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Quality Characteristics of Tilapia Fish (*Oreochromis Niloticus*)with Addition of Liquid Smoke

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A B S T R A C T

Kekian is a type of processed product generally made using meat that has been crushed and added with spices and then wrapped in skin. Kekian has an appearance similar to otakotak, kekian is one of the fish jelly products, where texture is a significant parameter in determining quality. Liquid smoke has a golden yellow color and plays a role in forming color because of the compounds in liquid smoke, namely carbonyl compounds. Liquid smoke contains cellulose and hemicellulose that produce organic acids such as acetic acid that acts as a carboxylate, phenol, cresyl, ketone, antibacterial, and carbonyl as color formation. This research aims to determine the effect of adding liquid smoke on the color and texture of tilapia fish. The procedure used in making tilapia kekian is preparing raw materials, making batter, and steaming. The experimental design used in this research was a Completely Randomized Design (CRD) with four different liquid smoke concentration treatments such as 0%, 0.5%, 1%, and 1.5%. Parametric data was analyzed using Analysis of Variance (ANOVA) and Honest Significant Difference (BNJ) on SPSS 26 software. Testing for tilapia fish fertility included water content, protein content, color test, texture test, amino acid test, and hedonic test. The addition of 1% liquid smoke was better than other treatments with a water content test of 61.06% ± 0.26, protein content 13.78% ± 0.07, phenol content 206.94 ppm ± 1.29, color test L*, a*, b* respectively 63.68, -4.41, and 16.76, the resulting texture is also good with a hardness of 56.21 ± 0.56, as well as the hedonic test with mean 7.98< μ <8.05. The exact concentration of liquid smoke produces kekian that has good characteristics and is chemically and sensory acceptable.

Keywords: *Liquid Smoke, Tilapia, Kekian, Texture, Color*

1. INTRODUCTION

Tilapia (*Oreochromis niloticus*) is a freshwater fish that is widely cultivated by the Indonesian people. Tilapia can easily adapt to different environments and is easy to cultivate. This fish has both economic and nutritional value. According to RR Saputra*et al*. (2020), tilapia has better nutritional content than other freshwater fish, such as catfish. The protein content of tilapia is 43.76%, water content is 79.44%, fat is 7.01%, and ash content is 6.80% per 100 grams of fish weight. In comparison, catfish has a protein content of 40.28%, fat content of 11.28%, and ash content of 5.52%.

Liquid smoke is the result of the distillation or condensation of steam from burning materials containing certain compounds or carbon like wood, corn cobs, etc. Liquid smoke contains large amounts of cellulose, hemicellulose, and lignin compounds. The pyrolysis results of these compounds are in the form of organic acids, phenols, and carbonyls that have a role in forming the color and taste of the product (Juwita*et al*. 2016).

Kekian is a processed fishery product using crushed fish/shrimp meat, flour, and other ingredients, shaped and wrapped using a skin that undergoes steaming treatment. Kekian is part of fish dumplings, where texture is a significant parameter in determining quality. The white color tends to attract less consumer interest. The addition of liquid smoke gives it a more attractive color, namely golden yellow to brown. It happened because liquid smoke contains carbonyl compounds.

This research aims to determine the quality characteristics of tilapia fish to which different concentrations of liquid smoke were added based on water content test, protein content test, phenol content test, color test, texture test, amino acid test, and hedonic test and determine the best quality of kekian. After adding liquid smoke with different concentrations of liquid smoke.

2. MATERIAL AND METHODS

2.1 Procedure

This research was carried out experimentally in a laboratory manner. The research using a simple Completely Randomized Design (CRD) with four treatments, namely the addition of liquid smoke concentrations of 0%, 0.5%, 1%, and 1.5%, with three repetitions. Data analysis was carried out using SPSS software with analysis of variance (ANOVA) testing and continued with the Honest Significant Difference (BNJ) test with a level of 5% for the water content test, protein content test, amino acid test, phenol content test, texture test, and color test. Sensory data testing was carried out using the nonparametric Kruskall-Wallis test and continued with the Mann-Whitney test.

2.2 Water Content Test (BSN, 2015)

Water content analysis uses the gravimetric method. This method has the principle that the water contained in the material will evaporate if the material is heated to a temperature of 105℃ during a specific time.

Water content can be weighed using the formula:

Water content (%) = $\frac{B-C}{B-A} X\ 100\%$

Information:

A : Weight of Empty Cup (g)

B : Weight of cup and sample before drying (g) C: Weight of cup and sample after drying (g).

2.3 Protein Content Test (BSN 2006)

Analysis of protein levels using the Kjeldahl method includes digestion, distillation, and titration. The sample was weighed 0.1-0.5 g and then placed in a Kjeldahl flask, after that 40 mg HgO, 1.9 mg K2SO4, and 2 ml H2SO4 into the flask. The flask containing the solution is placed in a heating device with a temperature of 430 C in the acid chamber. Digestion is carried out until it becomes a clear solution. The digestion results are slowly diluted with 10-29 ml of distilled water. After that, it goes to the distillation and titration stage.

Calculation of protein content can be obtained by

$$\%N = \frac{(A - B) \times N\ HCl \times 14}{mg\ sampel} \times 100$$

Protein content = %N x Conversion factor (6.25) A:

ml sample titration

B: ml blank titration

2.4 Phenol Content Test (Privateat al.,2013)

Testing for phenol content using the Folin-Ciocalteau method was carried out by dissolving 50 mg of the sample in 2.5 ml of 95% ethanol and then shaking using a vortex. The solution was centrifuged at a speed of 4000 rpm for 5 minutes. 1 ml of the supernatant from centrifugation was taken and mixed with 1 ml of 95% ethanol and 5 ml of distilled water, shaken using a vortex. The mixture was left to rest for 5 minutes. The solution was added to 1 ml of 5% Na2CO3, and then shaken with a vortex. The solution was kept for 1 hour in a dark room, then measurements were carried out with a spectrophotometer at a wavelength of 725 nm. Phenol content was determined based on the standard curve equation. The standard for making a standard curve is gallic acid (y=ax+b). Texture Test (Indiartoet al.,2012).

Test the texture using the tools Texture Analyzer Start by placing the sample on the testing plate under the probe. This probe is operated with Analyzer software, with a sample pressing speed setting of 1.1 nm/s. During pressing, the computer screen will display a graph from the zero position until it reaches the peak point (peak force). This point is the maximum gel strength point of the sample being tested and will return to zero once this point is reached. The peak point will be called the pressure to break the product (F), and the distance when the product breaks (D).

Calculation:

Gel strength: F x D (g.cm) Information :

F (Force): pressure to break down the product (g)

D (distance): distance when the product breaks (cm)

2.5 Color Test (Benjakul et al. 2017 and Indrayati et al. 2013)

The color test is carried out using a chromameter, the working principle of the chromameter tool is to obtain color based on the reflectivity of the sample against the light given by the chromameter. The tool used was Color Reader CR-400/410 (Minolta). The process begins with sample preparation by cleaning the sample so that it is free from dust, and then placing it in a stable chromameter to get accurate results. Make sure the tip of the chromameter is on the object to be measured, then turn on the tool to get the results a numerical value.

The color notation system is characterized by 3 values, namely L (lightness) a* (Redness)

b* (Yellowness)

The L, a, and b values have scale intervals that indicate the color level of the material being tested. The notation L states the brightness parameter with a value range from 0-100 shows from dark to light. The notation a (Redness) with a value range of (-80) ± (+100) indicates from green to red. The notation b (yellowness) with a value range of (-70) ± (+70) indicates from blue to yellow.

2.6 Amino Acid Test (Rahayuet al., 2020)

Test the amino acid lysine ground in a mortar, take 1 gram, and suspend 100 ml of distilled water in an Erlenmeyer flask. Add a 4% sodium bicarbonate solution, then heat at 40 C for 10 minutes using a water bath, then add a 0.1% ninhydrin solution and continue heating at the same temperature for 110 minutes. Next, 3 ml of 6 N hydrochloric acid solution was added and heated in an autoclave at 120 C for 60 minutes.

2.7 Hedonic Test (BSN 2015)

The hedonic test or liking test is carried out by panelists to measure the level of liking. Tests were carried out on appearance, aroma, taste, and texture. The hedonic test is carried out using a scoring method using a scoresheet. The assessment uses an assessment sheet table with a scale of 1-9. Scale 9 indicates like it very much, scale 7 indicates like it, scale 5 indicates quiet, scale 3 indicates dislike, and scale 1 indicates dislike very much. Several parameters are assessed including appearance, color, smell, taste, and texture.

For panelists, 30 panelists were used.

3. RESULTS AND DISCUSSIONS

3.1 Water Content Test

Table 1. Water content in tilapia fish added to liquid smoke.

Treatment	Water content (%)
K (0%)	69.23 ± 0.96^{d}
P1 (0.5%)	65.21 ± 0.27^{c}
P2 (1%)	61.06 ± 0.26^{b}
P3 (1.5%)	59.13 ± 0.69^{a}

Information:

- Data are the average of three replications with different liquid smoke concentrations ± SD
- The data shows that there is a significant difference ($P<0.05$)

The results of the table above show that the water content value decreased when liquid smoke was added. This is because the addition of 0.5% liquid smoke has an effectiveness of 4% in reducing the water content of the product, the addition of 0.5% liquid smoke has an effect of 2% in reducing the water content in a product. According to (Anggraini et al., 2022), the increasing concentration of liquid smoke causes a decrease in the water content of fish products. The reduction in water content is caused by the liquid smoke solution which seeps into the meat by osmosis so that free water is forced out. Following SNI 7756:2013, the maximum water content of processed fishery products is 60%, this research has quite high water content due to the raw materials and processing process. The steaming process with water vapor tends to increase the water content of food.

3.2 Protein Content Test

Table 2. Protein content in tilapia fish added with liquid smoke.

Treatment	Protein Content (%)
K (0%)	13.46 ± 0.18^{b}
P1 (0.5%)	13.47 ± 0.08^{b}
P2 (1%)	13.78 ± 0.07^{c}
P3 (1.5%)	11.38 ± 0.05^{a}

Information:

- Data are the average of three replications with different liquid smoke concentrations ± SD
- The data shows that there is a significant difference ($P<0.05$)

The protein content of tilapia fish did not increase significantly and decreased when the third 0.5% liquid smoke was added. The protein content value had an increase that was not too significant, namely 0.01 to 0.31. This is because the phenol content increases with the addition of liquid smoke. The high phenol content causes the protein to denature. According to (Anggraini et al., 2022) protein levels will decrease because the phenol content in liquid smoke will react with the protein components, so the amount of protein that reacts with phenol, the protein tends to decrease. According to (Dwiari et al., 2008), phenol compounds tend to react with the SH (Sulfur - Hydrogen) group of proteins. This reaction results in denatured proteins which can cause a decrease in the protein value of the smoked material.

3.3 Phenol Content Test

Table 3. Phenol levels in tilapia fish added to liquid smoke

Treatment	Phenol Content (%)
K (0%)	175.31 ± 3.11^{a}
P1 (0.5%)	185.5 ± 1.29^{b}
P2 (1%)	206.94 ± 1.29^{c}
P3 (1.5%)	245.32 ± 2.52^{d}

Information:

- Data are the average of three replications with different liquid smoke concentrations ± SD
- The data shows that there is a significant difference ($P<0.05$)

Phenol levels in tilapia fish that were added to liquid smoke increased. This is caused by the raw materials used in making kekian such as garlic, cornstarch, and liquid smoke which contains phenolic compounds and their derivative compounds. Garlic contains phenolic compound derivatives, namely flavonoids, amounting to 61.44mg GAE/g, and cornstarch contains phenolic compounds amounting to 7.29-15.35mg/100g. According to Swastawati et al., (2007), the phenol content in lamtoro wood liquid smoke is higher (481.2 ppm) than in corncob liquid smoke (335 ppm). The phenol content that is safe for consumption is 0.02% - 0.1% or 200 ppm - 1000 ppm. According to (Hutomo et al., 2015), phenols in fishery products act as antioxidants, which contribute to the color and taste of smoked products and have a bacteriostatic effect, which contributes to shelf life. Phenolic compounds and organic acids are used in preservation because they contain antibacterial and antioxidant compounds.

3.4 Texture Test

Table 4. Texture of tilapia fish with the addition of different concentrations of liquid smoke

Treatment	Hardness	Springness	Cohesive
K	61.35 ± 1.25^{c}	0.82 ± 0.01^{a}	0.41 ± 0.01^{a}
P1	57.64 ± 0.05^{b}	0.80 ± 0.02^{a}	0.36 ± 0.02^{b}
P2	56.21 ± 0.56^{b}	0.80 ± 0.03^{a}	0.37 ± 0.00^{bc}
P3	52.54 ± 0.91^{a}	0.78 ± 0.02^{a}	0.25 ± 0.01^{c}

Information:

- Data are the average of three replications with different liquid smoke concentrations ± SD
- The data shows that there is a significant difference ($P<0.05$)

Mark hardness is more related to the level of hardness of the product. The hardness value of tilapia fish added with liquid smoke decreased. Value resultshardness. The differences are due to water content and the materials used. The higher the flour added, the higher the value hardness will increase further. Increase hardness value influenced by protein and water content. The high water content will cause the hardness value to decrease and conversely, the lower the water content, the water content will cause the hardness value to increase. Kekian added with liquid smoke does not have a real effect on the springiness value or elasticity of the product. The average springness value results show a chewy nature, this is because there is tapioca flour in the raw material for making kekian. The levels of amylose and amylopectin in gelatinized flour, provide flexibility properties. According to (Sholichah et al., 2020), gelatinization is influenced by the amount of water and heat. The heat transfer process by water vapor during the steaming process occurs evenly in all parts so that the dough binds together and forms a cohesive and elastic lemang matrix. The cohesiveness of tilapia fish has decreased, this is influenced by the starch component in tapioca flour, starch undergoes gelatinization in the presence of water during the cooking process. According to (Sholichah et al., 2020), cohesion is not influenced by cooking itself; rather, it is influenced by the starch component, which undergoes gelatinization in the presence of water during the cooking process. Heat energy during cooking causes the breaking of hydrogen bonds in starch and forms hydrogen bonds with the molecules that make up starch.

3.5 Color Test

Table 5. Test results for various colors added with different liquid smoke

	K	P1	P2	P3
L*	66.87 ± 1.10^{b}	69.82 ± 1.04^{c}	63.68 ± 0.12^{a}	64.67 ± 0.56^{ab}
a*	-4.70 ± 0.19^{a}	-4.29 ± 0.16^{a}	-4.41 ± 0.17^{a}	-4.26 ± 0.08^{a}
b*	16.32 ± 0.07^{a}	16.62 ± 0.22^{ab}	16.67 ± 0.13^{b}	16.92 ± 0.05^{b}

Information:

- Data are the average of three replications with different liquid smoke concentrations ± SD
- The data shows that there is a significant difference ($P<0.05$)

The brightness value (L*) is a parameter that determines the brightness level of a product in color testing. The brightness level has a value range of 1-100. The color of tilapia fish has a high L* value, meaning that tilapia fish have good brightness. Conversely, if the value is low then it will increasingly have a dark color. The color of tilapia fish with the addition of liquid smoke has a yellowish-white color. The results of the L* value analysis of tilapia fish with the addition of liquid smoke have values ranging from 63.68-69.52. The brightness values of the 4 treatments did not differ much. This is due to the use of tofu flowers to wrap the dough before steaming. According to (Santoso et al., 2020), brightness is an important factor in the quality of food ingredients which can directly affect the physical appearance of food products. The brightness in food also greatly influences consumer decisions in selecting food products.

The redness level value (a*) is a parameter in color testing that shows the reddish or greenish color. The reddish color indicates the a* value has a positive number (+), while the greenish color indicates the a* value has a negative number (-). The results of the redness value analysis have a value range of -4.70 to -4.26. The lowest value was obtained by K with a value of -4.70 and the highest value was P3, namely -4.26. The results obtained from the four treatments showed that tilapia fish with the addition of liquid smoke tended to have a green color rather than red.

The yellowness level value (b*) is a parameter in color testing that shows the presence of yellow and blue colors. A positive b* value indicates yellow, while a negative b* value indicates blue. The results of the yellowness value analysis range between 16.32 and 16.92. The lowest value was obtained from treatment K with a value of 16.32, while the highest value was P3 with a value of 16.92. The analysis concludes that the addition of liquid smoke significantly affects the yellow color. This is because liquid smoke has a brownish-yellow color. According to RY Saputra et al. (2020), the color of liquid smoke becomes yellow due to the reduction of tar and benzo(a)pyrene content, resulting from the reaction of acetic acid, the dominant compound in liquid smoke.

3.6 Amino Acid Test

Table 6. Test results for various essential amino acids added with different liquid smoke

JenisAsam Amino	**Hasil**			
	K	**0,50%**	**1%**	**1,50%**
Histidin	0,90	0,65	0,75	0,79
Treonin	0,97	0,60	0,70	0,81
Valin	0,80	0,55	0,68	0,76
Metionin	1,04	0,78	0,89	0,95
Isoleusin	1,18	1,04	1,10	1,17
Leusin	1,66	1,32	1,47	1,59
Phenilalanin	0,97	0,76	0,82	0,89
Lisin	1,57	1,17	1,29	1,38

From the table above, there are eight essential amino acid components contained in kekian with the addition of smoke, either by soaking in liquid smoke. This shows that the quality of smoked kekian is quite high and good for consumption. Of the eight essential amino acid components in smoked kekian, the highest level is lysine. The lysine content in control smoked fish is 1.57%, while the percentage of lysine in smoked fish using liquid smoke at concentrations of 0.5%, 1%, and 1.5% are 1.17%, 1.29%, and 1.38%, respectively. Lysine is an essential amino acid necessary for growth. The amino acid lysine cannot be synthesized by the body, so it must be obtained from food intake. According to Himawati (2010), the phenol and organic acid content in liquid smoke influences the amino acid content of smoked fish. This is because the combination of phenol and high organic acid content synergistically prevents and controls the growth of microbes that cause spoilage, where proteins and amino acids are converted into ammonia compounds, which are alkaline in nature.

Table 6. Test results for other non-essential amino acids added to liquid smoke b different

JenisAsam Amino	Hasil			
	K	0,50%	1%	1,50%
AsamAspartat	1,87	1,56	1,64	1,73
AsamGlutamat	2,82	2,11	2,27	2,34
Serin	0,80	0,45	0,53	0,61
Glisin	1,13	0,72	0,88	0,93
Arginin	0,85	0,58	0,64	0,73
Alanin	1,51	1,07	1,22	1,34
Prolin	1,68	1,23	1,37	1,42
Tirosin	0,86	0,67	0,75	0,80
Sistein	0,96	0,60	0,68	0,81

The analysis of kekian tilapia fish with liquid smoke showed that there were amino acid components contained in kekian products with the addition of liquid smoke and without the addition of liquid smoke. The product with liquid smoke with a concentration of 1.5% has a higher total amino acid content than liquid smoke concentrations of 0.5% and 1%. The glutamic acid in non-essential amino acids is the highest in non-essential amino acids. The glutamic acid content in the control kekian was 2.82%, and in the kekian with liquid smoke, it was 0.5%, 1%, and 1.5%, namely 2.11%, 2.27%, and 2.34%. The necessary role of Glutamic acid is to give food a pleasant and delicious taste. According to Apituley (2010), liquid smoke can inhibit protein denaturation in the product which helps the amino acid content value be maintained. Phenol and carbonyl content of liquid smoke can inhibit the protein denaturation process.

3.7 Hedonic Test

Parameter	Perlakuan			
	K	P1	P2	P3
Kenampakan	7,33 ± 0.92^{a}	7,93 ± 1.25^{ab}	8,27 ± 0.98^{b}	7,53 ± 0.73^{a}
Bau	7,33 ±0.92^{a}	7,93 ± 0.00^{ab}	8,26 ± 0.98^{bc}	7,53 ± 0.78^{a}
Rasa	7,60 ± 0.82^{a}	7,73 ± 0.81^{a}	7,46 ± 0.80^{a}	7,46 ± 0.80^{a}
Tekstur	6,93 ±0.93^{a}	7,46 ± 0.98^{b}	8,07 ± 0.86^{c}	7,80 ± 0.99^{bc}
SelangKepercayaan	7.26< μ < 7.33	7.82< μ <7.91	7.98< μ <8.05	7.42< μ <7.74

Hedonic testing on kekian was carried out by assessing samples' appearance, odor, taste, texture, and mold parameters. The results of the Kruskal-Wallis test on the appearance of tilapia fish with different concentrations of liquid smoke showed a significant effect (P<5%) between treatments. Hedonic testing shows that the most preferred appearance is P2(1%), with a value of 8.27, where the tilapia fish has a complete appearance and attractive color caused by the processing and steaming process which can change the appearance of the tilapia fish Hedonic testing shows that the most preferred smell is P2 (1%), with a value of 8.26, where the tilapia fish has a specific smell originating from the raw materials and spices used, the liquid smoke used has a particular smell, thus influencing the panelists' liking level.

The results of the Kruskal-Wallis test on the taste of tilapia fish with different concentrations of liquid smoke showed no significant differences between treatments (P>5%). The average taste parameter of tilapia fish has a value between 7.46 and 7.73. The hedonic test results with the most preferred texture parameter are P2(1%), which has a dense texture but is not too soft because the water content contained in the product is not too high.

4. CONCLUSIONS

The conclusions of the research on the quality characteristics of Tilapia fish (Oreochromis niloticus) resulting from the addition of liquid smoke are as follows: The addition of liquid smoke to tilapia fish has a significant effect on its color, texture, water content, protein content, and phenol content. The water content, protein content, and texture decreased, while the phenol content increased. The amino acid profile of tilapia fish with the addition of liquid smoke varies at each concentration. Liquid smoke also results in kekian having a chewier, less hard texture and a more attractive color. The optimum concentration of liquid smoke for enhancing tilapia fish growth is 1%. The best concentration results were obtained from parametric tests for high levels of phenol and protein. Additionally, 1% liquid smoke increased the hedonic value of tilapia fish, making it the most popular among panelists.

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