Chemical composition and hedonic test of asar fish (smoked *Katsuwonus pelamis*) from Sorong, West Papua, Indonesia

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Abstract. Asar fish is a traditional processed product of smoked fish from West Papua with raw materials of Skipjack tuna/Yellowfin tuna/Smoked tuna/ Mackerel tuna, in the whole condition with vertical smoking. This research aimed to investigate the contents of proximate, fatty acids, amino acids, and hedonic properties of asar fish (containing smoked *Katsuwonus pelamis*). The research samples were obtained from the Sorong smoked fish producers. The proximate test used the Association of Official Analytical Chemists (AOAC) standard, the amino acid test used Liquid Chromatography-Mass Spectrometry (LC-MS), the fatty acid test used the Gas Chromatography-Mass Spectrometry (GC-MS), and the hedonic test used the Indonesian National Standard (SNI) 2346:2015 with 120 panelists. The results showed that the asar fish has 67.8% water content, 1.92% ash content, 1.74% total fat, 26.98% protein, 0.79% carbohydrates, and 2.44% crude fiber. The primary essential amino acids of asar fish contain 5.25% L-Lycine, 3.42% L-Histidine, and 2.45% L-Leucine. The primary nonessential amino acids contain 3.51% L-Glutamic acid, 2.44% L-Aspartic acid, and 2.22% L-arginine. The primary fatty acids of the asar fish were 37.44% C15:1 (cis-10), 19.6% C18:0, 11.12% C14:0, 10.85% C18:2 (all-trans-9,12), and 9.55% C20:0. Asar fish has good nutritional content, so it is good for health. In general, the panelists rated 'Like Slightly' for the test results of the hedonic asar fish. Research findings conclude that asar fish has good nutrition qualities and provides high protein and fatty acids intakes.
Keywords: amino acid, fatty acid, *Katsuwonus pelamis*, proximate, smoked fish.

Introduction. Fish processing with the smoking process has long been practiced everywhere in the world. Smoking is an alternative processing method that generates high added value for the product and extends the consumption period of the product compared to fresh fish (Gómez-Guillén et al 2009). One of the smoked fish products from the east of Indonesia, especially West Papua, is asar fish (Figure 1). The asar fish is similar to the smoked fish. However, their difference lies in the smoking method. The smoked fish is commonly placed above the smoking vertically. In contrast, asar fish are placed on coals producing smoke horizontally. Asar fish are traditional smoked fish made of skipjack tuna, yellowfin tuna, or mackerel tuna because their meat textures are pretty solid; therefore, they are not brittle when smoked. Skipjack tuna is one of the export commodities and marine natural resources of Papua. Skipjack tuna (*Katsuwonus pelamis*) is a healthy food source for society and a foreign exchange source (Effendi 2012).

Figure 1. The asar fish product.
Source: personal archive of the author (Mohammad Sayuti)

The smoking of asar fish is quite simple, starting from cleaning the entrails of the fresh fish, soaking the fish in salty water, and smoking it. Smoking is done in a closed room for 4-5 hours to let smoke seep into the meat until it is thoroughly cooked. The smoking process refers to the process of penetration of volatile compounds from the smoke source into the fish meat (Palm et al 2011). The smoked product has a typical taste and aroma, longer shelf life due to the antibacterial activity, and reduced enzymatic activity due to the smoking process (Abolagba & Igbinevbo, 2010; Kumolu-Johnson et al 2010). The factors that influence the characteristics of smoked fish are the type of smoking materials (Oduor-Odote et al 2010; Ahmed et al 2010), fish capture location, smoking time, and used smoking methods (Rørå et al 2004).

The relative concentration of phenolic compounds in smoked products is influenced by the types of wood used in the smoking process (Sopelana et al 2016). Different types of wood for smoking produce different complexes of chemical components. They have the form of a mixture of various structures of volatile and non-volatile compounds such as phenol, sirigol, and guaiacol compounds, and their derivate, with various sensory characteristics (Kostyra & Baryłko-Pikielna 2006).

The advantage of the traditional fish smoke product is producing a strong smoke aroma and taste in the smoked fish (Leksono & Padil 2009). Smoke contains many compounds, such as cellulose, hemicellulose, and lignin, formed by pyrolysis of wood. The most important group of these compounds include phenol, carbonyl, acid, furan, alcohol, esters, lactones, and polycyclic compounds (Darmadji et al 2000). Pyrolysis of lignin produces phenol, while pyrolysis of cellulose produces phenol compounds and acetic acid compounds that include carbonyl compounds; all of these compounds have functional properties in processing and preserving meat, such as antioxidant and antimicrobial and specific taste and color (Toldra & Nollet 2009). This study aimed to determine the nutrition characteristics and hedonic quality of asar fish (that is, smoked skipjack tuna) processed in Sorong, West Papua.

Material and Method

Sample handling. The study used fresh skipjack tuna of approximately 2.5 kg per head. The fish smoking process included the following steps: (1) washing the fish clean, (2) removing the fish's gills and entrails, (3) inserting a bamboo stick from the fish's mouth to tail as body support that prevents the fish body from being destroyed and facilitate flipping the fish when smoked. The study used 100 smoked skipjack tunas, smoked with raw materials from coconut fiber and coconut shell. This process was carried out in a smoking furnace with a length of 6 m, a width of 4 m, and a height of 60 cm. Each treatment required 150 kg of raw materials to smoke for one process. The smoking process lasted for five hours until the fish was cooked and turned golden-silver and then golden-yellow. The following characteristics were investigated: the physicochemical properties and fatty acid profiles of the smoked skipjack tuna and fresh skipjack tuna and the organoleptic ones of the smoked skipjack tuna.

Proximate analysis. The analysis of water content, protein, fat, and ash was determined using the Association of Official Analytical Chemists method (AOAC 2005). It was carried out in the Laboratory of Integrated Research and Testing of the University of Gadjah Mada.

Analysis of amino acids
Sample preparation. The process consisted of eight steps: weight the sample with an accuracy of ± 2.5 grams; put the sample in the 50-mL test tube of the threaded tube; add HCl 6N up to 20 mL; hydrolyze the sample in an autoclave at 110 °C for 12 hours; neutralize it with NaOH 6N; add NaOH 6N up to 50 mL; filter it with a filter of 0.22 μM; diluted it ten times, and inject it into LCMS 2 μL.
Mobile phase. A: 0.1% pentadecafluorooctanoic acid (PDFOA), 99.5%:0.5% water/CH3CN with 0.1% formic acid; B: 0.1% PDFOA, 10%:90% water/CH3CN with 0.1% formic acid; flow: 0.6 mL/min.

Analysis of saturated and unsaturated fatty acids
Hydrolysis. Hydrolysis consisted of nine steps: take a sample of 1-5 ml and add 5 ml of concentrated HCl; heat the sample in a water bath at 80ºC; let it boil for three hours; let it cool; extract sample with 15 ml of diethyl ether and petroleum ether (1:1); perform Vortex; let it settle in for 5 minutes; take the top layer as oil; evaporate the sample in a water bath with the help of N_2 gas.
Methylation. The methylation consisted of several stages: (1) add 1.5 mL of methanolic sodium solution to the sample, close and heat the sample at a temperature of 60°C for 5-10 minutes while shaking it, then refrigerate it; (2) add 2 mL of Boron trifluoride methanoic to the sample, heat at a temperature of 60°C for 5-10 minutes, then cool it; and (3) extract sample with 1 mL of Heptane and 1 mL of saturated NaCl, take the top layer and put it in Eppendorf, and inject the sample with Shimadzu GC-2010 up to 1μL.
GC conditions. Detector: FID, temperature: + 260 ° C, method: Methylester 37 New 3032017 Cal gcm, column: HP-88, length: 100 m

Organoleptic test. The organoleptic test was performed using a hedonic with a nine-point scale (Table 1). The test was carried out according to the Indonesian National Standard (SNI 2346:2015) of Sensory Testing (Badan Standardisasi Nasional 2015). This research involved 120 panelists from Java, Sulawesi, Maluku, Papua, and West Papua.

Table 1

The Score Scales of the Hedonic Test

Specifications	*Scores*
Like Extremely	9
Like Very Much	8
Like Moderately	7
Like Slightly	6
Neither Like nor Dislike	5
Dislike Slightly	4
Dislike Moderately	3
Dislike Very Much	2
Dislike Extremely	1

Source: Badan Standardisasi Nasional [Indonesian National Standard (SNI 2346:2015)].

Results and Discussion. The proximate test results for asar fish and fresh skipjack tuna are described in Table 2.

Table 2

Proximate Test Results of Asar Fish and Fresh Skipjack Tuna

No.	*Test parameters*	*Asar fish*	*Fresh skipjack tuna*
1	Water content	67.8 ± 0.03	68.57 ± 0.06
2	Ash content	1.92 ± 0.02	1.35 ± 0.03
3	Totals fat	1.74 ± 0.02	0.41 ± 0.03
4	Protein	26.98 ± 0.04	22.95 ± 0.09
5	Carbohydrates	0.79 ± 0.02	7.49 ± 0.04
6	Crude fiber	2.44 ± 0.02	5.92 ± 0.06

The score was derived from the average of ± standard deviation of three times expressed in the wet weight basis.

Table 2 shows a decrease in water content due to the smoking process from the raw material of fresh skipjack tuna to asar fish product. The water level decreased by 0.77%. The percentage of decline was small because the smoking process was quicker, and the product was frozen after smoking and before the proximate test. The water content of asar fish was still fairly high; in fact, the smoked fish should have a moisture content of less than 65% (Cardinal et al 2001). The different quality of raw materials and smoking methods can lead to the different nutritional content of smoked fish. Smoked tuna in Spain contains 58.6-66,2% moisture, 15.4-31.5% protein, 1.4-3.8% fat and 6.1-7.5% ash content (Fuentes et al 2010). The water content of the asar fish was higher compared to that of fresh skipjack tuna. The water content decreased by 0.77 %, carbohydrates by 6.7%, and crude fiber by 3.48%, while the protein content increased by 4.03%, total fat by 1.33%, and ash content by 0.57%. Smoking can influence the increase of protein content approximately 5.5%, 14% ash content, and reduced fat content as high as 27% (Famurewa et al 2017). The location, fish harvest season, and processing steps influence the final product's texture significantly (Sigurgisladottir et al 2000). The quantity of protein, fat, and ash content of smoked fish increases as the amount of moisture content during the smoking process decreases (Ahmed et al 2010). The smoking process can remove water content in the product in order to extend the self-life by halting microbe’s activity (Fasano et al 2016). The ash content of smoked skipjack tuna was 1.36% – 5.66% (Toisuta et al 2014). Prolonged smoking will increase the protein content and decrease the water content (Duedahl-Olesen et al 2010). The total protein range in fish was 63.80% to 78.15%, and the range of total fat content was 4.57% to 21.29% in different seasons (Emre et al 2018).

Table 3

The amino acid test results of asar fish and fresh skipjack tuna

No.	*Test Parameters*	*Asar fish (%)*	*Fresh skipjack tuna (%)*
		Essential amino acids	
1	L-Histidine	3.42	1.49
2	L-Lycine	5.25	3.79
3	L-Phenylalanine	1.3	0.99
4	L-Isoleucine	1.51	1.16
5	L-Leucine	2.45	1.96
6	L-Methionine	0.92	0.68
7	L-Valine	1.71	1.27
8	L-Threonine	1.25	0.94
9	L-Tryptofan	0.04	0.04
		Nonessential amino acids	
1	L-Tyrosine	1.01	0.76
2	L-Arginine	2.22	1.51
3	L-Proline	1.14	0.89
4	L-Glutamic acid	3.51	2.74
5	L-Aspartic acid	2.44	1.77

6	L-Cysteine	0.15	0.14
7	L-Serine	1.05	0.78
8	L-Alanine	1.63	1.27
9	L-Glycine	1.31	0.91

Asar fish and fresh skipjack tuna have nine essential amino acids and nine nonessential amino acids (Table 3). Essential amino acids include lycine, histidine, leucine, valine, isoleucine, phenylalanine, threonine, methionine, and tryptophan, while nonessential amino acids included glutamic, aspartic, arginine, alanine, glycine, proline, serine, tyrosine, and cysteine. The amino acids arginine, lysine, and leucine are essential amino acids of aquatic animals; therefore, aquatic animals are known as high-protein food (Rosa & Nunes 2004). Essential amino acids for children include arginine and histidine (Erkan & Selc 2010). Arginine is essential for children to increase growth hormone release (Adeyeye & Kenni, 2008). Lysine serves as the primary material of blood antibodies, strengthens circulation systems, and maintains normal cell growth. Furthermore, along with proline and vitamin C, lysine produces collagen and decreases excessive blood triglyceride levels. The average need for amino acid lysine intake per day is 1-1.5 g (Baker 2007). The three highest contents of nonessential amino acids in skipjack tuna asar and fresh skipjack tuna were glutamic acid by 3.07%, L-aspartic acid by 1.75%, and L-alanine by 1.24%. Glutamic and aspartic acids are essential because they create the typical aroma and flavor of food (Pratama et al 2018; Thariq et al 2014). Glutamic acid is a natural constituent component in almost all foods that contain high protein, such as meat, fish, milk, and vegetables (Jacoeb et al 2012). The high protein content of fish is a source of protein for the human diet (Sayuti et al 2020).

The analysis of fatty acids in asar fish and fresh skipjack tuna revealed several types of saturated and unsaturated fatty acids (Tabel 4; Figure 2; Figure 3). Saturated fatty acids were C14:0, C16:0, C18:0, and C20:0. The unsaturated fatty acids were C14:1, C15:1, C16:1, C17:1, and C18:2. The fatty acids with the highest concentration were C15:1 (cis-10), C18:0, and C18:2 (all-trans-9,12). The concentrations of fatty acids in skipjack tuna asar and skipjack tuna were C15:1 (cis-10) by 37.44% and 43.58%, C18:0 by 19.6% and 27.12%, C14:0 by 11.2% and 0%, C18:2 (all-trans-9,12) by 10.85% and 13.06%, C20:0 by 9.55% and 5.10%, C17:1 (cis-10) by 5.33% and 7,48%, and C16:0 4.05% and 3.66%. The high concentration of C15:1 (cis-10) and C18:0 supported by a good smoking process could maintain the quality of these fatty acid compositions. In addition, the smoking process can maintain phenolic antioxidants, which can prevent fatty acid damages. Sukarsa (2004) stated that the concentration of unsaturated fatty acids is higher than that of saturated fatty acids because unsaturated fatty acids are important for human metabolism. However, the low concentration of methyl palmitoleate in skipjack tuna asar and the loss of concentration of methyl tetradecanoate, myristoleit acid methyl ester, methyl linoleate, and methyl palmitoleate in raw materials of asar fish were caused by damage from a lipase enzyme produced by microbes. Therefore, emerging oxidation produces peroxide, ketone, and aldehyde. The oxidation process can also increase peroxide and thiobarbituric acids; thus, the amount of fatty acids was reduced.

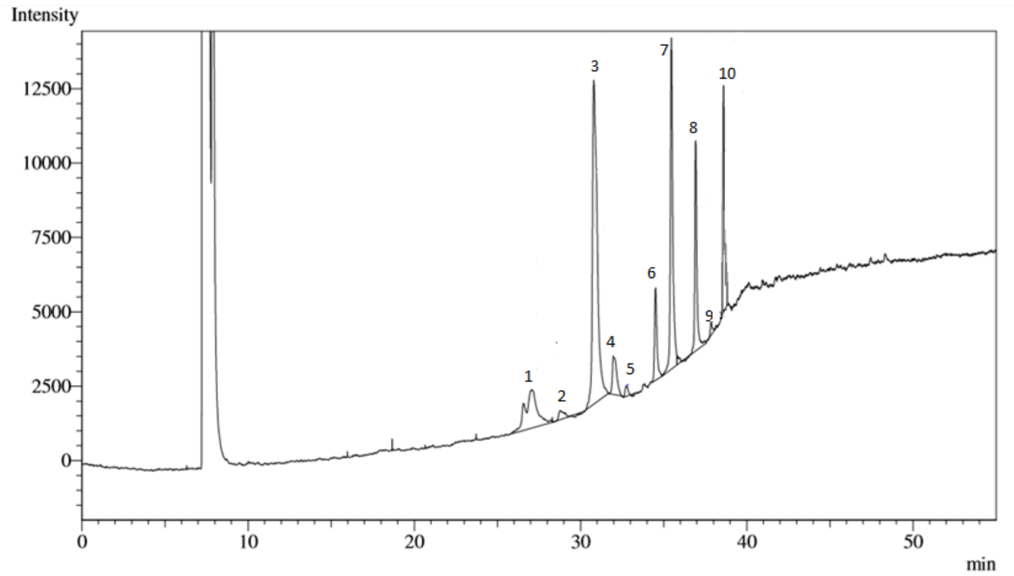

Figure 2. Fatty acids chromatogram of asar fish.

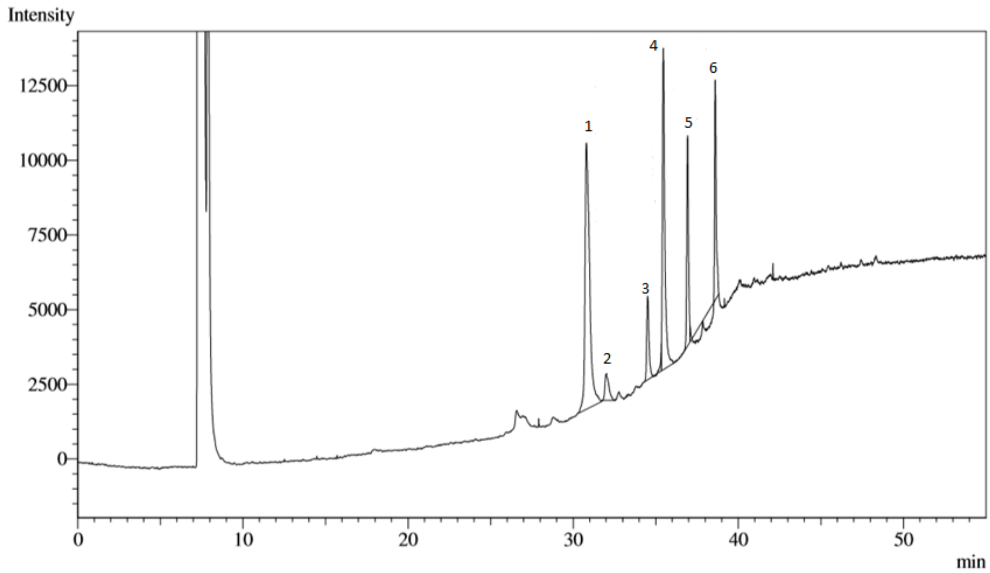

Figure 3. Fatty acids chromatogram of fresh skipjack tuna.

Table 4

The fatty acid test results of asar fish and fresh skipjack tuna

Compound name	*Molecular formula*	*Asar fish*		*Fresh skipjack tuna*	
		Peak	*Concentration (% relative area)*	*Peak*	*Concentration (% relative area)*
C14:0	$C_{15}H_{30}O_2$	1	11.12	-	-
C14:1	$C_{15}H_{28}O_2$	2	0.8	-	-
C15:1 (cis-10)	$C_{16}H_{30}O_2$	3	37.44	1	43.58
C16:0	$C_{17}H_{34}O_2$	4	4.05	2	3.66
C16:1 (cis-9)	$C_{17}H_{32}O_2$	5	0.6	-	-
C17:1 (cis-10)	$C_{18}H_{34}O_2$	6	5.33	3	7.48
C18:0	$C_{19}H_{38}O_2$	7	19.6	4	27.12
C18:2 (all trans-9,12)	$C_{19}H_{34}O_2$	8	10.85	5	13.06
C18:2 (all *cis*-9,12)	$C_{19}H_{34}O_2$	9	0.66	-	-
C20:0	$C_{21}H_{42}O_2$	10	9.55	6	5.10
Total			100		100

The average evaluation score of the 120 panelists for the asar fish was 6 (Like Slightly) (Figure 4). The highest score was given to texture and appearance. This may be due to the fact that the asar fish looked like fresh fish. The smoking process produced the brown to golden yellow appearance and color, as well as the delicious taste and aroma of typical smoked fish. Changes in the smoked fish taste and odor were caused by carbonyl and phenol compounds in the smoke. Kostyra & Baryłko-Pikielna (2006) contended that carbonyl and phenol compounds or their derivatives contribute to the typical colors, flavor, and aroma of smoked products.

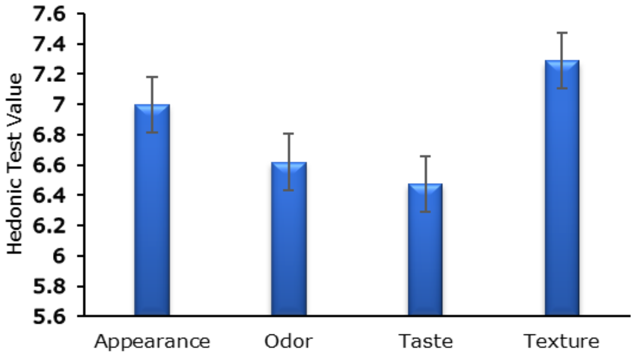

Figure 4. The hedonic test results of asar fish.

Panelists' preference for skipjack tuna asar, from the highest to the lowest, taking the living location into account, were Sumatra, Sulawesi, Papua, Maluku, West Papua, and Java (Figure 5). The organoleptic characteristics of this sample were not statistically different ($p > 0.05$) according to the origins of the panelists' living location, and the majority of the panelists rated them with 6, referring to something 'like moderately' Panelists from Sumatra rated 7 or 'like moderately' the appearance and texture of the product. The fat content possibly affects the texture score of the smoked fish. However, Mørkøre et al (2001) report that the texture of smoked Atlantic salmon is not related to its fat content. Several factors, such as the physicochemical quality of fresh fish, age, gender, seasonal variation, and the smoking process (smoke resources, smoke component, temperature, humidity, smoking, duration, and smoke density), can affect the organoleptic properties of the final product (Šimko 2005). In addition, consumers' eating habits and traditional acceptance of food in each region influence consumers' choices (María & Manzanos 2002). Phenol and carbonyl compounds play a crucial role in the smoked fish's taste, such as guaiacol and syringol, because phenolic compounds provide specific-organoleptic characteristics (Kjällstrand & Petersson 2001; Oduor-Odote et al 2010; Jónsdóttir et al 2008; Martinez et al 2007; Cardinal et al 2006).

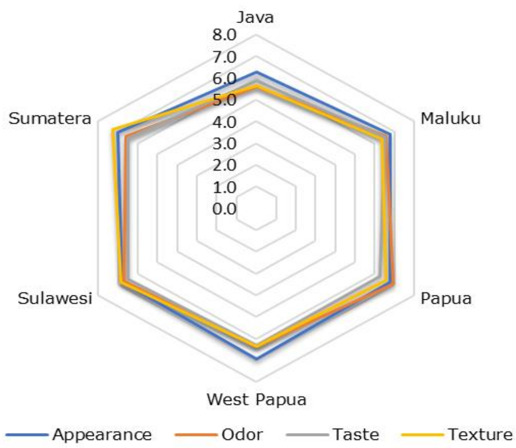

Figure 5. The chart of the organoleptic test results, based on the panelists' living location.

Conclusions. The primary component of asar fish was a protein, accounting for 26.98% of the total component. The asar fish protein contains 18 amino acids: nine critical amino acids and nine nonessential amino acids. However, essential amino acids dominate the total percentage. The main fatty acid of asar fish is C15:1 (cis-10) (37.44%), classified as an unsaturated fatty acid. The results of the hedonic test showed that the ranking by panelists' living location was Sumatra (6.8), Sulawesi (6.7), Papua (6,6), Maluku (6,57), West Papua (6.48), and Java (5.8). It can be concluded that the asar fish is a traditional smoked fish with a good nutritional composition.

References

Abolagba O. J., & Igbinevbo E. E., 2010 Microbial load of fresh and smoked fish marketed in Benin metropolis, Nigeria. Research Journal of Fisheries and Hydrobiology 5(2):99–104.

Abolagba O. J., & Melle O. O., 2008 Chemical Composition and Keeping Qualities of a Scaly Fish Tilapia , Oreochromis niloticus Smoked With Two Energy Sources. African Journal of General Agriculture 4(2):113–117.

Adeyeye E. I., & Kenni A. M., 2008 The relationship in the amino acid of the whole body, flesh and exoskeleton of common West African fresh water male Crab Sudananautes africanus africanus. Pakistan Journal of Nutrition 7(6):748–752. http://doi.org/10.3923/pjn.2008.748.752

Ahmed E. O., Ali M. E., Kalid R. A., Taha H. M., & Mahammed A. A., 2010 Investigating the Quality Changes of Raw and Hot Smoked *Oreochromis niloticus* and *Clarias lazera*. Pakistan Journal of Nutrition 9(5):481–484.

Association of Official Analytical Chemists (AOAC), 2005 *Official Methods of Analysis(18thed).* USA: Association of Official Analytical Chemist Inc.

Badan Standardisasi Nasional, 2015 *SNI 2346:2015* [Sensory Testing Guide on Fishery Products]. Jakarta [In Indonesian].

Baker D. H., 2007 Lysine, arginine, and related amino acids: An introduction to the 6 th amino acid assessment workshop. Journal of Nutrition 137(6):1599–1601. http://doi.org/10.1093/jn/137.6.1599s

Birkeland S., & Skåra T., 2008 Cold smoking of atlantic salmon (*Salmo salar*) fillets with smoke condensate - An alternative processing technology for the production of smoked salmon. Journal of Food Science 73(6):S326-32. http://doi.org/10.1111/j.1750-3841.2008.00850.x

Bower C. K., Hietala K. A., Oliveira A. C. M., & Wu T. H., 2009 Stabilizing oils from smoked pink salmon (oncorhynchus gorbuscha). Journal of Food Science 74(3):248–257. http://doi.org/10.1111/j.1750-3841.2009.01099.x

Cardinal M., Cornet J., Sérot T., & Baron R., 2006 Effects of the smoking process on odour characteristics of smoked herring (Clupea harengus) and relationships with phenolic compound content. Food Chemistry *96*(1):137–146. http://doi.org/10.1016/j.foodchem.2005.02.040

Cardinal M., Knockaert C., Torrissen O., Sigurgisladottir S., Morkore T., Thomassen M., & Luc Vallet J., 2001 Relation of smoking parameters to the yield, colour and sensory quality of smoked Atlantic salmon (*Salmo salar*). Food Research International 34(6):537–550. http://doi.org/10.1016/S0963-9969(01)00069-2

Darmadji P., Oramahi H. A., Haryadi, & Armunanto R., 2000 [Optimization of Production and Functional Properties of Rubber Wood Liquid Smoke]. Agritech of Gajah Mada University [in Indonesian].

Duedahl-Olesen L., Christensen J. H., Højg˚ard A., Granby K., and Timm-Heinrich M., 2010 Influence of smoking parameters on the concentration of polycyclic aromatic hydrocarbons (PAHs) in Danish smoked fish. Food Additives & Contaminants: Part A 27(9):1294–1305.

Effendi S., 2012 [Food Processing and Food Preservation Technology]. Bandung: (ID): Alfabeta [in Indonesian].

Emre N., Uysal K., Emre Y., Kavasoglu M., Akta¸s Ö., 2018 Seasonal and Sexual Variations of Total Protein, Fat and Fatty Acid Composition of an Endemic Freshwater Fish Species (*Capoeta antalyensis*). Aquatic Sciences and Engineering 33(1):6–10.
Erkan N., & Selc A., 2010 Department of the Seafood Processing and Quality Control, Faculty of Fisheries, Istanbul University, Laleli, Istanbul; € bitak Marmara Research Center, Food Institute, Gebze, Kocaeli, Turkey and 2 T u, *13*(6):1524–1531.
Famurewa J. A. V., Akise O. G., Ogunbodede T. E., 2017 Ect of storage methods on the nutritional qualities of African Catfish *Clarias gariepinus* (Burchell, 1822). African Journal of Food Science 11(7):223–233.
Fasano E., Yebra-Pimentel I., Mart´ınez-Carballo E., and Simal-G´andara J., 2016 Profiling, distribution and levels of carcinogenic polycyclic aromatic hydrocarbons in traditional smoked plant and animal foods. Food Control 59:581–590.
Fuentes A., Fernández-Segovia I., Barat J. M., & Serra J. A., 2010 Physicochemical characterization of some smoked and marinated fish products. Journal of Food Processing and Preservation 34(1):83–103. http://doi.org/10.1111/j.1745-4549.2008.00350.x
Gómez-Guillén M. C., Gómez-Estaca J., Giménez B., & Montero P., 2009 Alternative fish species for cold-smoking process. International Journal of Food Science and Technology 44(8):1525–1535. http://doi.org/10.1111/j.1365-2621.2008.01762.x
Guillén M. D., & Manzanos M. J., 2001 Some compounds detected for the first time in oak wood extracts by GC/MS. Sciences Des Aliments 21(1): 65–70. http://doi.org/10.3166/sda.21.65-70
Guillén M. D., & Manzanos M. J., 2002 Study of the volatile composition of an aqueous oak smoke preparation. Food Chemistry 79(3):283–292. http://doi.org/10.1016/S0308-8146(02)00141-3
Jacoeb A. M., Asnita L., & Lingga B., 2012 [Protein and Amino Acid Characteristics of Crab Meat (Portunus pelagicus) Due to Steaming]. Jurnal Pengolahan Hasil Perikanan Indonesia 15(2). http://doi.org/10.17844/jphpi.v15i2.6207 [in Indonesian].
Jónsdóttir R., Ólafsdóttir G., Chanie E., & Haugen J. E., 2008 Volatile compounds suitable for rapid detection as quality indicators of cold smoked salmon (*Salmo salar*). Food Chemistry 109(1):184–195. http://doi.org/10.1016/j.foodchem.2007.12.006
Kjällstrand J., & Petersson G., 2001 Phenolic Antioxidants In Wood Smoke. Science of the Total Environment 277(1–3):69–75. http://doi.org/10.1016/S0048-9697(00)00863-9
Kostyra E., & Baryłko-Pikielna N., 2006 Volatiles composition and flavour profile identity of smoke flavourings. Food Quality and Preference 17(1–2):85–95. http://doi.org/10.1016/j.foodqual.2005.06.008
Kumolu-Johnson C. A., Aladetohun N. S., & Ndimele P. E., 2010 The Effects of Smoking On The Nutritional Qualities and Shelf-Life of *Clarias gariepinus* (LACEPEDE). African Journal of Biotechnology 9(1):073–076. http://doi.org/10.4314/AJB.V9I1
Leksono T., & Padil A., 2009 [Application of liquid smoked made of oil palm shell on fresh-water catfish (*Pangasius hypopthalmus*) Preservation]. In *Proceeding International Seminar: From Ocean for Food Security, Energy, and Sustainable Resources and Environment. Unair Surabaya* [in Indonesian].
Martinez O., Salmerón J., Guillén M. D., & Casas C., 2007 Sensorial and physicochemical characteristics of salmon (*Salmo salar*) treated by different smoking processes during storage. Food Science and Technology International 13(6):477–484. http://doi.org/10.1177/1082013207087816
Mørkøre T., Vallet J. L., Cardinal M., Gomez-Guillen M. C., Montero P., Torrissen, O. J., Nortvedt R., Sigurgisladottir S., Thomassen M. S., 2001 Fat content and fillet shape of Atlantic salmon: Relevance for processing yield and quality of raw and smoked products. Journal of Food Science, 66(9):1348–1354. http://doi.org/10.1111/j.1365-2621.2001.tb15213.x
Oduor-Odote P., Obiero M., & Odoli C., 2010 Organoleptic effect of using different plant materials on smoking of marine and freshwater catfish. African Journal of Food, Agriculture, Nutrition and Development, 10(6):2658–2677.

http://doi.org/10.4314/ajfand.v10i6.58054
Palm L. M. N., Carboo D., Yeboah P. P., Quasie W. J., Gorleku M. A., & Darko A., 2011 Characterization of Polycyclic Aromatic Hydrocarbons (PAHs) present in smoked fish from Ghana. Advance Journal of Food Science and Technology 3(5):332–338.
Pratama R. I., Rostini I., & Rochima E., 2018 [Profile of Amino Acids, Fatty Acids and Volatile Components of Fresh and Steamed Carp (*Osphronemus gouramy*)]. Jurnal Pengolahan Hasil Perikanan Indonesia 21(2):219. http://doi.org/10.17844/jphpi.v21i2.22842 [in Indonesian].
Rørå A. M. B., Monfort M. C., & Espe M., 2004 Effects of country of origin on consumer preference of smoked salmon collected in a French hypermarket. Journal of Aquatic Food Product Technology 13(1):69–85. http://doi.org/10.1300/J030v13n01_07
Rosa R., & Nunes M. L., 2004 Nutritional quality of red shrimp, *Aristeus antennatus* (Risso), pink shrimp, *Parapenaeus longirostris* (Lucas), and Norway lobster, *Nephrops norvegicus* (Linnaeus). Journal of the Science of Food and Agriculture 84(1):89–94. http://doi.org/10.1002/jsfa.1619
Sayuti M., Kadarusman, Hismayasari I. B., Suhermanto A., Sofian A., Abadi A. S., Ernawati, Saidin, 2020 Chemical composition of Sentani gudgeon (*Oxyeleotris heterodon*). AACL Bioflux 13(5):3155-3162.
Sigurgisladottir S., Sigurdardottir M. S., Torrissen O., Vallet J. L., & Hafsteinsson H., 2000 Effects of different salting and smoking processes on the microstructure, the texture and yield of Atlantic salmon (*Salmo salar*) fillets. Food Research International 33(10):847–855. http://doi.org/10.1016/S0963-9969(00)00104-6
Šimko P., 2005 Factors affecting elimination of polycyclic aromatic hydrocarbons from smoked meat foods and liquid smoke flavorings. Molecular Nutrition and Food Research 49(7):637–647. http://doi.org/10.1002/mnfr.200400091
Sopelana P., Ibargoitia M. L., & Guillén M. D., 2016 Influence of fat and phytosterols concentration in margarines on their degradation at high temperature. A study by 1H Nuclear Magnetic Resonance. Food Chemistry 197:1256–1263. http://doi.org/10.1016/j.foodchem.2015.11.058
Sukarsa D. R. 2004 A Study of Activity of Omega -3 Fatty Acid of Some Marine Fish in Mice as the Experimental Animals. Jurnal Pengolahan Hasil Perikanan Indonesia,7(1):68–79. http://doi.org/10.17844/jphpi.v7i1.1060 [in Indonesian].
Thariq A., Swastawati F., & Surti T., 2014 The Effect of Differences in Salt Concentrations in Poodle pufferfish (*Rastrelliger neglectus*) on the content of Glutamic Acid Which Gives a Savory Taste (Umami). Jurnal Pengolahan Dan Bioteknologi Hasil Perikanan, 3(3): 104–111.[in Indonesian].
Toisuta B. R., Ibrahim B., and Herisuseno S., 2014 Characterization of fatty acid from By Product of Skipjacktuna (*Katsuwonus pelamis*). Global Journal of Biology, Agriculture and Health Science 3(1):278–282.
Toldra F., & Nollet L. M. L., 2009 [Handbook of Seafood and Seafood Products Analysis (1st ed.]. CRC Press, Marcel Dekker Inc. http://doi.org/https://doi.org/10.1201/9781420046359

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