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QUALITY CHARACTERISTIC OF CHIKUWA MADE FROM DIFFERENT SPECIES OF FISH

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ABSTRACT

This research was aimed to compare the quality characteristics of “chikuwa” (a Japanese jelly-like food product made from ingredients such as fish surimi, salt, sugar, starch). In this study four species of fish such as catfish, milkfish, tilapia and red snapper were produced with the addition of 2% liquid smoke as flavouring agent. The parameters include the changes of hedonic test, amino acid profile and proximate composition (moisture content, protein content, fat content and ash content) in chikuwa without addition of liquid smoke (control) and by the treatment of adding 2% liquid smoke to the safety level and characteristics of chikuwa. Different fish species and methods gave significantly different effect ($p<0.05$) to quality of “chikuwa”. The results showed the water content was found between 65.107% to 79.112%, protein content between 8.897% to 17.757% and fat content between 0.634% to 2.158% and ash content between 0.928% to 4.63%. There were about 16 amino acids found in this study, whereas the fatty acids were found about 11. Amino acid profile highest content in fresh milkfish was lysine of 221.8086 ppm and fatty acids content in composition was oleic acid ranging from 7.85% – 50.75% with an average of 40.42%. Chikuwa made from tilapia was found as the most acceptable by panelist with hedonic values; $8.68 < \mu < 8.69$.

Keywords: amino acids, chikuwa, liquid smoke, quality characteristic, tilapia fish.

INTRODUCTION

Chikuwa is one of the products based on surimi by adding the seasoning, then shaped using the bamboo rod and roasted at 130-180°C until its inner temperature reaches 75°C [1]. Chikuwa belongs to a gel-based fishery product, where the texture is an important parameter that can determine the quality of the product. Chikuwa products with low quality are easily broken when chewed. Therefore, fish meat used in the surimi manufacture as raw materials can affect the quality of chikuwa. Cheng et al. [2] stated that the species of fish affect the texture of chikuwa.

However, chikuwa has a relatively short shelf life, so preservative additives were needed to make it last. The effort that could be done was adding natural preservatives like liquid smoke. Liquid smoke contains chemical compounds and has an antimicrobial function and it was quite safe as a natural preservative [3]. There were several options for adding liquid smoke to food products, such as spraying, soaking, boiling, dyeing, or mixing in the ingredients. Fish used in making chikuwa in this study were catfish, milk fish, tilapia fish, and snapper. Each type of fish has different qualities and characteristics and could affect the quality of chikuwa without and with the addition of liquid smoke.

The objective of our study was to determine the effect of making chikuwa from different types of fish and determine the best quality of chikuwa after the addition of liquid smoke.

MATERIALS AND METHODS

Chikuwa Preparation

The process of making chikuwa refers to the research of Bhatkar *et al*. [3]. Chikuwa Making Process was done by adding different fish skin gelatin, namely tilapia skin, payus fish skin, and snapper skin as much as 3% of the weight of the fish used. Fish fillet meat was washed and cleaned with running water, then crushed with a meat grinder. The pulverized fillet of fish meat was then put into a food processor to be mixed with other seasonings such as sugar, salt, potato starch, and ice cubes. Homogeneous dough added 1 to 2 table spoons of water and then knead until mixed. Dough molding was done using a cutting board or placemat that has a flat surface. Roll the mixture on the bamboo neatly. The dough that has been rolled using bamboo was trimmed the edges until it was neat. The next process was the chikuwa roasting process. The roasting process was carried out using an electric stove. The roasting process was carried out for 20 minutes by rotating bamboo several times so that the roasting could be evenly distributed and obtain an even brown color. The cooked Chikuwa was released from bamboo and then tested in a laboratory.

Hedonic Test

Organoleptic testing was conducted to determine the effect of liquid smoke on milkfish stew on panelist acceptance levels. Organoleptic test was done by sensory test. Organoleptic testing was a way of testing using the human senses (taste) as the main tool to assess the quality of fishery products that have undergone processing.

Amino Acid Analysis

Amino acid compositions were determined by HPLC (Waters corporations, USA). Amino acid standard solution used for calibration from Thermo Scientific. AccqTagelumn (3.9 mm x 150 mm), at 37^0C; mobile phase acetonitrile 60% -AccqTag Eluent A. Flow rate 1.0 mL m-1 with fluorescence detector.

Quality Characteristic Analysis

Water content

The first step carried out to analyze water content was to dry the porcelain cup in the oven at 105^0C for 1 h. The cup was placed in a desiccator (approximately 15 min) and allowed to cool then weighed. The cup was re-weighed to a constant weight. A total of 5 g of sample was put into the cup, then dried in an oven at 105^0C for 5 h or until the weight was constant. After finishing, the cup was then put into the desiccator and allowed to cool and then weighed again.

The percentage of water content (wet weight) could be calculated using the formula as following:

$$Water\ content\ (\%) = \frac{A-B}{A} \times 100\% \quad (1)$$

Protein content

Determination of protein content in milkfish samples was done using the Micro Kjeldahl method. Basically divided into three stages, namely the process of destruction, distillation, and titration. The destruction stage was carried out by weighing the sample as much as 2 g and putting it into the kjeldahl flask, then adding it to the flask of 2 catalyst tablets, 15 ml concentrated H_2SO_4. Furthermore, it was heated by means of destruction in a fume hood at a temperature of 450^0C for 2 h (until the sample was clear). The distillation step was carried out by adding 100 ml of distilled water to the digestion flask, then added 10 ml of 30% NaOH. 25 ml of H_3BO_4 was put into a 250 ml erlenmeyer and added with 2 drops of the methyl red indicator, then the distillation device was paired. The titration step was carried out using a standard HCL 0.2 N solution for titration until the solution changes color from yellow to pink [4].

$$\text{Protein content (\%)} = \frac{(V_a - V_b)\text{HCl} \times \text{NHCl} \times 14{,}007 \times 6{,}25 \times 100\%}{W \times 1000} \quad (2)$$

Ash content

Ash content analysis was performed using the oven method. The principle was the combustion or ignition of organic materials which were broken down into water (H_2O) and carbon dioxide (CO_2) but inorganic substances do not burn. This inorganic substance was called ash. The procedure for analyzing ash content was as follows: the cup to be used was pre-dried for 30 min at 100-105º C, then cooled in a desiccator to remove moisture and weighed (A). The sample was weighed as much as 2 g in a dried cup (B) then burned on the flame of the burner until it was not smoky and continued with ashes in the furnace at 550-600º C until complete graying. Samples that have been refrigerated were desiccated and weighed (C). The combustion stage in the furnace was repeated until a constant weight was obtained. Ash content was calculated by the formula [5]:

$$\%\ Ash\ content = \frac{C-A}{B-A} \times 100\% \quad (3)$$

Note:
A : the weight of the empty cup was expressed in grams
B : the weight of the cup + initial sample was expressed in grams
C : Cup weight + dry sample expressed in grams

$$Ash\ content\ (dry\ weight) = \frac{Ash\ content}{100 - water\ content} \times 100 \quad (4)$$

Fat content

Fat content analysis was performed using the Soxhlet method. The principle was that the fat contained in the sample was extracted using a non-polar fat solvent. The fat analysis procedure was as follows: the fat flask to be used was roasted for 30 minutes at 100-105ºC, then cooled in a desiccator to remove moisture and weighed (A). The sample was weighed as much as 2 grams (B) and then wrapped in filter paper, covered with fat-free cotton and put into a soxhlet extraction device that had been connected with a flask of fat that had been roasted and known for its weight. Hexane solvents or other fat solvents were poured until the sample was submerged and fat reflux or extraction was carried out for 5-6 hours or until fat solvents descend into the clear fat flask. The fat solvent that has been used was distilled and collected after that the fat extract in the fat flask was dried in an oven at 100-105 ºC for 1 hour, then the fat flask was cooled in a desiccator and weighed (C). The drying step of the fat flask was repeated until a constant weight was obtained. Fat content was calculated by the formula:

$$\%\ Fat\ content = \frac{C-A}{B} \times 100\% \quad (5)$$

Note:
A: The weight of an empty round bottom flask was expressed in grams
B: sample weight was expressed in grams
C: weight of round bottom flask and extracted fat in grams

$$Fat\ content\ (dry\ weight) = \frac{Fat\ content}{100 - water\ content} \times 100 \quad (6)$$

Fatty acid

Fatty acids were analyzed using gas chromatography. Before the hydrolysis and esterification processes were carried out, first the extraction of fat samples was done using the Soxhlet method. After being esterified into fatty acid methyl ester (FAME), then analyzed using gas chromatography.

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RESULTS AND DISCUSSIONS

Preliminary research results obtained from sensory observations of "chikuwa" with different species of fish and methods of liquid smoke addition showed that the critical point of decline in chikuwa product quality.

Hedonic Score of Chikuwa

Hedonic testing was a test of preference which was very important for a product because it was related to consumer acceptance of the product. The purpose of the hedonic test was to determine the level of panelists' preference for fish brain products which added 2% liquid smoke. As shown in Table-1, it could be concluded that the addition of liquid smoke affects the level of panelists' preference. The results of the Kruskal-Wallis non-parametric test analysis showed significant differences between treatments in the hedonic test ($p < 0.05$). Based on hedonic testing that has been done on chikuwa products from catfish, milkfish, tilapia fish, and red snapper control and with the addition of 2% liquid smoke the results obtained in Table-1.

Table-1. Hedonic Score of chikuwa products from different species of fish and concentration of liquid smoke.

Fish Species	Concentration of liquid smoke	Specifications			
		Appearance	Odor	Flavor	Texture
Catfish	0%	8.16 ± 0.70^{abc}	8.00 ± 0.45^{abc}	7.90 ± 0.40^{a}	8.30 ± 0.47^{bcd}
	2%	7.90 ± 0.66^{abc}	8.06 ± 0.73^{abc}	8.13 ± 0.62^{ab}	8.03 ± 0.76^{abc}
Milkfish	0%	8.36 ± 0.49^{bcd}	8.00 ± 0.45^{abc}	7.80 ± 0.48^{a}	8.40 ± 0.50^{bcd}
	2%	8.43 ± 0.50^{cd}	8.40 ± 0.93^{b}	8.16 ± 0.64^{ab}	8.56 ± 0.50^{cd}
Tilapia	0%	7.70 ± 1.18^{a}	7.53 ± 1.07^{a}	8.13 ± 1.01^{ab}	7.60 ± 1.13^{a}
	2%	8.86 ± 0.51^{d}	8.60 ± 0.81^{c}	8.53 ± 0.73^{b}	8.73 ± 0.69^{d}
Red Snapper	0%	7.73 ± 1.34^{ab}	7.93 ± 1.01^{ab}	7.80 ± 1.00^{a}	7.83 ± 1.46^{ab}
	2%	8.46 ± 0.77^{cd}	8.23 ± 0.89^{bc}	8.06 ± 0.86^{ab}	8.43 ± 0.67^{bcd}

Superscript with different letter at the same column indicated significant difference between chikuwa ($P < 0.05$)

Appearance

Appearance was the first characteristic seen by consumers to be valued in determining a product. Appearance will give an impression to consumers through the appearance of the product. Based on Table-1, it could be seen that the hedonic testing conducted by 30 panelists gave the lowest average results in the treatment of snapper chikuwa control (7.73) and the highest in the treatment of tilapia fish chikuwa with the addition of liquid smoke (8.86). The addition of liquid smoke shows different values.

Odor

Odor was one of the assessment parameters that use the sense of smell. The odor becomes one of the attractions in determining the taste of a food. Odor testing was considered important in the food industry because it could quickly provide an assessment of whether or not a product was acceptable. The aroma was a smell sensation arising from the stimulation of chemical compounds. The distinct aroma of smoke would be stronger with the increase of the amount of liquid smoke in the product. In addition, liquid smoke could also gave a distinctive aroma. Based on Table-1, panelists preferred the chikuwa with the addition of liquid smoke. Phenolic compounds contained in liquid smoke consist of various components that have the ability to provide smoky scents that were specific to the product.

Flavor

Flavor testing was aimed at determining the level of consumer preference for the taste of chikuwa control and which was added with 2% liquid smoke. Sense was a quality attribute of a product which was usually an important factor for consumers in choosing a product. A product could be accepted by consumers if it has the desired taste. Based on Table-1, panelists prefer chikuwa with the addition of a 2% liquid smoke solution. Differences in panelist values could be caused by each panelist having a different level of preference for taste. Taste gives a strong stimulus to the level of panelist preference. Variety of preferences among each treatment may have been caused by different phenol content. The phenol fraction was very important in flavoring smoked fish.

Texture

The assessment of the texture was done by assessing the smoothness and elasticity of the product and was one of the parameters of the combination of the physical state of a food product and sensed by the sight and touch. It could be seen in Table 1, treatment without and with the addition of liquid smoke has varied effects on the texture of chikuwa. Differences in the level of preference for "chikuwa" could be influenced by the processing methods and ingredients added. Different addition methods will affect the compounds in liquid

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smoke contained in the chikuwa and thus could affect the water content and the texture of the product.

Amino Acid Content of Raw Fish and Chikuwa

The results of amino acid test results obtained from chikuwa testing of different types of fish and with or without the addition of different coconut shell liquid smoke as the treatment were presented in Table-2. Amino acids in chikuwa formed different types of fish and with or without the addition of 2% liquid smoke were presented in Table-3. Addition of liquid smoke results in the reaction of phenols with proteins that caused the protein to hydrolyze and amino acids in the protein also decrease.

Based on Table-3, the highest amino acid content was glutamic acid. High glutamic acid content caused by raw materials from different types of fish also contain high glutamic acid. Chikuwa without the addition of liquid smoke showed the highest levels of glutamate followed by lysine, leucine, and aspartic acid. The difference in amino acid content could be caused by fish species, fish habitat, and how to extract.

Table-2. Essential Amino acids (ppm) raw fish and chikuwa with different species fish.

Fish species	Type of sample	Threonin	Methionin	Valin	Phenylalanin	Ileusin	Leusin	Lysin	*Histidin
Catfish	Raw Material	49.6518	24.7544	54.2265	48.8008	49.6856	90.6163	173.5420	36.4260
	0%	34.3389	19.3329	38.0901	32.1132	34.8613	61.2318	108.9395	22.0257
	2%	34.9365	n.a.	n.a.	33.3044	36.8835	62.1563	97.8354	n.a.
Milkfish	Raw Material	66.8180	55.6482	n.a.	61.8668	70.2001	120.4778	221.8086	85.7985
	0%	39.9508	14.8307	45.1549	41.4613	38.2449	67.6607	114.1089	52.2973
	2%	38.0381	11.6778	44.8544	33.8282	36.9150	65.3098	102.3017	48.7863
Tilapia	Raw Material	51.0939	34.9346	59.7182	52.8882	55.5109	96.3111	173.4983	31.0641
	0%	37.0709	22.9832	42.9018	35.5340	38.4316	68.1359	123.0482	22.8766
	2%	31.8265	15.0870	36.9508	30.1671	32.1089	59.0187	96.5502	21.2320
Red snapper	Raw Material	52.7850	30.6026	62.1094	51.7097	52.9953	97.5299	171.8409	30.6790
	0%	34.6227	40.4161	35.1812	35.1812	35.4421	65.2117	105.3712	20.8626
	2%	31.8294	18.4089	38.7660	31.2712	35.3674	61.3927	100.2737	21.2562

* Essential for children

Table-3. Non-essential Amino acids (ppm) raw fish and chikuwa with different species of fish.

Fish species	Type of sample	Aspartic acid	Glutamic acid	Serin	Glisin	Arginin	Alanin	Tyrosin
Cat Fish	Raw Material	109.4275	168.5894	48.0512	49.2007	83.2409	68.4335	59.5966
	0%	73.3397	115.3765	31.5829	36.3289	55.6325	42.4628	39.5449
	2%	73.4476	115.6246	32.9710	34.7964	58.5603	42.3466	n.a.
Milkfish	Raw Material	137.3165	n.a.	57.3028	59.3708	106.9879	89.1175	n.a.
	0%	79.3373	121.4972	35.0890	37.3504	60.5431	54.2883	47.7678
	2%	76.1898	117.1024	34.8434	36.8112	59.3688	51.8738	46.6783
Tilapia	Raw Material	114.1546	175.6338	48.6024	50.8645	85.8375	73.2561	18.9191
	0%	81.0462	127.5599	35.3912	39.2278	62.9062	50.5106	43.4144
	2%	70.7212	111.0724	30.6744	32.3247	53.0883	43.1500	41.0468
Red snapper	Raw Material	116.6534	173.5499	50.7591	45.9950	86.9722	81.9473	69.7645
	0%	76.4303	118.8235	33.4557	35.4752	57.9832	49.5731	45.2711
	2%	72.8086	114.0199	29.8588	30.5008	55.4479	44.0307	38.9692

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Proximate Content of Chikuwa

Proximate analysis was performed to find out the estimated relative amounts of protein, fat, water, ash and carbohydrates in an ingredient. Based on the proximate analysis of chikuwa with and without the addition of liquid smoke 2% was presented in Figure-1-4.

Water Content

Water is an important component in food ingredients because it can affect the appearance, texture, and taste of food. Water content in food was also a factor that determined the level of durability in the product. The water content of chikuwa is presented at Figure-1.

Data on the results of the chikuwa water content test showed that the highest water content value in the treatment of red snapper chikuwa with the addition of liquid smoke (75.71%) and the lowest in the treatment of tilapia fish chikuwa with the addition of liquid smoke (63.54%). The difference in the value of water content due to chikuwa with the addition of liquid smoke has a higher phenol content so that the higher the phenol content, the lower the water content contained in fish chikuwa.

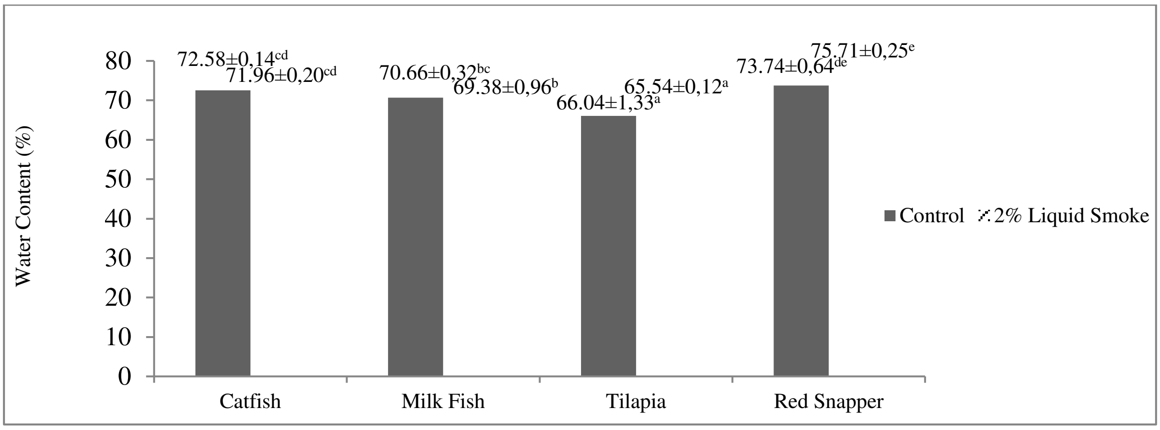

Figure-1. Water content of Chikuwa without (control) and with liquid smoke (2%). Superscript with different letter indicated significant difference between chikuwa (P<0.05).

Ash Content

Figure-2 showed the ash content of chikuwa from different fish species with and without liquid smoke. Different species and concentration of liquid smoke significantly affected to ash content (P<0.05). The highest ash content achieved by chikuwa from tilapia fish added with 2% liquid smoke. Otherwise the lowest ash content attained by chikuwa from milkfish with liquid smoke 2%. Data from chikuwa ash test results showed the highest average results in the treatment of tilapia fish chikuwa with the addition of liquid smoke (4.62%) and the lowest in the treatment of red snapper chikuwa with the addition of liquid stewards (2.95%). The value of ash content was influenced by the mineral content contained in a food ingredient.

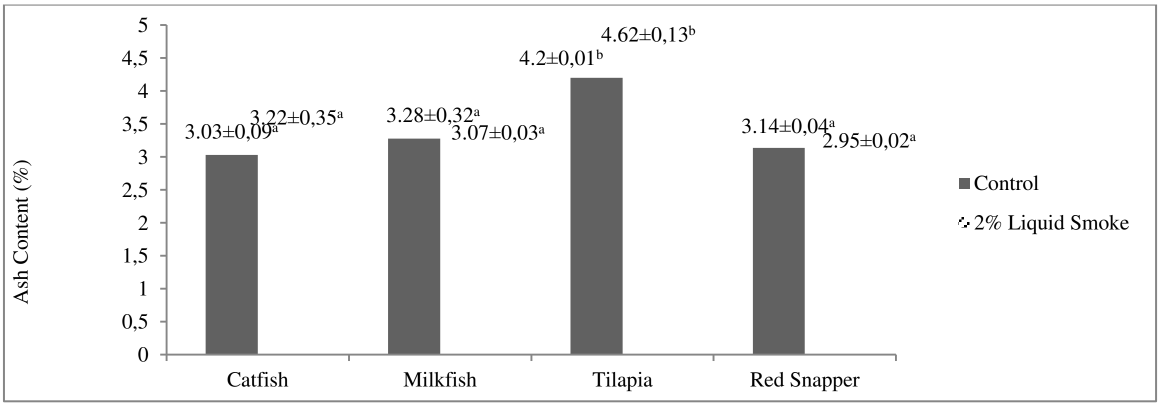

Figure-2. Ash content of chikuwa. Superscript with different letter indicated significant difference between chikuwa (P<0.05).

Protein Content

Protein was one of the substances needed by the body that functions as a builder and regulatory agent. Proteins were composed of amino acids that were bound by peptide bonds with the elements carbon (C), hydrogen (H), oxygen (O), and nitrogen (N). Tilapia chikuwa protein content could be seen in Figure-3. Based on the data obtained in Figure-3, it showed that there were differences in the value of chikuwa protein levels. Data on the test results of protein content with the highest average

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was obtained in chikuwa treatment with the addition of liquid smoke 2% (12.34%). Chikuwa fish treated with the addition of liquid smoke have a greater value of protein content compared to controls.

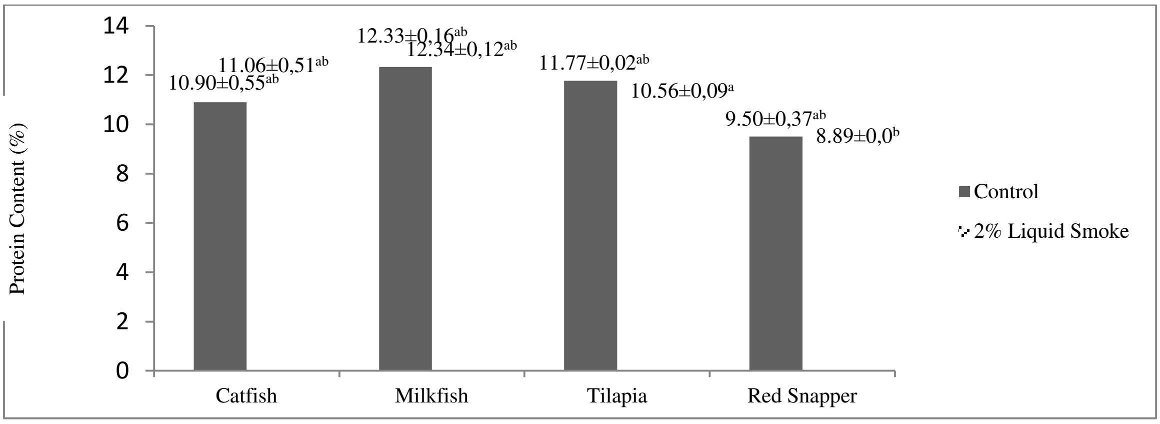

Figure-3. Chikuwa Protein Content. Superscript with different letter indicated significant difference between chikuwa (P<0.05).

Fat Content

The highest lipid content was found in chikuwa snapper treatment of addition of liquid smoke 2% by mixing with 1.97% and the lowest was in chikuwa tilapia treatment of addition of liquid smoke 2% with 0.69% (Figure-2). The difference in the value of the fat content of each treatment in the products of chikuwa fish was influenced by the amount of water content and phenol compounds from liquid smoke which could inhibit the damage of fat in the product. The activity of phenolic compounds contained in food could inhibit fat oxidation so as to prevent fat damage. The higher the phenol concentration of the sample, the more the fat damage process could be inhibited. The higher the water content coming out of the material, the greater the amount of fat content measured in the proximate test.

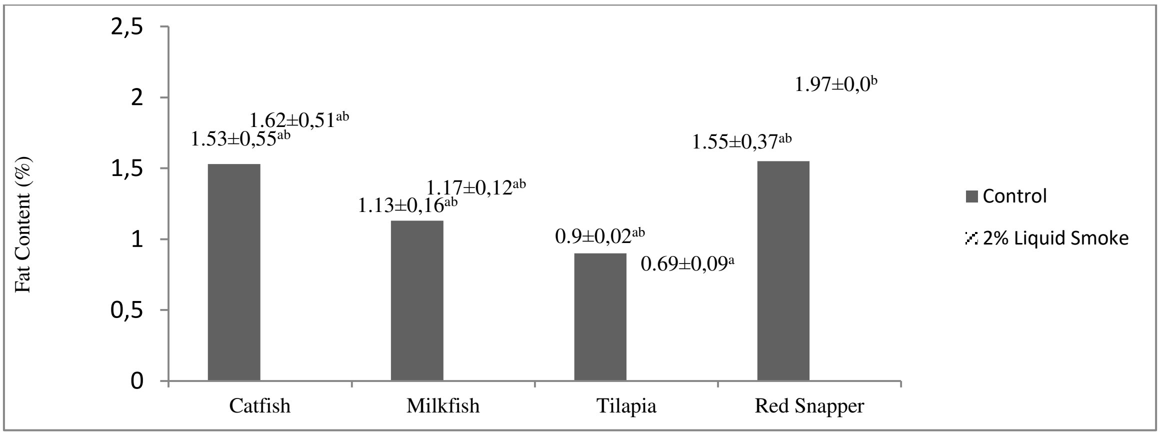

Figure-4. Fat Content of chikuwa. Superscript with different letter indicated significant difference between chikuwa (P<0.05)

Fatty Acids Profile of Chikuwa

Fatty acid profile testing was carried out to determine the fatty acid content found in chikuwa from different types of fish and treatment without or with the addition of 2% liquid smoke. The content of fatty acids in chikuwa include saturated fatty acids (SFA), monounsaturated fatty acids (MUFA), and polyunsaturated fatty acids (PUFA). SFA was a fatty acid that has no double bonds in the carbon chain. MUFA was a fatty acid with a single double bond. Unsaturated fatty acids (PUFAs) consist of polyolefinic acids with regular double bond positions. The content of commercial fish oil fatty acids could be seen in Table-4.

The content of fatty acids in chikuwa samples included lauric acid, myristic acid, capric acid, oleic acid, palmitic acid, lignoceric acid, stearic acid, linoleic acid, arachidonic acid, elaidic acid, and arachidic acid. Among these fatty acids, oleic acid was the highest composition of fatty acids. Oleic acid content ranged from 7.85 - 50.75% with an average of 40.42% and tilapia chikuwa with the addition of liquid smoke has the highest oleic acid content (50.75%).

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Table-4. Saturated Fatty acids (% from total fatty acids) of Fish and Chikuwa with different species fish.

Fish species	Type of sample	Lauric Acid	Myristic Acid	Capric Acid	Palmitic Acid	Lignoceric Acid	Stearic Acid	Arachidic Acid
Catfish	Raw Material	1.64	2.72	0	42.65	0.96	8.4	0
	0%	4.75	3.37	0.32	32.1	0.36	6.41	0
	2%	0	1.13	0	24.88	0	7.58	0
Milkfish	Raw Material	1.07	2.87	0.8	41.65	0.63	9.18	0.38
	0%	0.49	0.98	0	31.33	0.29	8.22	0.63
	2%	0.93	3.14	1.76	27.73	0.38	6.33	0
Tilapia	Raw Material	0.83	1.58	0.25	44.3	0.34	6.67	0.34
	0%	2.16	4.28	0.53	39.2	0.38	6.34	0
	2%	0	0	3.14	21.21	0	6.68	0
Red snapper	Raw Material	2.27	0.59	0.51	39.15	1.31	33.16	1.7
	0%	0.5	1.31	1	31.86	0.36	8.35	0
	2%	0	0	2.59	20.64	0	5.97	0

Table-5. Unsaturated Fatty acids (% from total fatty acids) of Fish and Chikuwa with different species fish.

Fish species	Type of sample	Oleic Acid	Linoleic Acid	Arachidonic Acid	Elaidic Acid
Catfish	**Raw Material**	**38.44**	**2.59**	**0**	**0**
	0%	46.16	0.37	0.45	1.11
	2%	50.34	2.41	2.34	2.24
Milkfish	Raw Material	27.67	0.31	0.41	1.67
	0%	48.49	0.39	1.6	1.4
	2%	37.14	1.26	0	3.22
Tilapia	Raw Material	38.2	0.57	0.21	2.28
	0%	40.89	0.37	0	4.51
	2%	50.75	1.81	2.46	5.74
Red snapper	Raw Material	7.85	2.44	0.48	1.29
	0%	48.94	1.38	1.23	1.44
	2%	50.17	1.43	2.26	4.01

The value of appearance of catfish meatballs with the addition of liquid smoke redestilation was the appearance with the highest value in all treatments that was equal to 7.93. Chikuwa appearance in general was shaped like a tube with a hollow center and the outside was shrunken and white and there was a brown ring on the outside. Chikuwa appearance with the addition of liquid smoke has the same appearance as the control but the color on the outside was different. Chikuwa light brown liquid on the outside and wrinkled [6].

According to Swastawati [7], the color difference between products was due to the relationship between the amount of carbonyl and the type of liquid smoke raw material used. The appearance of tilapia chikuwa with the addition of different liquid fumes was preferred because the appearance of chikuwa was browner in color due to the carbonyl and phenol content in the liquid smoke which plays a role in giving color.

Amino acids were the main components making up proteins, and were divided into two groups, namely essential and non-essential amino acids. Essential amino acids could not be produced in the body so often must be added in the form of food, while non-essential amino acids could be produced in the body [8]. According to Hafiludin [9], the nutritional value of each fish will be different depending on internal factors and external factors. Internal factors such as the type or species of fish, sex and age, while external factors include factors that exist in the environment of fish such as habitat, food availability, and the quality of the waters where fish live.

From the research results obtained the amino acid content of fresh fish and chikuwa consists of 16 types of amino acids. The average amino acid decreased after passing the curing process. The highest essential amino acid content was lysine amino acid, which was 221.8086 ppm in fresh milkfish and becomes 102.3017 ppm after being chikuwa and given the addition of liquid smoke treatment 2. Besides that, other essential amino acids were also found in many samples namely acids amino Glutamine was 175.6338 ppm in fresh tilapia fish and becomes 111.0724 ppm after becoming chikuwa and given the addition of 2% liquid smoke. Amino acids could provide different flavor characteristics, this was certainly in accordance with the nature of each amino acid. Types of amino acids namely aspartic acid and glutamic acid if in high amounts would dominantly give a sour taste because it has a carboxylic group, likewise bitter taste could be contributed by arginine, lysine and proline or by the presence of neutral amino acids and have large alkyl groups, acids amino that has large and small alkyl groups or two dominant amounts of aromatic amino acids [10].

According to Najih *et al.* [11], each type of liquid smoke has different phenol compounds depending on the type of wood. Many or fewer phenols that enter the fish meat could affect the acceleration of water evaporation. This was also confirmed by Zuraida *et al.* [12], that liquid smoke added to meatball products could cause water loss in the product. Gomez-Guillen et al. [13] also added is the so-called salmon fillets causing irregularity of connective tissue in the meat resulting in the release of fish meat. According to Hadinoto and Kolanus [14], that ash was an inorganic residue from food by combining the organic components in it. Hasanah and Suyatna [15] added that about 96% of food consists of organic matter and water, while the rest were mineral elements. The addition of salt in making chikuwa also affected the amount of ash produced. According to Sanny [16], that the higher the levels of salt or NaCl in a food, the higher the ash content because NaCl caused an increase in the amount of sodium minerals.

Ash content tested on chikuwa produces different values. This due to the chemical content of the raw material for making liquid smoke used, namely coconut shell containing ash content. According to Darmanto et al. [17], the chemical composition of ash content from coconut shells was 8.94%. According to Budiarti et al. [18], that the addition of liquid smoke in a processed product could cause an increase in protein due to the acidic nature of liquid smoke so that the protein did not dissolve. Sanny [16] also added that liquid smoke has high osmotic pressure so that the water contained in fish meat could be attracted and cause protein denaturation and coagulation.

Based on the results of tests that have been carried out, the value of protein content was inversely proportional to the value of the water content produced. The higher the protein content, the lower the water content. That was because the processing process in the form of roasting and adding liquid smoke. The low water content caused the protein and fat content in fish to be higher due to the heating process so that the water content decreases and gives effects such as protein denaturation [19,20]. This was also confirmed by Megawati *et al.* [21], which during the heating process that occurs would cause water losses so that protein content will increase per unit weight of the material.

According to Malelak *et al.* [22], that se'i meat was added with liquid smoke with high carbonyl content, so the fat, protein, and water content were also high because the carbonyl content functions towards the flavor produced. This was confirmed also by Widiastuti et al. [23], insignificant increase in fat content caused by the fogging process using liquid smoke could maintain the nutritional value of fat contained without changing the composition of the fat itself. Liquid smoke also has the potential to maintain durability so that there was no degradation of fat by microorganisms, because liquid smoke was able to bind water content.

Widiastuti *et al.* [23], insignificant increase in fat content caused by the fogging process using liquid smoke could maintain the nutritional value of fat contained without changing the composition of the fat itself. Liquid smoke also has the potential to maintain durability so that there was no degradation of fat by microorganisms, because liquid smoke was able to bind water content. According to Assidiq *et al.* [24], in liquid smoke contains phenol compounds which were as antioxidants, so as to prevent damage to a food product by donating hydrogen so that in very small amounts effectively inhibits the oxidation of fat by oxygen.

Oleic acid was a mono Unsaturated Fatty Acid (MUFA) known as omega 9 which could reduce blood pressure and increase HDL levels. Linoleic acid was a poly unsaturated fatty acid (PUFA) or omega 6 which plays an important role in fat transport and metabolism. Oleic acid was more effective in reducing LDL cholesterol and increasing K-HDL, whereas PUFA could reduce K-LDL but also reducing HDL, so that oleic acid was more popularly used as a food formulation [25].

Chikuwa also contains saturated lauric acid, palmitic acid, stearic acid, myristic acid, lignoceric acid, and arachidonic which was not large with an average proportion of 1.22%, 33.05%, 9.44%, 1, 83%, 0.41% and 0.95%. Of the six saturated fatty acids, palmitic acid was a saturated fatty acid where red snapper chikuwa with the addition of liquid smoke has the lowest palmitic acid content (20.64%) and the highest in fresh tilapia fish (44.3%). Saturated fatty acids (SFA) were fatty acids that contain a single bond in the hydrocarbon chain. The most saturated fatty acid content found in red snapper meat was palmitic acid (C16: 0), stearic (C18: 0) and myristic (C14: 0) [26].

CONCLUSIONS

Provision of three types of liquid smoke namely lemongrass stems, coconut shells, and corncobs on chikuwa from catfish, milkfish, snapper, and tilapia fish treatment without and with the addition of 2% liquid smoke gave a real influence on hedonic values, phenol content, levels of water, protein content, ash content, and fat content. Amino acid profile highest content in fresh milkfish was lysine of 221,8086 ppm and fatty acids content in composition was oleic acid ranging from 7.85% - 50.75% with an average of 40.42%. Chikuwa made from tilapia was found as the most acceptable by panelists with hedonic values; 8.68 <μ <8.69.

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