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Sensory and Chemical Characteristics of Fish Sauce from Different Types of Fish Raw Materials with the Addition of Trypsin Enzyme

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A B S T R A C T

Fish sauce is a fermented product made from trash fish and fish waste as a condiment for cooking. The best fish sauce is made from anchovies. The limited availability of anchovies, which depends on the season, causes a decline in fish sauce productivity, while the catch of other types of trash fish tends to be high. This could be another alternative as a raw material for making fish sauce. This study aims to determine the sensory and chemical characteristics of the best fish sauce with different raw materials that have low economic value, such as petek fish, juwi fish, and parang-parang fish, with the addition of 25% salt (NaCl) and 0.3% trypsin enzyme during 45 days of fermentation. The experimental design used in this study was a completely randomized design with three treatments, namely three different fish sauce raw materials and three replicates. Quality testing analysis included hedonic, pH, salt content, color, and total N. Parametric data were analyzed using ANOVA, and differences between treatments were tested using the Honest Significant Difference test. The results showed that differences in raw materials had a significant effect ($P<0.05$) on the value, yield, pH, Total N, salt content, color, and hedonic properties of fish sauce. At the end of the fermentation process, based on different raw material treatments, the use of petek fish raw material had the best quality among the three treatments with an average hedonic value of $6.91 < \mu < 7.27$, pH (6.11), Total N (11.27 g/L), and salt content (255.91 g/mL). The highest yield and L* color test values were found in parang-parang fish sauce (yield = 36.09% mL/g), (L* = 46.91). The highest a* color test value was found in juwi fish sauce (a*=0.26), and the highest b* color test value was found in petek fish sauce (b*=26.87).

Keywords: Fish Sauce, Petek Fish, Juwi Fish, Parang-Parang Fish, Trypsin, Characteristics

INTRODUCTION

Indonesia has a very low level of fish sauce production. This is related to the availability of fish raw materials that are suitable for use in fish sauce production. Several fish sauce producers want to use anchovies as raw material in their production. However, anchovies are not always easy to obtain, given that natural conditions and seasons affect their availability. This would not be a difficult problem for fish sauce producers if they knew of other alternative fish that could be used as raw materials for fish sauce. Besides anchovies, other low-value fish that can be used as raw materials for fish sauce are rucah fish, which include petek fish, juwi fish, and parang-parang fish. According to Subiharta et al. (2001), fishermen around Tegal consider rucah fish to have low economic value, so they are usually discarded or sold at low prices. Rucah fish such as petek fish have good nutritional content that is good for consumption. The use of petek fish as a processed fishery product has an impact on improving the economy of fishermen.

The use of petek fish, juwi fish, and parang-parang fish as raw materials in the production of fish sauce is to increase nutritional value and turn these fish into products with high economic value. Petek fish, juwi fish, and parang-parang fish are less popular in their fresh form, so they are mostly marketed in dried/boiled salted form. In this case, the fish will be processed into fish sauce products. The relatively long process of making fish sauce requires enzymes to shorten the fermentation time. The use of enzymes in the fish sauce production process can accelerate fermentation, thereby reducing the time required for production. In addition to accelerating fermentation, the use of enzymes can also affect the sensory and chemical properties of the fish sauce. The sensory and chemical values of a product are very important in relation to consumer acceptance of the product. According to Mahrus and Zulkifli (2019), fish sauce can also be made by adding certain enzymes to accelerate protein hydrolysis, known as the enzymatic method.

Fish have different characteristics depending on the type, including chemical characteristics. This greatly affects the nutritional content of fish sauce products. According to Permanasari et al. (2014), the types of fish used in the production of fish sauce vary and affect the nutritional quality of fish sauce, especially its nitrogen content. Hafiludin (2015) added that the nutritional content of each fish will vary depending on internal factors (fish type, sex, age) and external factors (living environment).

Based on previous studies, the production of fish sauce using various raw materials added with enzymes causes different sensory test results. The chemical composition of various types of fish, one of which is amino acids, causes the taste, aroma, and color of the resulting fish sauce to also differ. Based on previous tests, further research is needed on the quality criteria in terms of sensory (appearance, aroma, taste) and chemical (total N, pH, and salt content) aspects of fish sauce products made from petek, juwi, and parang-parang fish.

RESEARCH METHOD

Tools and Materials

The materials used in this study were petek fish, juwi fish, and parang-parang fish obtained from the Morodemak, Demak, Central Java fish landing site. The fish used were fresh and clean.

The equipment used included a blender, basin, digital scale, glass jars, spoons, tea strainer, muslin cloth, *autoclave*, and *centrifuge.*

Fish Sauce Production Process

The method for making fish sauce using petek, juwi, and parang-parang fish as raw materials began with washing the fish thoroughly, then blending each fish until it became a paste. Samples for each treatment were weighed at 598 grams, then 149.5 grams of salt (25% w/w) and 1.8 grams of trypsin enzyme (0.3% w/w) were added and mixed thoroughly. The mixture was then placed in glass jars and sealed tightly. Fermentation was carried out for 45 days at room temperature. After 45 days of fermentation, the mixture was sterilized using *an autoclave* at$^{115°C}$for 15 minutes. The sterilized product is then filtered in three stages using a coconut milk strainer, tea strainer, and muslin cloth. The filtered solution formed after the fermentation process is then separated from the solids using *a centrifuge* at a speed of 5000 rpm for 15 minutes. The fat on the surface is removed using a spoon, and the supernatant is filtered again using filter paper.

Yield

Fish sauce yield (%) indicates the ratio between the fish sauce produced during the fermentation process (mL) and the total weight of the sample used (g). The fish sauce yield percentage is calculated using the formula:

$$\text{Yield (\%)} = \frac{Product\ mass}{Mass\ of\ raw\ materials} \times 100$$

pH (BSN, 2004)

pH (acidity) measurements using a pH meter refer to the pH measurement method SNI 06-6989-11-2004. pH determination is as follows:

1. The pH meter is first calibrated with standard pH buffers of 4 and 7. The pH meter is stabilized for 15-30 minutes, then the electrode is rinsed with distilled water and dried.
2. A 5 mL sample is prepared, then the electrode is immersed in the sample solution and the pH value can be measured.
3. The electrode is left immersed for a few moments until a stable reading is obtained, then the result of the scale reading or the number displayed on the pH meter is recorded

Salt Content Test Using the Mohr Argentometric Titration Method (Wiryawan, 2011)

Salt content can be determined using the titration method. The principle of Argentometric salt content testing using the Mohr method is to react the sample with a silver nitrate solution that has been previously added with potassium chromate indicator. First, 10 ml of the fish sauce sample to be tested is taken. Then, the sample is diluted using distilled water in a 100 ml measuring flask up to the mark. After that, it is homogenized. Then, 10 ml of the solution is taken and placed in an Erlenmeyer flask. Next, several drops of potassium chromate (K2CrO4) indicator are added to the solution, and it is titrated using silver nitrate (AgNO3) solution until the color changes to brick red. The amount of AgNO3 used is recorded and calculated using the formula:

$$\%\text{NaCl} = \frac{\text{(V.N AgNO3)x Be NaCl x fp}}{\text{mL sample x 1000}} \times 100$$

Explanation:

V $AgNO_3$ = volume used to change the solution color until a brick-red precipitate forms

N $AgNO_3$ = Normality of $AgNO_3$ Be NaCl = 58.5

Fp = Dilution factor (10/100)

Total Nitrogen Kjeldahl Method (AOAC, 2005)

1. The calculation of total nitrogen (Total N) using the Kjeldahl method according to (AOAC, 2005) is as follows:

The sample is weighed at 2 grams, then placed into a 50 mL Kjeldahl flask. 7.0 g of$K2SO4$ and 0.8 g of Cu$SO4$ are also added to the flask as catalysts.

After that, each tube was added

$H2SO$e (4).

2. The sample was destroyed at a temperature of 410°C for ± 2

3. hours until the liquid turned clear green. The Kjeldahl flask was washed with distilled water to 80 mL, then the water was placed in the distillation apparatus. The distillation product was collected in a 125 mL Erlenmeyer flask containing 25 mL of 4% boric acid ($H3BO3$) containing the following indicators

bromochlorisol green 0.1% and methyl red 0.1%

in a 2:1 ratio.

4. Distillation is performed by adding 50 mL of 40% NaOH solution to the distillation apparatus until 100-150 mL of distillate is collected in the Erlenmeyer flask, with the distillate appearing green in color. The distillate is titrated with 0.1M HCl until the first pink color change occurs. The volume of titrant is read and recorded. The blank solution is also analyzed like the sample. The nitrogen content is calculated using the following formula:

$$\%N = \frac{\text{mlL HCL} - \text{mL blank x N HCL x 14.007}}{\text{mg sample}} \times 100$$

Color Test using Hunterlab ColorFlex EZ Spectrophotometer (Putra, 2012)

The sample was placed in a glass beaker until the entire bottom of the glass beaker was covered by the material. Color analysis was then performed using the Hunterlab ColorFlex EX Spectrophotometer. The fish sauce color test was performed using the Hunter L*, a*, b* color system. The chromameter was first calibrated with the white color standard provided with the device. The analysis results produced several L (Lightness), a*, and b* values. The total color degree measurement used a white color base as the standard.

Hedonic Test (BSN, 2006)

Hedonic testing is a test that shows the level of consumer preference for a product. This test was conducted by 30 semi-trained panelists who assessed the products based on a provided *scoresheet*. The rating scale was, which is 1-9, with the highest score being 9 and the lowest being 1. The calculation of these values uses standard deviation and standard deviation, resulting in a hedonic score. For the final results, the smallest value from the interval is used.

Data Analysis

The method used in this study was the *laboratory experimental method*. The experimental design used was a complete randomized design (CRD) factorial with treatments differing in raw materials, namely petek fish and juwi and ikan parang-parang with the addition of 0.3% trypsin enzyme to observe the effect of treatment on the sensory and chemical quality of fish sauce. The tests conducted included total nitrogen, pH, color, yield, salt content, and hedonic tests on fish sauce. Then, ANOVA was tested to determine whether there were significant differences. If the results showed significant differences, then the Honest Significant Difference (HSD) test was conducted to determine the differences between treatments. Non-parametric test data obtained

The results of the hedonic test for fish sauce were analyzed using the Kruskal-Wallis test to determine whether there was a significant difference, followed by the Mann-Whitney test to determine the differences between treatments.

Results and Discussions

Yield

The results of the analysis of variance (ANOVA) for fish sauce yield showed that the use of different types of raw materials in the production of fish sauce had a significant effect (P < 5%). Result of yield on fish sauce can beviewed in Table 1.

Table 1. Fish Sauce Yield Results with Different Types of Fish Raw Materials

No	Treatment	Yield (%mL/g)
1.	Juwi	28.4 ± 0.62^{a}
2.	Petek	33.47 ± 0.61^{b}
3.	Parang-Parang	36.09 ± 0.54^{c}

- Data are the results of three repetitions ± standard deviation
- Data followed by different superscript letters indicate significant differences (P<0.05).

The results of the BNJ test for fish sauce yield showed significant differences in each treatment. The results of the fish sauce yield test for petek fish, parang-parang fish, and juwi fish ranged from 28.4-39.09% mL/g. Based on the data The yield produced shows that differences in raw materials used in the production of fish sauce affect the yield value of fish sauce products. According to Annisa *et al*. (2017), differences in yield values are caused by

differences in fish species used in the study, which have different soluble nutritional components during the hydrolysis process. Jamil *et al. (*2016) also explain that differences in yield may be due to differences in fish species, fish parts, types of enzymes used, salt concentration, and hydrolysis conditions applied.

In the study by Simanjorang *et al.* (2012), it was added that the more salt there is, the more water will come out of the snail meat. Along with the release of water, salt will enter the tutut meat. Astawan (1988) also added that the process of soy sauce formation is aided by the activity of protease and lipase enzymes, which break down fish proteins and fats into simpler components (amino acids and fatty acids) that can be absorbed by our bodies. The addition of enzymes will cause higher hydrolysis and produce higher levels of simple compounds. The simple compounds resulting from hydrolysis will exit the tissue and mix in the liquid formed during the fermentation process.

pH (Acidity Level)

The results of the analysis of variance (ANOVA) test showed that the pH of fish sauce indicated that the use of different types of raw materials in the production of fish sauce had a significant effect (P<5%). Result of pH test on fish sauce can beviewed in Table 1

Table 2. pH Test Result of Fish Sauce with Different Types of Fish Raw Materials

No	Treatment	Yield (%mL/g)
1.	Juwi	5.51 ± 0.020^{a}
2.	Petek	5.89 ± 0.015^{b}
3.	Parang-Parang	6.11 ± 0.056^{c}

- Data are the results of three replicates ± standard deviation
- Data followed by different superscript letters indicate significant differences (P<0.05).

The results of the BNJ pH test for fish sauce show that fish sauce made from petek fish has a higher pH than fish sauce made from parang parang fish and juwi fish. The pH test results for fish sauce ranged from 5.51 to 6.11, which means that all three fish sauces meet the pH requirements for fish sauce in SNI and *Codex* 302-2011. Based on BSN (2017), the pH of fish sauce between 5-6 is typical for traditional products, but should not be lower than 4.5 if ingredients are used to aid the fermentation process.

Different types of fish are thought to affect the pH value of fish sauce products, based on the physical and chemical properties of each fish, such as growth patterns that influence the components of fish tissue. According to Nurjanah *et al*. (2011), lactic acid production from anaerobic glycolysis after the fish dies determines the pH change in fish meat. Changes in the pH value of fish depend on various factors such as fish species, fishing methods, food, and other conditions. Anggraeni and Yuwono *(*2014) added that the differences in pH values among these varieties are due to each variety having different physical and chemical properties, so that the pH value of this raw material can affect the pH value of fermented sweet potato flour.

The decrease in the pH value of fish sauce is also influenced by the addition of enzymes and salt. Enzymes added during the fish sauce production process cause the pH value of the product to decrease. With the presence of enzymes, the degree of hydrolysis increases, producing acidic compounds. In addition, the use of salt in the fermentation process also affects the pH value, because during the fermentation process, salt inhibits the growth of spoilage microbes and stimulates the growth of lactic acid bacteria. Lactic acid produced from metabolism during the fermentation process can lower the pH. According to Kristianawati *et al. (*2014), in addition to the addition of enzymes, the low pH value of fish sauce is thought to be due to the use of a fairly high concentration of salt.

Salt Content (NaCl)

The results of the NaCl variance test (ANOVA) show that the use of different types of raw materials in the production of fish sauce has a significant effect (P < 5%).

Table 3. Results of Salt Content (NaCl) Test of Fish Sauce with Different Types of Fish Raw Materials ract

No	Treatment	NaCl (g/L)
1	Juwi	249.43 ± 1.18^{a}
2	Parang-Parang	251.76 ± 0.75^{b}
3	Petek	255.91 ± 0.23^{c}

- Data are the results of three repetitions ± standard deviation
- Data followed by different superscript letters indicate significant differences (P<0.05).

The results of the BNJ NaCl fish sauce test showed significant differences in each treatment. Salt content (NaCl) is an important parameter for determining the quality of fish sauce products. The salt content test results for petek fish sauce, parang parang fish sauce, and juwi fish sauce ranged from 249 to 255

g/liter, indicating that the salt content of these fish sauces meets the Indonesian National Standard (SNI) and *Codex Alimentarius* for fish sauce. According to the FAO (2011), the salt content of fish sauce should not be less than 200 g/liter. In this study, there was an increase and decrease in the salt content of the products. The increase in salt content occurred in petek fish sauce and parang-parang fish sauce from 25% added salt to 25.17-25.59%. The increase in salt content is thought to be due to the salt dissolved in the liquid, resulting in a higher salt content in the filtrate than the added salt. Then, a decrease in salt content occurred in the juwi fish sauce product. According to Ardiansyah *et al. (*2015), the decrease in salt content during the fermentation process is caused by the breakdown of salt into $Na^{(+)}$and $Cl^{(-)}$ions.

The salt content of fish sauce can be influenced by several factors, including the type of fish, enzymes, and salt addition. According to Karim *et al.* (2014), the use of different raw materials in the production of shrimp paste will affect the salt content in the final product. Different sizes and types of fish certainly have different nutritional content, such as water and sodium levels in the fish's body. Suardani (2012) added that in the production of fish sauce containing proteolytic enzymes, the added salt penetrates the fish tissue, thereby pushing water out of the fish tissue that contains minerals in the form of salt, thus increasing the salt content of the fish sauce.

Total Nitrogen

The results of the Total N analysis of variance (ANOVA) showed that the use of different types of raw materials in the production of fish sauce had a significant effect (P < 5%).

Table 4. Results of Total N Test of Fish Sauce with Different Types of Fish Raw Materials

No	Treatment	Total N (g/L)
	Juwi	9.31 ± 0.13^{a}
2	Parang-Parang	10.17 ± 0.27^{b}
3	Petek	11.27 ± 0.25^{c}

- Data are the results of three repetitions ± standard deviation
- Data followed by different superscript letters indicate significant differences (P<0.05).

The results of the BNJ Total N test on fish sauce showed significant differences between each treatment. Total nitrogen is an important parameter for determining the quality of fish sauce products. The results of the N-total test for petek fish sauce, parang parang fish sauce, and juwi fish sauce ranged from 9.31 to 11.27 g/L. The total N in petek fish sauce and parang fish sauce met the SNI and Codex Alimentarius standards, while the N-total results for juwi fish sauce did not meet the SNI and *Codex Alimentarius* standards for fish sauce. According to Codex (2011), the nitrogen content must not be less than 10 g/L.

The total N value can be influenced by several factors, including the type of fish, salt concentration, and enzymes used. Different types of fish certainly have different protein values. During the fermentation process, protein hydrolysis will occur. This will affect the total N content after fermentation. The total nitrogen in fish sauce after fermentation will have a lower value than before the fermentation process. Due to the fermentation process, protein nitrogen and non-protein nitrogen are broken down into volatile compounds such as trimethylamine, ammonia, and free amino acids as a result of microbial activity during the fermentation process. According to Iskandar and Widyasrini (2009), the decrease in total nitrogen is likely due to the formation of volatile nitrogen compounds (NH3) by putrefactive bacteria, resulting in a reduction in total nitrogen. In addition, some of the total nitrogen compounds are used by putrefactive bacteria as a source of nitrogen. This process causes changes in the enzyme environment, resulting in decreased enzyme activity.

The longer the fermentation time of fish sauce and the higher the addition of enzymes, the higher the total nitrogen value. Total nitrogen increases due to the hydrolysis of proteins, which causes the N content to rise. According to Briani *et al.* (2014), the total N value increases with the length of fermentation time of rucah fish sauce and the higher concentration of papain enzymes. The increase in total N is thought to be due to protein hydrolysis, which causes N levels to rise. Kurniawan (2008) adds that the longer the fermentation time, the more protein molecules are broken down, causing total nitrogen to increase.

Color

The results of the analysis of variance (ANOVA) of the L*a*b* values of fish sauce show that the use of different types of raw materials in the production of fish sauce has a significant effect (P < 5%).

Table 5. Results of Fish Sauce Color Test with Different Types of Fish Raw Materials

No	Treatment	L*	a*	b
1	Juwi	37.92 ± 0.31[a]	0.26 ± 0.12[c]	15.77± 0.06[a]
2	Petek	45.82 ± 0.05[b]	-3.14 ± 0.01[a]	26.87 ± 0.04[c]
3	Parang-Parang	46.91 ± 0.05[c]	-1.98 ± 0.03[b]	24.33 ± 0.12[b]

- Data are the results of three repetitions ± standard deviation
- Data followed by different superscript letters indicate significant differences (P<0.05).

The results of the BNJ test of the L*a*b* values of fish sauce show significant differences in each treatment of different fish raw materials. Based on the fish sauce color test table data, the highest L* value was found in fish sauce made from parang parang fish, while the highest a* intensity value was found in juwi fish sauce with a (+) value indicating a reddish-brown color, and the highest b* value was found in petek fish sauce with a yellowish color. Low brightness indicates dark colors, while high *lightness* indicates bright colors. According to Huntarlab *et al. (*2012), low brightness L* values (0-50) indicate dark colors. Meanwhile, high L* values (51-100) indicate bright colors.

The use of different raw materials in the fermentation process also affects the values of lightness intensity, redness intensity (a*), and yellowness intensity (b*). The brownish-red color in fish sauce that occurs during the fermentation process is likely due to a non-enzymatic reaction, namely the *Maillard* reaction. According to Lopetcharat *et al. (*2001), the *Maillard* reaction may contribute to the red color tendency. Reducing sugars and oxidation products such as aldehydes can react with free amino acids, which are released more as the fermentation time increases.

The color formed in fish sauce made from petek fish, parang-parang fish, and juwi fish is brownish yellow, so the b* value tested is positive. In juwi fish sauce, the degree of yellow is lower than the other two samples, so descriptively, juwi fish sauce is brighter than petek and parang fish sauce. parang. According to Suharyanto (2009), the value of b is in line with the value of L. The higher the value of L, the higher the value of b, which means that the color will be brighter.

The type of fish used in the production of fish sauce also causes differences in product color, where the main factor affecting product color is the pigment content in each type of fish. Petek fish has a pigment that tends to be whiter than parang parang and juwi fish. Juwi and parang parang fish are small pelagic fish, while pepetek fish is a demersal fish (white meat fish). According to Muchlisin (2017), the main cause of the difference between white and red meat is the pigment content, where myoglobin is the main pigment found in red meat. The myoglobin molecule consists of two parts, namely protein (globin) and non-protein (heme). Furthermore, it is stated that the myoglobin content in each meat varies depending on the type.

Hedonic

Hedonic testing is the most widely used test to measure the level of preference for a product. The results of the hedonic test for fish sauce made from petek fish, juwi fish, and parang-parang fish are presented in Table 6.

Table 6. Results of the Hedonic Test of Fish Sauce with Different Types of Fish Raw Materials

Parameter	Treatment		
	Petek	Parang-Parang	Juwi Fish
Appearance	6.60 ± 0.855[a]	7.23 ± 0.679[b]	7.47 ± 0.681[b]
Aroma	7.23 ± 0.626[b]	6.73 ± 0.944[a]	6.47 ± 0.937[a]
Taste	7.43 ± 0.773[b]	6.80 ± 0.761[a]	6.33 ± 0.802[a]

- Data are the results of three repetitions ± standard deviation
- Data followed by different superscript letters indicate significant differences (P<0.05).

Appearance

Fish sauce made from juwi fish has a bright, clean appearance and a reddish-brown color, almost the same as the appearance of parang-parang fish sauce, which is bright and yellowish-red in color. Meanwhile, fish sauce made from petek fish has a less bright/slightly dull appearance and a greenish-yellow color. The color of fish sauce becomes darker as the fermentation process progresses fermentation time. According to Sari *et al.* (2018), the longer the fermentation process, the more brown the color of the fish sauce becomes due to the increasing number of components in the fermentation liquid. This is because the more hydrolyzed protein content, the greater the amount.

Descriptively, fish sauce made from juwi fish has the best appearance. It is not significantly different from fish sauce made from parang parang fish. This is influenced by the color produced during fermentation, which is a bright reddish brown. This color is formed not only due to the fermentation process and the Maillard reaction, but also influenced by the type of fish, the addition of enzymes, and the salt concentration used. This is in contrast to petek fish sauce, which has the lowest appearance value, namely a pale yellow color. According to Pramita *et al. (*2020), fish sauce produced enzymatically is clear brown in color, unlike traditionally processed fish sauce, which is generally dark brown. Kongpun (2012) adds that the color of fish sauce varies from pale/cloudy yellow, bright yellow, to reddish brown.

Aroma

Based on the results of the hedonic test analysis, the aroma parameter shows that the aroma of fish sauce made from petek fish is significantly different from that of juwi and parang parang fish sauce, but there is no significant difference between the aroma of juwi and parang-parang fish sauce. The fish sauce with the highest aroma value was fish sauce made from petek fish, which was 7.23. Meanwhile, the fish sauce with the lowest aroma value was fish sauce made from juwi fish, which was 6.47. The aroma that arises in fish sauce products comes from the chemical composition of the raw material, namely the fish itself. However, the use of different fish raw materials in the fermentation process will certainly affect the aroma of each fish sauce sample. According to Permanasari *et al. (*2014), the aroma produced in each treatment is thought to have a distinctive aroma. The aroma formed in fish sauce is thought to be influenced by the distinctive aroma of the chemical composition of the raw materials.

Physiologically, petek fish are demersal fish, while parang parang and juwi fish are small pelagic fish, so the aroma produced in each treatment will be different. According to Peralta *et al. (*1996) in Yongsawatdigul *et al. (*2004), variations in volatile compounds, acids, carbonyls, nitrogen compounds ( ), nitrogen compounds ( ), and nitrogen compounds ( ), sulfur compounds ( ), and sulfur compounds ( ) formed during the fermentation process are thought to influence the formation of different aromas in fish sauce. The aroma *of condiments* can originate from the presence of volatile compounds with low molecular weights, namely organic acids and carbonyls.

In addition to raw material factors, the aroma of fish sauce is also influenced by added enzymes and enzymes found in the fish itself, such as enzymes in the fish's stomach contents. According to Sudaryanti and Aji (2014), during the fish sauce production process, fermentation or decomposition of fish tissue occurs due to enzymes produced by microbes or added enzymes, as well as enzymes contained in the fish tissue itself, resulting in a distinctive aroma and taste. Wichaphon *et al. (*2013) added that several compounds along with trimethylamine, which is one of the dominant basic nitrogen compounds along with ammonia, are associated with aroma characteristics with high total nitrogen.

The aroma of fish sauce decreases as fermentation progresses, and overall, the aroma value of fish sauce made from petek fish is higher than that of juwi and parang parang fish sauce. According to Widiantara *et al.* (2018), if the fermentation process is too long, it causes an increase in the number of bacteria, the amount of free fatty acids, and a decrease in fungal growth, leading to further protein degradation and the formation of ammonia. As a result, the product undergoes spoilage and its aroma becomes unpleasant. Mohamed *et al. (*2012) added that there are three main aromas produced during fish sauce fermentation: cheesy (cheese-like aroma), meaty (fish meat aroma), and ammonia.

Taste

The results of the fish sauce taste test showed significant differences in each treatment. The fish sauce with the highest taste score was the fish sauce made from petek fish, with a score of 7.43, followed by the parang-parang fish sauce with a score of 6.80. The fish sauce with the lowest taste score was the fish sauce made from juwi fish, with a score of 6.33. This shows that the fish sauce made from petek fish was preferred by the panelists compared to the fish sauce made from parang-parang and juwi fish. Each person's level of preference varies, including taste parameters, because hedonic testing is a qualitative assessment that is transformed into a numerical form so that can be carried out data collection. According to Winarno (2008), each person has a lowest concentration threshold for a particular taste to be perceived, and this threshold varies from person to person.

The flavor formed in fish sauce products is a distinctive salty taste with a fresh aroma from the fish itself. Treatment with juwi fish raw materials has a more savory taste compared to treatment with juwi fish and parang-parang fish. The taste of soy sauce is influenced by the soluble protein and amino acid content. Products that are high in protein generally have a more savory taste. According to Rahayu *et al (*1992), the principle of fermentation that occurs in fish is the biological or semi-biological decomposition of complex compounds, especially proteins, into simpler compounds under controlled conditions. During the fermentation process, fish protein is hydrolyzed into amino acids and peptides. The amino acids are then further broken down into other components that play a role in forming the flavor of the product. Kim *et al. (*2002) added that the composition of free amino acids in soy sauce affects the flavor of the soy sauce product.

In addition to the different chemical compositions of each fish, the flavor of fish soy sauce products is also influenced by the addition of enzymes and salt. Buckle *et al*. (1987) revealed that trypsin is a protease enzyme, and that protease enzymes together with salt are able to break down proteins into several components such as peptides, peptones, and amino acids, which interact with each other to create a distinctive flavor.

4. Conclusions

The use of different fish raw materials affects the sensory and chemical characteristics of fish soy sauce. The best sensory and chemical characteristics were shown in fish sauce made from petek fish, but in this case, in hedonic testing, the appearance parameter of juwi fish sauce had the highest value, as shown by its bright appearance and reddish-brown color compared to petek fish sauce, which had a greenish-yellow color and was slightly dull.

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