

Evaluating the protein and fat content of skipjack (*Katsuwonus pelamis*) in the smoking process of arabushi

by Rita Marsuci Harmain

Submission date: 03-Jun-2023 10:35PM (UTC-0500)

Submission ID: 2108311470

File name: Doe_2020_IOP_Conf._Ser._Earth_Environ._Sci._404_012052.pdf (682.54K)

Word count: 3196

Character count: 15929

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To cite this article: K Doe et al 2020 IOP Conf. Ser.: Earth Environ. Sci. **404** 012052

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Evaluating the protein and fat content of skipjack (*Katsuwonus pelamis*) in the smoking process of arabushi

K Doe, F A Dali* and R M Harmain

Department of Fisheries Product Technology, Faculty of Fisheries and Marine Science, State University of Gorontalo, Indonesia

*E-mail: dali.faiza@yahoo.co.id

Abstract. Arabushi (a semi-finished product from katsuobushi) can be produced from skipjack by a gradual smoking process using varying temperatures. Different methods of smoking can cause differences in the nutrition of arabushi produced. The purpose of this study was to determine the levels of skipjack protein and fat at each smoking stage, as well as amino acid and fatty acid content of the arabushi. The smoking process was carried out by one small and medium enterprise in Bone Bolango District, Gorontalo. Smoking was carried out 7 times using temperature variations from hot to cold, namely 89°C-90°C (stage 1), 50°C-60°C (stage 2) and 40°C (stages 3 to 7). Protein content increased in each stage of smoking. Stage 1 smoked skipjack fish has a protein of 22.37%, then changed to 40.21% at stage 2 and to 58.07% at the final stage. The fat content also increased, from 20.26% at stage 1 to 27.62% at the final stage. Fifteen amino acids and 23 fatty acids were identified in the arabushi.

Keywords: amino acid, arabushi, fatty acid, skipjack fish

1. Introduction

Skipjack (*Katsuwonus pelamis*) is one of the dominant commodities landed in Gorontalo. Gorontalo was able to produce skipjack reaching 12,855.5 tonnes/year (DKP Gorontalo 2015). The abundance of skipjack fish stocks has encouraged the community to process them as an alternative to reduce the problem of decay or decrease the quality of fresh skipjack fish. Gorontalo people generally process skipjack into smoked fish known as *cakalang fufu*. Smoked fish processing was carried out at the small and medium enterprises using traditional smoking methods. Some smoked fish processors are currently expanding their business by producing *ikan kayu*. *Ikan kayu* is a processed fish product that is smoked gradually until the texture of the fish becomes hard in texture and usually Japanese people call it by the name Arabushi. This product is shipped to several countries, especially Japan.

Ikan kayu contained nutrients including 67.54% protein and 1.57% fat (Sunahwati 2000). Ulfaturrizza *et al* (2019) reported the protein content of *ikan kayu* after cleaning was 25.42%, boiling 20.42% and drying 27.87%, while Pundoko *et al* (2014) stated fresh skipjack protein content was 27.37%, fat was 2.19% and changed after boiling where the protein was 29.38% and fat was 2.72%. The temperature and duration of fish smoking influence the nutritional composition (Idah *et al* 2013). During the processing of arabushi there will be changes in nutrient content caused by cleaning, boiling, variations in temperature and the duration of smoking.



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Sunahwati (2000) reported that the process of smoking of arabushi was carried out to stage 20 with temperature 75°C-85°C for 6 hours per day. One small and medium enterprise (UKM) in Gorontalo produces arabushi from skipjack with 7 smoking stages and various temperature. Information about the nutrient content of arabushi from skipjack, especially those produced by small and medium enterprises was not yet known. The purpose of this study was to determine the protein and fat of skipjack smoked to become arabushi at the stages of smoking 1, 2, 3 and 7, and amino acid and fatty acid of final arabushi.

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2. Materials and methods

2.1. Materials

The raw material used was skipjack (*Katsuwonus pelamis*, L). Other chemicals included chloroform, catalyst tablets, boiling stones, boric acid solutions, H₂SO₄, H₂O₂, distilled water, H₂BO₃, sodium hydroxide-thiosulfate, HCl 0.2 N. Equipment used included mortar, cup, analytical balance, oven, filter paper, round bottom flask, fat sleeve, soxhlet contractor, Kjeldahl digestion, steam distillation, destruction flask, measuring flask, glass funnel, buret, volumetric pipette, Erlenmeyer, measuring cup, glass cup, drop pipette, stir bar, High-Performance Liquid Chromatography (HPLC LC 20A-Shimadzu) and gas chromatography (GC-2010 Plus-Shimadzu).

2.2. Methods

The making of skipjack arabushi was carried out jointly with the industry (small-medium enterprise) of Fish Tilapo Tumbihe Village, Kabila District, Bone Bolango Regency. Fishes were cleaned and sorted based on the size, type, and quality of fish. Then the fish were weighed and put in a box. After that the fish was washed before gutting by removing the gills and cutting the abdominal wall. The viscera was removed and the fish was washed. The fish were arranged on a boiling container with the stomach facing up. Furthermore, water was heated until the temperature reached about 70°C. Cooking center temperature was 60°C. The duration of boiling was determined based on the doneness of the boiled fish.

Smoking fish to produce arabushi was done in stages as much as 7 times. Each stage of smoking used different temperatures. Smokers used fuel, namely mango wood which was placed at the bottom (stove) and wooden rack-shaped containers (8 stacking) to put the fish on top. Stage 1 smoking temperature ranges from 80-90°C for 4 hours. Every 1 hour of smoking, 2 shelves will be moved from the bottom (near the fire stove) to the top, while the top was shifted down. The total time needed for the smoking of the 8 shelves was 4 hours per day. After each smoking, the fish were left in the open air overnight. The next day stage 2 smoking was carried out with temperatures ranging from 50°C-60°C for 4 hours. Furthermore, stage 3 to stage 7 smoking uses a low temperature of 40°C.

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Sample was carried out on fish that had been smoked in step 1 as sample A, stage 2 smoke (sample B), stage 3 (sample C) and stage 7 (sample D) for protein and fat analysis (BSN 2006). Analysis of amino acids and fatty acids (AOAC 2005) samples taken at stage 7 smoked were given the symbol D. The production flow of arabushi is presented in figure 1.

3. Results and discussion

Arabushi from skipjack contained protein 58.07% and fat 27.62% (wet basis). Protein level in skipjack arabushi were higher than fresh skipjack by Harmain *et al* (2018). In addition, fresh skipjack fish contained protein and fat 25.29% and 0.60%, respectively (Nurjanah *et al* 2015). Smoking process increased protein level of skipjack in accordance with the results of Sunahwati (2000), Pundoko *et al* (2014) and Nabila *et al* (2017). Similarly, the results of the study showed fat levels were higher compared with some previous studies. Protein levels and fat of skipjack arabushi can be presented in

table 1. Factors that influence the differences in the chemical characteristics of skipjack arabushi, including differences in smoking methods, quality of fish and fuel used. Salindeho *et al* (2014) reported the use of different sources of smoking caused different chemical content in smoked skipjack.

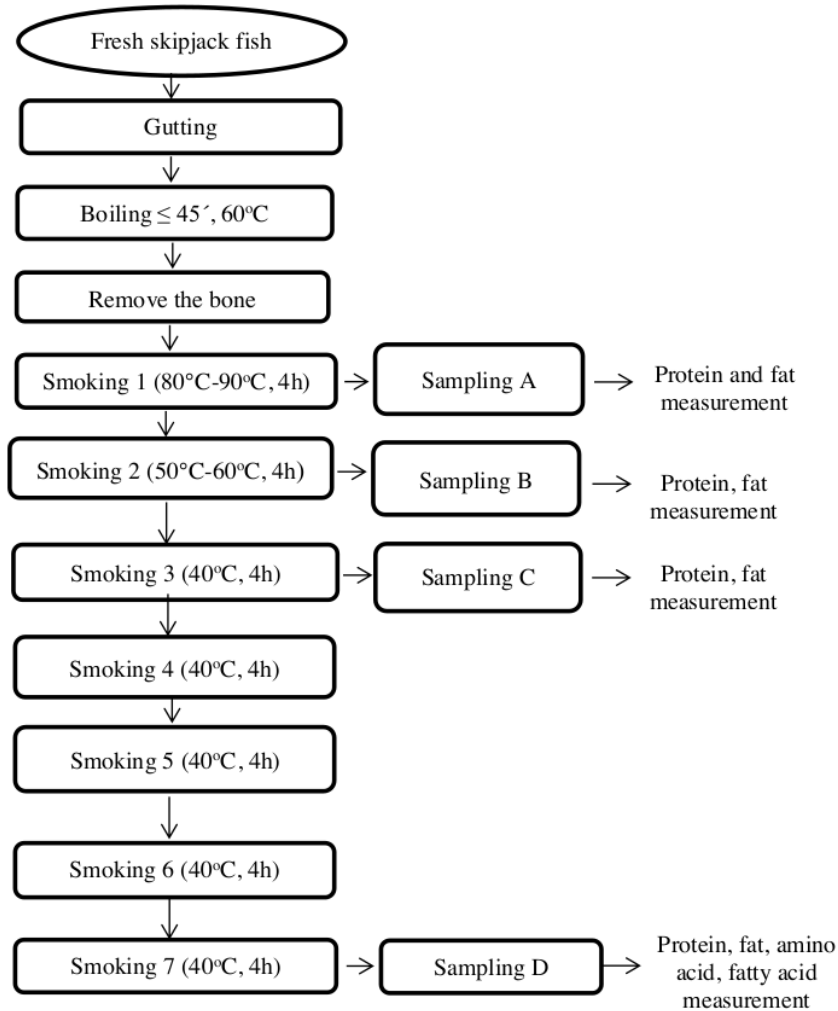


Figure 1. Production flow of arabushi.

The results of the analysis at each stage of smoking with different process temperatures showed different levels of protein and fat. Protein and fat content in skipjack smoked fish 7 times (sample D) was higher than smoked sample once (sample A). Changes in fish protein and fat content increased due to smoking during arabushi processing. The heat smoking temperature (80°C-90°C) used in step 1 (sample A) results in lower skipjack protein and fat content compared to stage 2 (50°C-60°C) smoke, stage 3 (40°C) and stage 7 (40°C).

Table 1. Nutrition of skipjack arabushi.

Parameter	Current results (%)	Skipjack arabushi (%)*	Skipjack arabushi (%)**	Skipjack arabushi (%)***	Fresh skipjack (%)****
Protein	58.07	67.54	67.55	54.79	19.35
Fat	27.62	1.57	3.99	4.07	0.44

*Sunahwati (2000) **Pundoko *et al* (2014) ***Nabila *et al* (2017) ****Harmain *et al* (2018)

Smoking carried out in stages as much as 7 times smoking with differences in temperature used to cause levels of protein and fat increase. Each phase of smoking takes 4 hours per day, so the total duration of skipjack arabushi smoke was around 28 hours. According to Sulfiani *et al* (2017) and Nabila *et al* (2017), longer smoking treatment affects the reduction in fish water content, thereby increasing the protein and fat components. The average values of skipjack protein and fat with different stages and smoking temperatures were presented in table 2.

Table 2. Protein and fat levels in skipjack during smoking.

Parameter	Smoking Stage			
	Stage 1	Stage 2	Stage 3	Stage 7
Protein (%)	22.37	40.21	49.09	58.07
Fat (%)	10.26	24.97	26.25	27.62

Table 3. Amino acid levels in skipjack arabushi.

Amino Acid Type	Current result (g/100 g protein)	Skipjack <i>ikan kayu</i> * (g/100 g protein)	Fresh skipjack** (g/100 g protein)
Non-essential Amino Acids			
Aspartic acid	7.61	5.07	7.35±0.11
Glutamic acid	11.19	9.84	11.22 ±0.14
Serine	3.03	8.70	2.69±0.04
Arginine	4.65	nt	4.85±0.09
Glycine	3.68	15.36	4.83±0.20
Alanine	4.58	13.14	5.04±0.09
Total of amino acid non essential	34.74	52.11	35.98
Essential amino acids			
Threonine	3.70	6.40	3.30±0.05
Tyrosine	2.88	2.80	2.54±0.04
Methionine	2.20	10.43	2.16±0.04
Valine	4.41	nt	4.25±0.04
Phenylalanine	3.53	nt	3.23±0.02
Isoleucine	3.86	nt	3.89±0.04
Leucine	6.37	1.50	5.89±0.05
Lysine	7.59	6.20	6.29±0.38
Histidine	5.08	0.27	6.72±0.12
Total of amino acid essential	39.62	27.6	38.27
Total amino acid	74.36	79.71	74.25

*Sunahwati (2000)

**Nurjanah *et al* (2015)

nt (not detected)

Table 4. Levels of arabushi skipjack fatty acid.

Types of fatty acids	Current result (%)	Fresh skipjack*(%)
Saturated fatty acid (SFA)		
Decanoic acid	0.88	nd
Butyric acid	1.48	nd
Heneicosanoic acid	0.46	nd
Heptadecanoic acid	1.89	nd
Palmitic acid	24.37	21.88±1.53
Pentadecanoic acid	1.04	0.66±0.09
Stearic acid	10.87	11.69±0.67
Tetradecanoic acid	2.73	nd
Total	43.72	34.23±2.29
Monounsaturated fatty acid (MUFA)		
Myristic acid	0.14	nd
Palmitoleic acid	2.62	2.49±0.78
Octadecanoic acid	nd	2.14±0.43
Eicosenoic acid	0.48	nd
Erucic acid	2.7	nd
Nervonic acid	4.01	nd
Heptadecenoic acid	0.63	nd
Oleic acid	1.83	10.03±0.72
Total	12.41	14.66±1.93
Polyunsaturated fatty acid (PUFA)		
Trans-9- elaidic acid	5.69	nd
Linoleic acid	0.99	1.38±0.13
Linolelaidic acid	0.45	0,03±0,01
Linolenic acid	nd	0.13±0.00
Eicosadienoic acid	0.21	0,18±0,01
Adrenic acid	nd	6.04±0.39
Docosapentaenoic acid	nd	1.13±0.25
Arachidonic acid	nd	0.32±0.37
Eicosapentaenoic acid	0.93	4.74±0.39
Docosadienoic acid	4.68	0,03±0,01
Docosahexaenoic acid	30.2	35.66±0.23
Eicosapentaenoic acid	0.34	nd
Total	43.49	49.64±1.79
Total fatty acid	99.62	98.53±6.01

*Mahaliyana *et al* (2015), nd (not detected)

The main constituent components of proteins were amino acids which were divided into two groups, namely essential and non-essential amino acids. The results of research on skipjack arabushi obtained amino acid composition of 15 types consisting of 6 types of non-essential amino acids (aspartic acid, glutamic acid, serine, arginine, glycine, alanine) and 9 types of essential amino acids (threonine,

tyrosine, methionine, valine, phenylalanine, isoleucine, leucine, lysine, histidine). The total amino acids in skipjack arabushi, which was 74.36%, where the total essential amino acids were 39.62% and the non-essential amino acids 34.74%. The highest amino acid composition in skipjack arabushi, namely glutamic acid was 11.19%. Glutamic acid was one of the components forming delicious flavors in ikan kayu products. Glutamate produced by skipjack arabushi was higher than Sunahwati (2000) research which was 9.84%. Nurjanah *et al* (2015) states that fresh skipjack contains 11.22% glutamic acid and 2.69% serine.

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The content of non-essential serine amino acids was available in small amounts in skipjack arabushi, which was 3.03%, while the least essential amino acids in methionine were around 2.20% and the most were lysine around 7.59%. The types of amino acids lysine and glutamate were contained in fresh fish according to Dali and Harmain reported (2017). The amino acid composition contained in skipjack arabushi results of the study can be seen in table 3.

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The composition of fatty acids contained in skipjack arabushi can be seen in table 4. Fatty acids are divided into 2 groups, saturated fatty acids, and unsaturated fatty acids. The skipjack arabushi fatty acid obtained from the research results obtained a total of 99.62% consisted of 43.72% saturated fatty acid (SFA), 12.41% monounsaturated fatty acid (MUFA), polyunsaturated fatty acid (PUFA) 43.49%. The composition of fatty acids contained in skipjack arabushi found 23 types, classified as SFA 8 types, MUFA 7 types, and PUFA 8 types. The highest SFA skipjack arabushi content was palmitate acid and the least heneicosanoic acid was 24.37% and 0.46%, respectively.

The most dominant unsaturated fatty acid available in skipjack arabushi was docosahexaenoic acid (DHA) of 30.2%. Skipjack including Scombridae which provides a considerable amount of DHA. DHA in skipjack arabushi is low compared to fresh skipjack. The decrease in DHA levels was caused by the use of high temperatures when smoking about 40°C-90°C. Fresh skipjack contained 19.27% DHA (Nurjanah *et al* 2015) and 35.66% (Mahaliyana *et al* 2015).

4. Conclusion

Skipjack protein at the stages of smoking 1, 2, 3, 7 were 22.37%, 40.21%, 49.09%, 58.07%, respectively and 10.26% fat, 24.97%, 26, 25%, 27.62%, respectively. Amino acids in skipjack arabushi had 74.36% (essential 39.62% and non essential 34.74%), while total fatty acids were 99.62% (SFA 43.72%, MUFA 12.41%, PUFA 43.49%).

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