salmon (5.39% w/w) is lower than small eel (6.08% w/w) and large eel (6.99% w/w). DHA is an omega-3 fatty acid that has various health benefits, such as helping growth in infants and toddlers, reduces cardiovascular risk, improves immune function, improves learning ability in children, and can prevent breast cancer risk in postmenopausal women. The human body cannot produce DHA, therefore, DHA must be obtained by consuming food ingredients. However, DHA can be produced in small amounts in infants from the synthesis of ALA [16].

Other omega-3 fatty acids that are high in content and significantly different from both large eel, small eel and salmon are eicosapentaenoic acid (EPA) and linolenic acid (ALA). EPA in small eel is 2.00% w/w smaller than large eel (2.25% w/w) and salmon has the highest content, which is 3.57% w/w. ALA in
salmon also has a higher content (3.27% w/w) compared to large eels (1.42% w/w) and small eels (1.22% w/w).

Arachidonic acid (ARA) is an omega-6 fatty acid whose content is significantly different in the three types of fish. The highest ARA content was found in large eels (0.95% w/w), followed by small eels (0.84% w/w), while salmon had the lowest ARA content of 0.51% w/w. Other omega-6 fatty acids found in eels (small and large) and salmon are EPA and γ-ALA. There is a significant difference in the content of EPA between salmon (0.45% w/w) and small eels (0.49% w/w) and large eels (0.47% w/w). However, EPA in large eels and small eels were not significantly different. γ-ALA in salmon (0.20% w/w) is smaller than large eels (0.36% w/w) and small eels (0.35% w/w).

The content of the three omega-6 fatty acids (γ-ALA, EPA and ARA) in salmon is lower than that of large eels and small eels. According to Methere et al. [16], freshwater fish is a better source of omega-6 fatty acids than sea water fish. Some of the benefits of omega-6 in humans are lowering blood pressure, lowering cholesterol levels, can increase insulin resistance, and reduce the incidence of diabetes [17].

There is a significant difference in the content of cis-eicosadinoic and cis-docosadinoic fatty acids between eels (small and large) and salmon. The highest content of these two fatty acids was found in salmon, namely cis-eicosadinoic acid (1.27% w/w) and cis-docosadinoic acid (0.12% w/w). The content of cis-eicosadinoic acid in small eels (0.64% w/w) was not significantly different from large eels (0.69% w/w). The content of cis-docosadinoic acid between small eels (0.03% w/w) and large eels (0.0400% w/w) was not significantly different, while the cis-docosadinoic acid content of the two eels was significantly different from that of salmon (0.12% w/w). The highest total PUFA was found in salmon (28.50% w/w), followed by large eel (20.78% w/w), and small eel being the lowest (19.90% w/w).

![Figure 1. Total Fatty Acids of Small Eel, Large Eel, and Salmon](image)

Total fatty acids in salmon (88.07% w/w) were significantly higher than large eels (81.88% w/w) and small eels (75.68% w/w) as can be seen in Figure 1. The difference in total fatty acids in eel and salmon is due to differences in habitat between the two types of fish. Although both types of eel and salmon have similar life cycles, these fish live to grow into adults in different waters. According to Mowi [6], fish originating from marine waters do have a higher fatty acid content than fish originating from fresh water. There is also a significant difference in the total fatty acids between large eel and small eel. This is due to differences in fish body size. According to Sprague [7], the larger the size of the fish, the feed necessity will also increase therefore affecting nutritional content of fish derived from the feed source. This is because when the fish are in their infancy, the use of feed used for energy is much greater than the amount of fat stored in the body [7].

The sensory characteristics of boiled eel and salmon that were tested included five parameters, namely
texture (firmness and juiciness), aroma, taste, and overall. From Table 5, it can be seen that the total score of preference between eel and salmon was not much different. Salmon has a higher preference score (27.78) than eel (26.45).

**Tabel 5:** Panelists' Preference for Boiled Eel and Salmon

| Test Sample | Score Firmness | Score Juiciness | Score Aroma | Score Taste | Score Overall | Total Score |
|-------------|----------------|-----------------|-------------|-------------|---------------|-------------|
| Eel         | 5.39<sup>a</sup> | 5.58<sup>a</sup> | 5.06<sup>a</sup> | 5.25<sup>a</sup> | 5.17<sup>a</sup> | 26.45       |
| Salmon      | 5.53<sup>a</sup> | 5.33<sup>a</sup> | 5.61<sup>a</sup> | 5.64<sup>a</sup> | 5.67<sup>a</sup> | 27.78       |

Independent T-test (p < 0.05). For each parameter, the value followed by a different letter indicates significantly different (p < 0.05)

The sensory test results on the five parameters (firmness, juiciness, aroma, taste, overall) of eel and salmon can also be seen in Table 5. Panelists' preferences for texture (firmness, juiciness), aroma, taste, and overall for the two types of fish were not significantly different but for overall taste, salmon tends to be more favorable than eel. However, eel actually also has potential that is not inferior to salmon. This can be seen from the assessment score which is not much different from salmon.

The assessment of panelists' preference for the texture (firmness) of eel and salmon was not significantly different, namely salmon with a score (5.53) tended to be preferred compared to eel (5.39). But in the assessment of juiciness texture, panelists tended to prefer eel (5.58) to salmon (5.33). This shows that eel has a softer and juicy fish texture. Although not significant, the aroma preference score of salmon was higher (5.61) compared to eel (5.06). This is probably due to the fact that eels tend to have a fishy aroma which is less preferred by panelists than salmon. This fishy aroma can be caused by oxidation of fatty acids. The fat content of eel is higher than salmon, so the possibility of fatty acid oxidation will be greater than salmon. The taste of salmon (5.64) tends to be more favorable than that of eel (5.25). This is because the taste of salmon is better known to the panelists, while the eel is still unknown to the panelists. Overall (overall), salmon tends to be preferred by panelists compared to eel. To determine the sensory acceptance of eel and salmon meat if consumed with or without dipping sauce, a hedonic test was also carried out on eel and boiled salmon using a dipping sauce which includes three parameters, namely aroma, taste, and overall. The sensory test results can be seen in Table 6.

**Table 6:** Panels' Preference for Boiled Eel and Salmon with Dipping Sauce

| Test Sample | Score Aroma | Score Taste | Score Overall | Total Score |
|-------------|-------------|-------------|---------------|-------------|
| Eel         | 5.75<sup>a</sup> | 5.97<sup>a</sup> | 5.83<sup>a</sup> | 17.55       |
| Salmon      | 6.00<sup>a</sup> | 6.19<sup>a</sup> | 6.22<sup>a</sup> | 18.41       |

Independent T-test (p < 0.05). For each parameter, the value followed by a different letter indicates significantly different (p < 0.05)

The panelists' preference for the three parameters tested, namely aroma, taste, and overall, was not significantly different. This shows that both eel and salmon are suitable when consumed using a dipping sauce. Both types of fish can be cooked in more varied ways to increase the diversification of the processing of these two types of fish. The favorite score for the aroma of eel with dipping sauce (5.75) was smaller than the aroma score of salmon with dipping sauce (6.00), but this value was not significantly different. Compared with the aroma score of boiled eel consumed without dipping sauce (5.06), boiled eel consumed with dipping sauce had a higher aroma score (5.75). This shows that the eel which is consumed with dipping sauce is preferred because the dipping sauce can mask the fishy aroma. The taste preference score for eel (5.19) and salmon (6.19) was not significantly different. However, when compared with the taste score of boiled eel consumed without dipping sauce (5.25), boiled eel that was consumed with...
dipping sauce tended to be higher (5.97). This shows that eel is preferable when consumed with dipping sauce.

4. Conclusion

Based on the results, it can be concluded that eel in both small and large consumable sizes, contains 25 types of fatty acids, while salmon has 24 types of fatty acids. Eel has heptacosanoic acid which is absent in salmon. The total fatty acid content of large eels, small eels and salmon is significantly different. The highest total fatty acid content was found in salmon (88.07% w/w), followed by large eel (81.88% w/w) and the lowest was in small eels (75.68% w/w). The highest SFA content is found in eel. Meanwhile, salmon contains MUFA and PUFA which are higher than eel. Sensory evaluation revealed the panelists' preferences for texture (firmness, juiciness), aroma, taste, and overall of boiled salmon with and without dipping sauce were not significantly different from boiled eel. Our study suggests that Indonesian shortfin eels possess a great source of fatty acids and is a palatable fishery product alternative to salmon.

5. References

[1] Colombo S M, Wacker A, Parrish C C, Kainz M J and Arts M T 2017 Environ. Rev. 25 163-174
[2] Calder P C 2018 Proc. Nutr. Soc. 77 52-72
[3] Tocher D R 2015 Aquaculture 449 94-107
[4] Hooper L, Al-Khudairy L, Abdelhamid A S, Rees K, Brainard J S and Brown T J 2018 Cochrane Database Syst. Rev. 11 CD011094
[5] Kagawa H, Tanaka H, Ohta H, Unuma T and Nomura K 2006 Fish Physiol.Biochem. 31 193-199
[6] O’Neill SM, Ylitalo G M and West J E 2014 Endangered Species Res. 25 265-281
[7] Sprague M, Dick J and Tocher D 2016 Sci Rep 6 21892
[8] Birmie-Gauvin K, Thorstad E B and Aarestrup K 2019 Rev. Fish Biol. Fish. 29 749-766
[9] Jamaluddin J, Amelia P and Widodo A 2018 Galenika J. Pharm. 4 73-78
[10] Goel A, Pothineni N V, Singhal M, Paydak H, Saldeen T and Mehta J L 2018 Int. J. Mol. Sci. 19 3703
[11] Skjærven K H, Oveland E, Mommens M, Samori E, Saito T, Adam A C and Espe M 2020 Comp. Biochem. Physiol. A Mol.Integr. Physiol. 247 110717
[12] Bomfim V S, Jordão A A Jr, Alves L G, Martinez F E and Camelo J S Jr 2018 PloS one 13(9) e020279
[13] Pfeuffer M and Jaudszus, A 2016 Adv. Nutr. 7(4) 730-734
[14] den Hartigh L J 2019 Nutrients 11 370
[15] Jandacek R J 2017 Healthcare 5 25
[16] Metherel A H, Lacombe R, Chouinard-Watkins R, Hopperton K E and Bazinet R P 2018 J. Lipid Res. 59 357-367
[17] Fleming J A, Kris-Etherton P M. 2014 Adv. Nutr. 5 863S