PHYSICOCHEMICAL AND SENSORY CHARACTERISTICS OF REBON (ACETES SP.)SHRIMP PASTE SAUCE

ABSTRACT

Rebon shrimp paste can be used as an additional ingredient in food products because it has the potential to act as a flavour enhancer. One form of processed shrimp paste that can increase the economic value of shrimp paste is making it into a sauce. The aim of this research was to determine the differences in the characteristics of shrimp paste sauce and find out the best treatment based on the different concentrations of adding rebon shrimp paste. The process of making shrimp paste sauce consists of drying the shrimp paste and continuing with making shrimp paste sauce. This research method used an experimental laboratory and a completely randomized design (CRD) with 3 replications. The treatments in the study were different concentrations of shrimp paste at concentrations of 0%, 10%, 15% and 20%. The parameters observed include protein content, glutamic acid, viscosity, color and sensory (hedonic) tests. Parametric data were analyzed using the ANOVA test and continued with the BNJ test, while non-parametric data were analyzed with the Kruskal-Wallis test and continued with the Mann-Whitney test. The results showed that the addition of rebon shrimp paste had a significant effect ($P < 5\%$) on protein content, glutamic acid, viscosity and sensory assessment. The best shrimp paste sauce formulation in this study with the addition of 15% rebon shrimp paste was assessed from the protein content of 15.70%, glutamic acid 4.26%, viscosity 1759.3 cP and sensory test with a confidence interval of $7.28<\mu<7.46$.

Keywords:*rebon shrimp; shrimp paste sauce; flavor enhancer; quality*

INTRODUCTION

Shrimp Paste (Acetes sp.) is a type of seafood belonging to the crustacean family, characterized by its smaller size compared to other shrimp species. These shrimp inhabit shallow, muddy coastal waters. In Indonesia, shrimp production reached 1.21 million tons in 2021, reflecting a 9.20% increase from the previous year's total of 1.11 million tons (Ministry of Marine Affairs and Fisheries, 2021). The high production volume has driven the processing of shrimp paste, one of which is fermented shrimp paste ("terasi"). This type of shrimp is more commonly found in the form of fermented paste or dried products rather than in its fresh form. According to Murti et al. (2021), shrimp paste is typically utilized as a raw material in flavor enhancers such as shrimp paste (terasi), shrimp sauce (petis), and dried shrimp powder (rebon), all of which offer a savory taste. However, the most common application of this shrimp is in the production of shrimp paste.

Shrimp paste is a traditional fishery product widely produced in Southeast Asia. It comes in both solid and paste forms, processed by adding salt and fermenting for several days at specific temperatures. The fermentation process imparts a distinctive taste and aroma to the paste. The fermentation relies on enzymes from the fish or shrimp used in the production. According to Romadhon et al. (2018), shrimp paste is a type of food seasoning, typically in paste form, with a distinctive odor resulting from the fermentation of shrimp, fish, or a combination of both with salt or other additional ingredients. The characteristics of the shrimp paste vary depending on the raw materials used in its production.

Shrimp paste made from Acetes sp. can serve as a flavor enhancer in various food products due to its nutritional content and unique flavor, which can enhance the taste of dishes and increase consumer acceptance. The development of fishery products, such as shrimp paste, is crucial for meeting market demands and gaining wider societal acceptance. One value-added product that can be derived from shrimp paste is shrimp paste sauce. This sauce acts as a seasoning to enhance the flavor of food products. The incorporation of different concentrations of Acetes shrimp paste into the sauce is necessary to determine its characteristics. Shrimp paste is known for its high glutamic acid content, which contributes to the umami flavor, enhancing the taste of the sauce. According to Ukhty et al. (2017), shrimp paste products are characterized by their distinctive taste, with glutamic acid serving as a key precursor in evaluating their quality. The high levels of glutamic acid in shrimp paste make it a potential seasoning component, which can be utilized in the production of shrimp paste sauce.

MATERIALS AND METHODS

Matrials and Equipment

The main ingredient in this study was shrimp paste obtained from UMKM Sedap Rasa Cepiring Kendal. Additional ingredients in this study included lemongrass, bay leaves, lime leaves, garlic, galangal, turmeric, brown sugar, salt and CMC obtained from PasarDamarBanyumanik, NaS2O2.5H2O, HCl 0.02 N, distilled water, ninhydrin and 96% ethanol. The tools used in this study were analytical scales, kjeldahl destruction, steam distillation, 250 mL destruction flask, 250 mLerlenmeyer flask, measuring cup, dropper, test-tube, test-tube rack, spectrophotometer, colorimeter, viscometer and scoresheet.

Shrimp Paste Production

a. Shrimp paste drying

The drying process for shrimp paste using the oven-drying method follows the procedure outlined by Riyadi et al. (2020), with modifications. To dry Acetes shrimp paste, the paste is sliced thinly, with a thickness of less than 2 mm, to accelerate the drying process. The drying is then carried out in an oven at 60°C for 4 hours, with the paste being stirred every 30 minutes using a spoon to ensure even drying. Once dried, the shrimp paste is blended and sieved using an 80-mesh sieve to obtain a fine powder. The sieved shrimp paste powder is packaged in 250 mL jars, with silica gel added inside to maintain dryness, and stored at room temperature.

b. Shrimp paste sauce production

The process of making shrimp paste sauce follows the procedure used by Wenno et al. (2022), with modifications. Garlic is thinly sliced, while lemongrass, galangal, and turmeric are bruised. Water is then heated until it boils, after which the spices, including garlic, lemongrass, galangal, turmeric, bay leaves, and kaffir lime leaves, are added to the boiling water. Once the color of the water changes, the mixture is strained, and palm sugar is added to the strained water. Once the palm sugar has dissolved, shrimp paste powder is added in concentrations of 0%, 10%, 15%, and 20%, according to the specified treatment. The next step involves adding dissolved carboxymethyl cellulose (CMC). The shrimp paste sauce is then cooled to room temperature, packaged in 250 mL jars, and stored in a refrigerator.

Glutamic Acid Analysis (Apriyantono, 1989)

The glutamic acid content analysis follows the ninhydrin-spectrophotometric method. The procedure involves dissolving 1 gram of the sample in distilled water (aquadest) to a final volume of 100 mL. The solution is then filtered using filter paper. A 1 mL portion of the clear solution is placed into a test tube, followed by the addition of 2 mL of ninhydrin reagent. The mixture is heated in a water bath at 50°C for 30 minutes. After heating, the sample is cooled to room temperature and diluted with 96% ethanol to a final volume of 10 mL. The diluted sample is homogenized using a vortex mixer, and its absorbance is measured at a wavelength of 520 nm using a spectrophotometer. The spectrophotometric results are calculated using a standard curve for glutamic acid. To prepare the standard curve, 50 mg of standard glutamic acid is dissolved in 100 mL of distilled water (aquadest).

Protein Content (AOAC, 2005)

The protein content test is conducted by weighing 1 gram of the sample and placing it into a digestion flask. Then, 3.5 g of potassium sulfate (K_2SO_4), 12 mL of sulfuric acid (H_2SO_4), and 3 mL of hydrogen peroxide (H_2O_2) are added. The mixture is digested for approximately 2 hours at 410°C. After digestion, the solution is cooled, and 70 mL of distilled water, 60 mL of sodium thiosulfate (Na□S□O□·5H□O), 40 mL of boric acid (H□BO□), and 0.01 grams of an indicator (a mixture of methyl red and bromocresol green) are added. The distillation process is carried out for 5 minutes, with the distillate being collected in an Erlenmeyer flask until the volume reaches 150 mL and the solution turns greenish. The distillate is then titrated using 0.01 N hydrochloric acid (HCl) until a color change to pink is observed. A blank solution is analyzed in the same manner as the sample. The protein content is calculated using the following formula:

$$\%N = \frac{(Va\text{-}Vb)\ HCl \times N\ HCl \times 14{,}007 \times 6{,}25 \times 100\%}{mg\ sample}$$

Information:

Va : mL HCl for sample titration
Vb : mL HCl for blank titration
N : Normality of Standard HCl used
14,007 : Atomic weight of nitrogen
6,25 : Protein conversion factors for fish

Color Analysis (Indrayati, 2013)

The color measurement is conducted using a colorimeter, which operates on the principle of determining color based on the reflectance of the product when exposed to light from the colorimeter. The color system used is the Hunter’s Lab Colorimetric System, which is characterized by three key values: L* (lightness), a* (redness), and b* (yellowness). These values provide a scale for assessing the color of the tested material.The L* value represents the lightness parameter, with a range from 0 to 100, indicating a spectrum from dark to light.The a* value (redness) ranges from -80 to +100, representing a scale from green to red.The b* value (yellowness) ranges from -70 to +70, representing a scale from blue to yellow.The color measurement for the sample is performed twice to ensure accuracy.

Viscosity Analysis (AOAC, 2007)

Viscosity is measured using a rotational viscometer (Elcometer 2300). A 60 mL sample is placed into a container, and the spindle is immersed into the sample (the spindle selection is adjusted according to the viscosity of the sample). The height of the viscometer is set so that the spindle is submerged up to the indicated line, after which the device is operated. The reading displayed on the viscometer is recorded as the viscosity value, expressed in centipoise (cP).

Sensory Analysis(NSA, 2015)

The sensory evaluation of shrimp paste sauce is conducted using a hedonic test. The hedonic test is a method that measures the degree of preference for a product through a rating sheet. The attributes assessed in the hedonic test include appearance, taste, aroma, and texture. The evaluation is based on the panelists' level of liking for the product. The test follows the guidelines outlined in SNI 01-2346-2015, which provides standards for sensory testing in fishery products. The hedonic test for shrimp paste sauce uses a 9-point scale, with the following specifications:1: Extremely dislike 2: Strongly dislike3: Dislike 4: Slightly dislike 5: Neutral 6: Slightly like 7: Like8: Strongly like 9: Extremely like The panel for this sensory test consists of semi-trained 30 students from the Fisheries Product Technology study program.

RESULTS AND DISCUSSIONS

Protein Content

The results of the protein content analysis in shrimp paste sauce with varying concentrations of fermented shrimp paste (0%, 10%, 15%, and 20%) indicate that the optimal concentration was 20%, yielding a protein content of 21.04%. The lowest protein content was observed at a concentration of 0%, which recorded a protein level of 7.40%. These findings suggest that an increase in the concentration of fermented shrimp paste correlates with a higher protein content. According to Karim et al. (2014), the protein content of fermented shrimp paste is reported to be 35.10%. Fermented shrimp paste is a processed ingredient known for its relatively high protein content. The protein present in the control shrimp paste sauce is derived from palm sugar, which is used to enhance flavor and viscosity. Adisetya et al. (2022) noted that the protein component in coconut sap, a raw material for producing palm sugar, is approximately 0.41%.

The range of protein content in shrimp paste sauce with the addition of powdered fermented shrimp paste at concentrations from 0% to 20% is between 7.40% and 21.04%. This protein content is significantly higher compared to that found in shrimp soy sauce with ginger, which ranges from 6.74% to 9.77% (Maliha et al., 2018), and sambal terasi, which has a protein content of 1.76% to 6.00% (Suhartini et al., 2019). According to Winarno (2008), the quality of protein can be evaluated based on the ratio or composition of amino acids it contains. High-quality protein is characterized by its ability to provide essential amino acids in proportions that meet human nutritional requirements. In contrast, low-quality protein is defined by an insufficient or excessive amount of essential amino acids.

Glutamic Acid Content

The results of the glutamic acid content analysis in shrimp paste sauce, subjected to varying concentrations of powdered fermented shrimp paste (0%, 10%, 15%, and 20%), indicated that the highest glutamic acid content was found at a concentration of 20%, with a measured value of 6.34%. The lowest content was observed at the 0% concentration, which recorded a glutamic acid level of 0.02%. The glutamic acid content in shrimp paste sauce increased proportionally with the addition of powdered shrimp paste. These findings suggest a direct correlation between the amount of powdered shrimp paste added and the glutamic acid content in the sauce; thus, a higher quantity of powdered shrimp paste results in an increased glutamic acid level. According to Ropikoh et al. (2022), glutamic acid is the predominant amino acid found in shrimp paste. The elevated levels of glutamic acid in shrimp paste can be attributed to the protein content of the final product post-fermentation, as amino acids are the building blocks of proteins. Glutamic acid contributes to the umami flavor profile or savory taste associated with shrimp paste.The shrimp paste sauce could be seen on Figure 1.

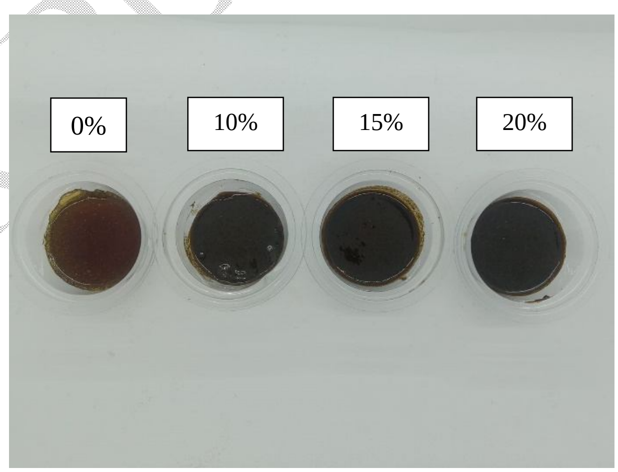

Figure 1. Shrimp Paste Sauce with Different Shrimp Paste Concentration

The range of glutamic acid content in shrimp paste sauce with the addition of powdered fermented shrimp paste at concentrations from 0% to 20% is between 0.02% and 6.34%. In a study conducted by Pratiwi et al. (2021), the glutamic acid content in squid offal sauce was reported to be 0.66%. Similarly, research by Warang (2018) on tuna fish sauce indicated a glutamic acid content of 1.01%. Consequently, the glutamic acid content in shrimp paste sauce is higher than that reported in both squid offal sauce and tuna fish sauce. The level of glutamic acid in food products can significantly influence the overall flavor of the dish.

Table 1. Results of Protein Content, Glutamic Acid Content and Viscosity of Shrimp Paste Sauce

Concentration of Rebon Shrimp Paste	Protein Content (%)	Glutamic Acid Content (%)	Viscosity (cP)
0%	7.40 ± 0.35[a]	0.02 ± 0,00[a]	934.00 ± 9.60[a]
10%	11.35 ± 0.34[b]	2.74 ± 0.25[b]	1539.50 ± 13.50[b]
15%	15.70 ±0.62[c]	4.26 ± 0.17[c]	1759.30 ± 0.70[c]
20%	21.04 ± 0.21[d]	6.34 ± 0.13[d]	1934.30 ± 5.28[d]

Information:
Data are the average results of three repetitions
Data followed by different superscript letters indicate a significant difference

Viscosity

The results of the viscosity analysis in shrimp paste sauce, subjected to varying concentrations of powdered fermented shrimp paste (0%, 10%, 15%, and 20%), indicated that the optimal concentration was 20%, yielding a viscosity of 1934.30 cP. The lowest viscosity was observed at a 0% concentration, with a measurement of 934.00 cP. These findings suggest that an increase in the concentration of powdered fermented shrimp paste results in higher viscosity levels. The varying concentrations of powdered shrimp paste added to the sauce can significantly influence the viscosity of the shrimp paste sauce. Palm sugar can also affect the viscosity of the product due to the gelatinization process that occurs. According to Arziyah et al. (2022), the use of different concentrations of sugar results in significantly different viscosity values for a given product. The addition of carboxymethyl cellulose (CMC) can further influence product viscosity. Zulaikhah and Sulistiyawati (2021) noted that CMC is effectively utilized in food products due to its ability to enhance viscosity. Thus, the viscosity and thickness of a product are directly correlated.

The viscosity range of shrimp paste sauce with the addition of powdered fermented shrimp paste at concentrations from 0% to 20% was measured to be between 934.00 cP and 1934.30 cP. Shrimp paste sauce with the addition of powdered shrimp paste exhibited viscosity values comparable to sweet soy sauce with tofu dregs, which had viscosity values ranging from 1716.67 to 1933.33 cP (Lavina, 2011). According to Usman et al. (2019), the observed variations in viscosity indicate the significant influence of the ingredients on the viscosity of the resulting sauce. Several factors influence the viscosity of sauces, including concentration, stirring, evaporation, and temperature. Additionally, an increase in the total dissolved solids correlates with higher viscosity levels. The viscosity of the sauce can also be affected by the protein content it contains. A high protein content in the sauce can enhance viscosity, as proteins can form cross-links with other molecules, increasing viscosity. According to Raharja and Suryadarma (2020), proteins play a significant role in the physical properties of food materials by binding water, thereby influencing food texture formation.

Color

The L* value is a parameter used in color assessment that indicates brightness (lightness). Based on color testing, the addition of powdered fermented shrimp paste was found to decrease the brightness of the product. The L* value obtained from the shrimp paste sauce with 0% powdered shrimp paste (control) was 30.81, indicating that the control shrimp paste sauce exhibited a relatively bright color compared to the sauces with added powdered shrimp paste. The L* values for the shrimp paste sauces with 10%, 15%, and 20% powdered shrimp paste were 27.98, 28.41, and 27.54, respectively. These values indicate that the addition of 10%, 15%, and 20% shrimp paste did not result in significant differences; however, a decrease in brightness was still observed in the sauces with 15% and 20% concentrations. This reduction in brightness is attributed to the darker pigments present in the powdered shrimp paste used, resulting in a darker color for the shrimp paste sauce. Referring to the research by Sumardianto et al. (2019), the brightness of fermented shrimp paste with varying concentrations of palm sugar (0%, 7.5%, 10%, and 12.5%) yielded values of 44.83, 46.52, 42.43, and 42.06, respectively. The sample without sugar demonstrated higher brightness compared to those with sugar. The lower brightness of the shrimp paste sauce with added powdered shrimp paste is due to the relatively high concentration of the powdered shrimp paste, which reduces the brightness of the sauce.

The a* value (redness) is a color parameter that indicates the chromatic mixture of red-green hues. The results obtained for the a* values of the shrimp paste sauce with 0% (control), 10%, 15%, and 20% powdered shrimp paste were 1.36, 1.35, 2.16, and 2.80, respectively. Based on these results, it can be concluded that the color of the shrimp paste sauce with added powdered shrimp paste is red. This red color is attributed to the addition of palm sugar, which constituted 13.50% to 14.50% of the shrimp paste sauce formulation. According to Setiawan (2020), palm sugar is a solid sugar with a reddish-brown color. The red hue becomes more intense with increasing amounts of powdered shrimp paste added during the sauce preparation. The a* values for the sauces with 0% and 10% powdered shrimp paste were not significantly different; however, the color remained increasingly intense. This is due to the brown color of the powdered shrimp paste, which contributes to the deepening of the shrimp paste sauce's color. As noted by Meilani (2013), the addition of dark colors can enhance the intensity of a given color. Since shrimp paste has a brown color, it possesses the potential to darken the overall color intensity.

The b* value (yellowness) is a color parameter that indicates the chromatic mixture of blue-yellow hues. The b* values obtained from the testing of the shrimp paste sauce with 0% (control), 10%, 15%, and 20% powdered shrimp paste were 7.54, 7.34, 8.86, and 9.69, respectively. Based on these results, it can be concluded that the color of the shrimp paste sauce with added powdered shrimp paste is yellow. The yellow hue becomes more pronounced with increasing amounts of powdered shrimp paste in the sauce formulation. The b* values for the shrimp paste sauces with 0% and 10% powdered shrimp paste were not significantly different from those with 15% and 20% concentrations; however, the color intensity continued to deepen. This is also influenced by the yellow color from turmeric, which contributes to the color intensity of the shrimp paste sauce. The amount of turmeric added in the shrimp paste sauce formulation was 1.50%. According to Rahardiyanti (2022), the primary component that determines the quality of turmeric is curcuminoids, which are compounds that contribute to the color formation in turmeric. Curcumin is a natural coloring agent permitted for use in food products.

Table 2. Color Value of Shimp Paste Sauce

Concentration of Rebon Shrimp Paste	L*	a*	b*
0%	30,81 ±0,55^{b}	1,36 ± 0,09^{a}	7,54 ± 0,24^{a}
10%	27,98 ± 0,20^{a}	1,35 ± 0,27^{a}	7,34 ± 0,40^{a}
15%	28,41 ± 0,26^{a}	2,16 ± 0,30^{b}	8,86 ± 0,42^{b}
20%	27,54 ± 0,33^{a}	2,80 ± 0,11^{c}	9,69 ± 0,23^{b}

Information:
Data are the average results of three repetitions
Data followed by different superscript letters indicate a significant difference

Sensory Analysis

a. Appearance

The results of the organoleptic test on the appearance parameter revealed a significant difference between the shrimp paste sauce with 0% and 20% concentrations of powdered fermented shrimp paste, with respective scores of 6.33 and 5.77. In contrast, the shrimp paste sauces with 10% and 15% concentrations did not show significant differences, yielding scores of 7.10 and 7.40, respectively. The appearance of the shrimp paste sauce is influenced by the concentration of powdered fermented shrimp paste added. This is likely due to the darker appearance of the powdered shrimp paste used in the sauce preparation, resulting in a shrimp paste sauce that is dark brown, glossy, and homogeneous. The appearance of a product can significantly influence consumer decisions. The appearance scores for the shrimp paste sauce, with concentrations ranging from 0% to 20%, averaged between 5.77 and 7.40, indicating that the overall appearance of the shrimp paste sauce was generally favored by the panelists. Relating this to the color testing results, the most preferred shrimp paste sauce had a medium lightness (27.98 - 28.41), whereas the sauce with the highest lightness (30.81) was the least favored.The appearance scores for the shrimp paste sauce align with previous research. According to a study conducted by Jumiati and Suprapti (2023), the appearance of crab broth paste received hedonic scores ranging from 6.04 to 8.36, with dark brown, glossy pastes being the most preferred. Tarwendah (2017) noted that the appearance of a product is one of its most important attributes. Consumers tend to consider the appearance of a product when making selections and often overlook other sensory attributes.

b. Aroma

The results of the organoleptic test on the aroma parameter indicated a significant difference between the shrimp paste sauces with 0% and 20% concentrations of powdered fermented shrimp paste, with respective scores of 6.37 and 5.63. In contrast, the shrimp paste sauces with 10% and 15% concentrations did not show significant differences, yielding scores of 7.03 and 7.37, respectively. Aroma is a parameter that utilizes the sense of smell in its assessment. The shrimp paste sauce most favored by the panelists was that with a 15% concentration of powdered shrimp paste, receiving a score of 7.37, while the least favored was the sauce with a 20% concentration, which scored 5.63. The aroma scores of the shrimp paste sauce align with research conducted by Jumiati and Suprapti (2023), where the aroma of crab broth paste received hedonic scores ranging from 6.04 to 8.36. The hedonic test results for the aroma of shrimp paste sauce indicate that the aroma of the sauce with added powdered shrimp paste was generally well-received by the panelists; however, the sauce with 20% powdered shrimp paste was less favored. This aversion to the sauce with the higher concentration of powdered shrimp paste is attributed to the overpowering odor of the shrimp paste as the concentration increases. According to Amaluddin and Yuwono (2015), the compounds responsible for the aroma of shrimp paste are volatile carbonyl compounds dispersed among other volatile components, resulting in a stronger shrimp paste aroma.

c. Taste

Taste is a biological perception, a sensation generated by materials entering the mouth. The results of the organoleptic test on the taste parameter indicated no significant difference between the shrimp paste sauces with 0% and 20% concentrations of powdered fermented shrimp paste, with respective scores of 6.33 and 5.53. In contrast, the sauces with 10% and 15% concentrations of powdered shrimp paste showed significant differences, scoring 7.23 and 7.27, respectively. The resulting shrimp paste sauces possessed a distinct flavor characteristic of fermented shrimp paste. These results demonstrate that the addition of shrimp paste can enhance the taste value of the shrimp paste sauce; however, excessively high concentrations of shrimp paste can diminish the overall flavor. The decline in panelist preference for taste was observed in sauces with 15% and 20% concentrations of powdered shrimp paste. This decrease in preference is likely due to the overpowering odor of the shrimp paste, which influences the panelists' perception. According to Tarwendah (2017), taste is not only perceived by taste receptors in the mouth but is also affected by aroma receptors in the nose. Winarno (2008) notes that the aroma of food plays a significant role in determining its palatability. The taste of food is influenced by several factors, including concentration, chemical compounds, temperature, and interactions with other taste components.

d. Texture

Texture is a significant factor influencing consumer acceptance of food. Food texture can be categorized as smooth or coarse, hard or soft, liquid or solid, and tender or tough (Adinugraha and Michael, 2015). The texture scores for the shrimp paste sauce with added concentrations of powdered fermented shrimp paste ranging from 0% to 20% averaged between 5.77 and 7.43. The most favored shrimp paste sauce by the panelists was that with a 15% concentration of powdered shrimp paste, scoring 7.43. Conversely, the least favored sauce was the one with a 20% concentration, receiving a score of 5.77. The decrease in panelist preference for texture was observed in the shrimp paste sauces with 15% and 20% concentrations. This can be correlated with the viscosity test results, where the sauce with 20% powdered shrimp paste exhibited the highest viscosity level of 1934.3 cP, potentially affecting the texture evaluation. According to Winarno (2008), changes in texture and viscosity in food can alter the resulting taste and aroma, as they can influence the speed of stimulation to the olfactory receptor cells and salivary glands. As the viscosity of a food product increases, the acceptance of taste, aroma, and flavor intensity tends to decrease.

Table3. Sensory Value of Shimp Paste Sauce

Concentration of Rebon Shrimp Paste	Appearance	Aroma	Taste	Texture	Average Value
0%	6.33 ± 0.96^{b}	6.37 ± 0.93^{b}	6.27 ± 0.87^{b}	6.57 ± 1.17^{b}	$6.12<\mu<6.64$
10%	7.10 ± 0.71^{c}	7.03 ± 0.76^{c}	7.23 ± 0.73^{c}	7.47 ± 0.73^{c}	$7.04<\mu<7.38$
15%	7.40 ± 0.56^{c}	7.37 ± 0.56^{c}	7.27 ± 0.52^{c}	7.43 ± 0.57^{c}	$7.28<\mu<7.46$
20%	5.77 ± 0.94^{a}	5.63 ± 1.16^{a}	5.53 ± 1.20^{a}	5.77 ± 0.86^{a}	$4.90<\mu<5.34$

CONCLUSIONS

The addition of powdered fermented shrimp paste to shrimp paste sauce significantly affects its characteristics, as observed in terms of protein content, glutamic acid content, viscosity, color, and sensory evaluation (hedonic). As the concentration of powdered shrimp paste increases in the shrimp paste sauce, the glutamic acid content, viscosity, and protein content also increase, while the color shifts towards darker shades (L*), increased redness (a*), and increased yellowness (b*). Additionally, the sensory evaluation (hedonic) across all parameters decreases at the 20% concentration.The shrimp paste sauce with a 15% addition of powdered fermented shrimp paste represents the best treatment, demonstrating significant differences in physicochemical and sensory characteristics. This is supported by a protein content of 15.70%, a glutamic acid content of 4.26%, and a viscosity value of 1759.3 cP. Furthermore, the addition of 15% powdered fermented shrimp paste produced the highest sensory scores, with a confidence interval of $7.28 < \mu < 7.46$.

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