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Physicochemical and Sensory Characteristics of Rebon (*Acetes* SP.) Shrimp Paste Sauce

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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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 characterize shrimp paste sauce based on shrimp sauce phsyico-chemical and sensory properties. The main process to manufacture shrimp paste sauce were the addition of dried shrimp paste into shrimp paste sauce mix**. Experimental laboratory and a completely randomized design (CRD) with 3 replications were used as research method. 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

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(hedonic) tests. Parametric data were analyzed using the analysis of variance (**ANOVA**) test and continued with the **Tukey's 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 of shrimp paste sauce**. 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.

1. INTRODUCTION

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. Indonesia was the second-largest producer of farmed shrimp in the ASEAN region, trailing just behind Vietnam [1]. The high production volume has driven the processing of **Acetes sp.**, 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. [2], 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. [3], 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. Shrimp paste products are characterized by their distinctive taste, with glutamic acid serving as a key precursor in evaluating their quality [4]. 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. Therefore, the purpose of this study was to determine the basic characteristics of shrimps paste sauce produced based on physico-chemical and sensory properties.

2. MATERIALS AND METHODS

2.1 Materials and Tools

The primary component in this study was Acetes sp. (shrimp paste) sourced from the local market in Kendal. Additional components, including lemongrass, bay leaves, lime leaves, garlic, galangal, turmeric, brown sugar, and salt utilized in sauce preparation, were of standard food-grade quality. Carboxymethyl cellulose was procured from the local market in Semarang. Chemical materials include **$NaS_2O_2.5H_2O$**, HCl 0.02 N, distilled water, ninhydrin and 96% ethanol. The substances examined in the investigation were of analytical grade. **The tools used in this study were various quartz flask (Pyrex), spectrophotometer (Rayleigh UV-VIS 1800), colorimeter (Konica Minolta CR-400), viscometer (Brookfield DV2T) and scoresheet**.

2.2 Shrimp Paste Sauce Production

a. **Shrimp paste drying: The drying process for shrimp paste was adopted with Riyadi et al. [5] method, with modifications**. To dry Acetes shrimp paste, the paste was sliced thinly, with a thickness of less than 2 mm, to accelerate the drying process. The drying was 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 was blended and sieved using an 80-mesh sieve to obtain a fine powder. The sieved shrimp paste powder was 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. [6], with modifications. Garlic is thinly sliced, while lemongrass, galangal, and turmeric are bruised. **Water was then boiled**, after which the spices, including garlic, lemongrass, galangal, turmeric, bay leaves, and kaffir lime leaves, were added to the boiling water. The mixture was then stirred until the **color of the water changes. After that the mixture was strained, and palm sugar was 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.

2.3 Glutamic Acid Analysis [7]

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).

2.4 Protein Content [8]

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 ($Na_2S_2O_3 \cdot 5H_2O$), 40 mL of boric acid (H_3BO_3), 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:

$$\%N = \frac{(Va\text{-}Vb)\ HCl \times N\ HCl \times \mathbf{14.007 \times 6.25} \times 100\%}{mg\ sample}$$

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

2.5 Color Analysis [9]

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.

2.6 Viscosity Analysis [10]

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).

2.7 Sensory Analysis [11]

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 pastes sauce uses a 9-point scale, with the following specifications: 1: Extremely dislike 2: Strongly dislike 3: Dislike 4: Slightly dislike 5: Neutral 6: Slightly like 7: Like 8: Strongly like 9: Extremely like. The panel for this sensory test consists of semi-trained 30 students from the Fisheries Product Technology study program.

3. RESULTS AND DISCUSSIONS

3.1 Protein Content

The results of the protein content analysis in shrimp paste sauce with varying concentrations of fermented shrimp paste (10%, 15%, and 20%) indicate that the optimal concentration was 20%, yielding the highest protein content of 21.04% among other concentrations. **The lowest protein content beside control of 0% was observed at 10% concentration** which recorded a protein level of 11.35%. These findings suggest that an increase in the concentration of fermented shrimp paste correlates with a higher protein content. The protein content of fermented shrimp paste is reported to be 35.10% [12]. 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.** Fresh palm sap, which is used to produce palm sugar, contains approximately 3.63% protein. This protein content is higher than that found in traditional cane sugar, making palm sugar a more nutritious option [13]. The results suggest that shrimp paste is an abundant source of protein as it increases the protein content of shrimp paste sauce significantly compared to control sample with no addition of shrimp paste.

The protein content of shrimp paste produced significantly higher compared to that found in chicken chili sauce with 7.88% protein content [14], and sambal terasi, which has a protein content of 1.76% to 6.00% [15]. The quality of protein can be evaluated based on the ratio or composition of amino acids it contains [16]. 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. The protein content of shrimp paste varies based on factors such as the type of shrimp used, the fermentation process, and regional production methods [17].

3.2 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%, while the lowest glutamic acid concentration was recorded in 10% concentration with 2.74% value.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. Glutamic acid is the predominant amino acid found in shrimp paste [18]. 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 Fig. 1.

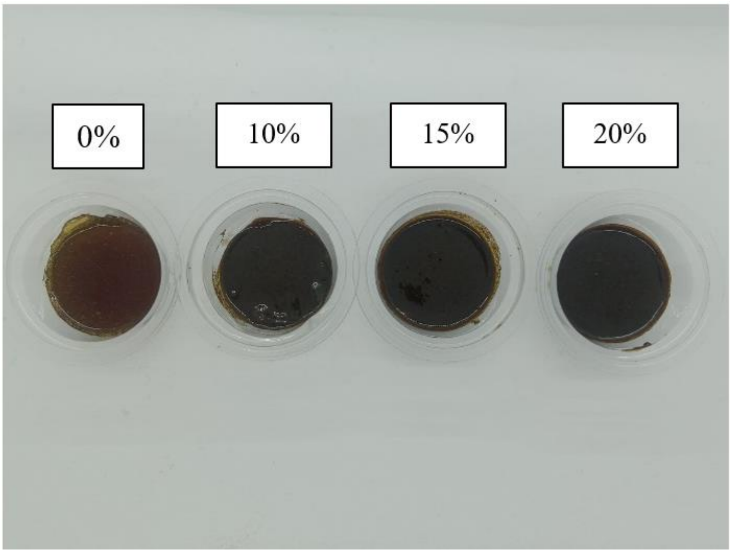

Fig. 1. Shrimp paste sauce with different shrimp paste concentration

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% (control)	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 with standard deviation
Data followed by different superscript letters indicate a significant difference

In a study conducted by Pratiwi et al. [19], the glutamic acid content in squid offal sauce was reported to be 0.66%. Similarly, research by Park [20] on vietnamese fish sauce indicated a glutamic acid content of 1.49%. Consequently, the glutamic acid content in shrimp paste sauce is higher than that reported in both squid offal sauce and vietnamese fish sauce. The level of glutamic acid in food products can significantly influence the overall flavor of the dish. The glutamic acid content in shrimp paste sauces can vary significantly based on the type of shrimp used, the fermentation process, and any additional ingredients. Fermentation significantly influences the glutamic acid content of shrimp paste, a traditional condiment prevalent in Southeast Asian cuisine. The process of fermentation not only enhances the flavor profile of shrimp paste but also alters its nutritional composition, particularly the amino acid content. Studies indicate that longer fermentation periods generally result in higher concentrations of free glutamic acid. For instance, shrimp paste fermented for 60 days exhibited optimal glutamic acid levels, while prolonged fermentation beyond a year may lead to a decrease in free amino acids due to further degradation processes [21]. The addition of salt is crucial as it not only acts as a preservative but also enhances the umami flavor associated with glutamic acid. Research shows that varying salt concentrations can significantly affect glutamic acid levels; for example, shrimp paste with 20% salt fermented for 60 days showed improved glutamic acid and protein content compared to lower salt concentrations [2].

3.3 Viscosity

The viscosity analysis of shrimp paste sauce with varying concentrations of powdered fermented shrimp paste (0%, 10%, 15%, and 20%) revealed that the concentration was 20% achieving the highest viscosity with the value of 1934.30 cP. The lowest viscosity was observed at a 10% concentration, with a measurement of 1539.00 cP. These findings indicate that increasing the concentration of powdered fermented shrimp paste leads to higher viscosity levels. The different concentrations of powdered shrimp paste added to the sauce substantially impact the viscosity of the shrimp paste sauce. Palm sugar can also affect the viscosity of the product due to the gelatinization process that occurs. The use of different concentrations of sugar results in significantly different viscosity values for a given product [22]. The addition of carboxymethyl cellulose (CMC) can further influence product viscosity. CMC is effectively utilized in food products due to its ability to enhance viscosity [23]. Thus, the viscosity and thickness of a product are directly correlated.

Shrimp paste sauce with the addition of powdered shrimp paste exhibited viscosity values comparable to bulogogi sauce, which had viscosity values ranging from 1248 to 1631 cP [24]. According to Usman et al. [25], 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. Proteins play a significant role in the physical properties of food materials by binding water, thereby influencing food texture formation [26]. Higher protein concentrations generally lead to increased viscosity. This is because proteins contribute to the thickness of the solution by increasing friction between particles in the liquid. During fermentation, proteins are broken down into smaller peptides and amino acids. This process can initially increase viscosity due to the solubilization of proteins. However, excessive hydrolysis may lead to a decrease in viscosity if proteins become too fragmented [27]. The addition of thickeners or sugars can also enhance viscosity by binding water and creating a more gel-like structure within the sauce.

3.4 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. [28], the brightness of fermented shrimp pastes 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. The addition of dark colors can enhance the intensity of a given color [29]. 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%. 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 [30].

3.5 Sensory Analysis

a. **Appearance:** The organoleptic test results for the appearance parameter revealed a statistically significant difference between shrimp paste sauces containing 0% and 20% powdered fermented shrimp paste, with respective scores of 6.33 and 5.77. In contrast, the sauces containing 10% and 15% powdered shrimp paste showed no significant difference, receiving scores of 7.10 and 7.40, respectively. The appearance of the shrimp paste sauce was influenced by the concentration of powdered fermented shrimp paste, as the darker hue of the powder used contributed to a dark brown, glossy, and homogeneous appearance in the final product. This visual characteristic can substantially impact consumer preference, as the appearance score of shrimps paste sauces—across concentrations of 0% to 20%—averaged between 5.77 and 7.40, indicating overall positive evaluations by panelists. In relation to color testing, the most preferred sauce displayed moderate lightness (27.98–28.41), whereas the sauce with the highest lightness level (30.81) was rated less favorably. These findings align with previous studies; for instance, Jumiati and Suprapti [31] reported that dark brown, glossy crab broth pastes received hedonic scores from 6.04 to 8.36, marking them as most preferred. Andersen et al. [32] emphasized the importance of appearance as a key product attribute, noting that consumers frequently prioritize appearance in their purchasing decisions, often at the expense of other sensory qualities. The sensory value of shrimp paste sauce could be seen on Fig. 2 and the overall value for each concentration of shrimp paste sauce could be seen on Table 3.

b. **Aroma:** Organoleptic test results on the aroma parameter showed a significant difference between the shrimp paste sauces with 0% and 20% powdered fermented shrimp paste, with scores of 6.37 and 5.63, respectively. The shrimp paste sauces with 10% and 15% concentrations did not show a significant difference, with scores of 7.03 and 7.37, respectively. Aroma is a criterion that employs the olfactory sense for evaluation. The shrimp paste sauce most preferred by the panelists contained a 15% concentration of powdered shrimp paste, achieving a score of 7.37, whilst the least preferred sauce had a 20% concentration, scoring 5.63. The aroma ratings of the shrimp paste sauce correspond with the findings of Jumiati and Suprapti [31], which indicated that the aroma of crab broth paste garnered hedonic scores between 6.04 and 8.36. The hedonic test results for the aroma of shrimp paste sauce reveal that the aroma of the sauce with additional powdered shrimp paste was predominantly well-received by the panelists; however, the sauce with 20% powdered shrimp paste was less preferred. The aversion to the sauce with a larger concentration of powdered shrimp paste is due to the intensified odor of the shrimp paste as its concentration rises. That the aroma of shrimp paste is attributed to volatile carbonyl compounds intermixed with other volatile components, leading to an intensified shrimp paste fragrance [33].

c. **Taste:** Taste is a biological experience, a sensation produced by substances entering the oral cavity. The organoleptic test findings for the taste parameter revealed no significant difference between the shrimp paste sauces containing 0% and 20% concentrations of powdered fermented shrimp paste, yielding scores of 6.33 and 5.53, respectively. The sauces with 10% and 15% concentrations of powdered shrimp paste exhibited notable changes, with scores of 7.23 and 7.27, respectively. The resultant shrimp paste sauces exhibited a unique flavor indicative of fermented shrimp paste. The results indicate that including shrimp paste can improve the flavor profile of the shrimp paste sauce; however, too high concentrations may impair the overall taste. A decrease in panelist preference for taste was noted in sauces containing 15% and 20% concentrations of powdered shrimp paste. The decline in preference is probably attributable to the pungent aroma of the shrimp paste, which affects the panelists' perception. That taste is influenced not just by gustatory receptors in the mouth but also by olfactory receptors in the nose [32]. The scent of food significantly influences its palatability. The flavor of food is affected by various factors, including concentration, chemical constituents, temperature, and interactions with other taste elements [34].

d. Texture: Texture is a crucial determinant affecting customer acceptability of food. Food texture can be classified as smooth or coarse, firm or soft, liquid or solid, and tender or rough [35]. The texture scores for the shrimp paste sauce, with powdered fermented shrimp paste concentrations varying from 0% to 20%, averaged between 5.77 and 7.43. The respondents' preferred shrimp paste sauce contained a 15% concentration of powdered shrimp paste, achieving a score of 7.43. In contrast, the sauce with a 20% concentration was the least preferred, attaining a score of 5.77. A decline in panelist preference for texture was noted in the shrimp paste sauces with 15% and 20% concentrations. The viscosity test findings indicate that the sauce containing 20% powdered shrimp paste displayed the maximum viscosity level of 1934.3 cP, which may influence the texture assessment. Modifications in texture and viscosity of food can affect flavor and scent, as they influence the rate of stimulation to the olfactory receptor cells and salivary glands [36]. Texture analysis involves measuring various parameters such as firmness, cohesiveness, and consistency. These parameters are instrumental in determining how a sauce feels in the mouth, which directly correlates with its viscosity. For instance, higher viscosity usually results in a thicker texture that can enhance the perception of richness. The use of hydrocolloids (like xanthan gum or gellan) can significantly alter the viscosity of sauces [37]. These ingredients interact to create a network that affects both flow behavior and textural attributes. For example, higher concentrations of certain gums can lead to increased viscosity due to their ability to form gels or thicken liquids [38].

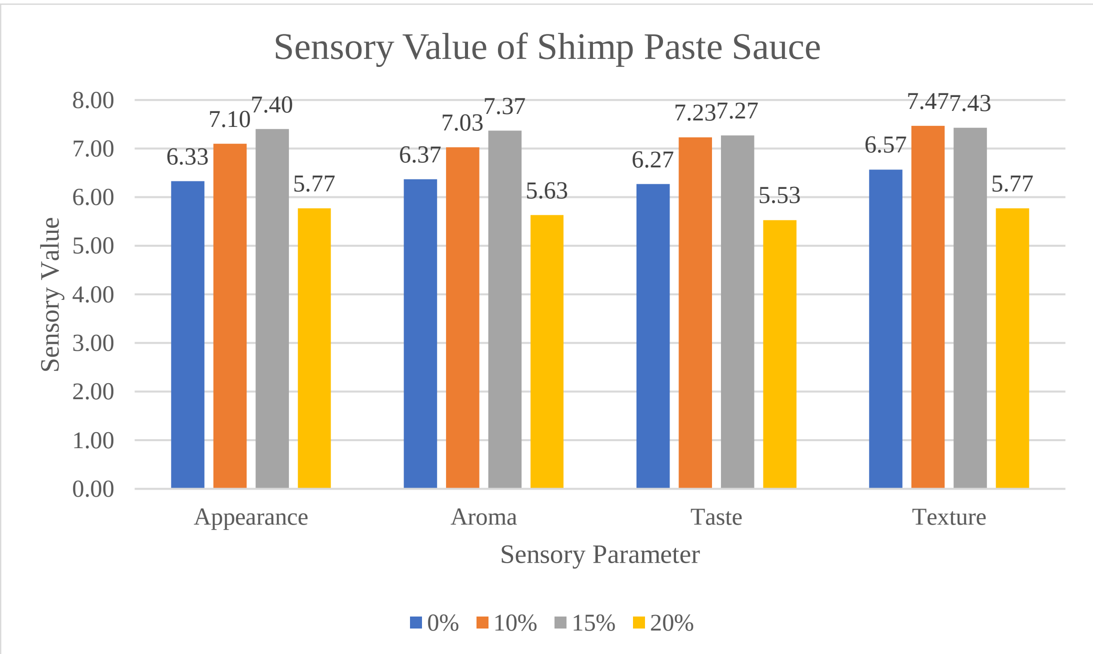

Fig. 2. Sensory value of shrimp paste sauce

Table 2. Color value of shimp paste sauce

Concentration of Rebon shrimp paste	L*	a*	b*
0% (control)	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 with standard deviation
Data followed by different superscript letters indicate a significant difference

Table 3. Average sensory value of shrimp paste sauce

Concentration of Rebon shrimp paste	Average value
0%	$6.12<\mu<6.64$
10%	$7.04<\mu<7.38$
15%	$7.28<\mu<7.46$
20%	$4.90<\mu<5.34$

4. 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 $7.28 < \mu < 7.46$.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. FAO. The state of world fisheries and aquaculture 2018: Meeting the sustainable development goals. In: FAO. 2018.
   Available:http://www.fao.org/state-of-fisheries-aquaculture
2. Murti RW, Sumardianto, Purnamayati L. The quality of organoleptic and chemically in rebon shrimp paste to different of salt concentration and duration fermentation. Jurnal Pengolahan Hasil Perikanan Indonesia. 2021;24(1): 50–9.
   Available:https://doi.org/10.17844/jphpi.v24i1.33201
3. Romadhon, Rianingsih L, Anggo AD. Antibactery activities from some quality rate of rebon shrimp. Jurnal Pengolahan Hasil Perikanan Indonesia. 2018;21(1):68–77.
   Available:https://doi.org/10.17844/jphpi.v21i1.21263
4. Herlina VT, Setiarto RHB. Terasi: Exploring the Indonesian ethnic fermented shrimp paste. Journal of Ethnic Foods. 2024;11(1):7.
   Available:https://doi.org/10.1186/s42779-024-00222-w
5. Riyadi S, Wiranata A, Jaya FM. Addition of mangosteen peel extract (*Garcinia mangostana* L.) with different composition

as a natural colorant in the processing of powdered shrimp shrimp. Jurnal Ilmu-Ilmu Perikanan dan Budidaya Perairan. 2020;15(1):28–36.

DOI: 10.31851/jipbp.v15i1.4406

6. Wenno MR, Leiwakabessy J, Wattimena ML, Tupan J, Parinussa K. Chemical composition and amino acids profile from shrimp paste yielded in Namara Village, Aru Islands Regency. Jurnal Teknologi Hasil Perikanan. 2022;2(1):108–12.

   Available:https://doi.org/10.30598/jinasua.2022.2.1.108

7. Friedman M. Applications of the ninhydrin reaction for analysis of amino acids, peptides, and proteins to agricultural and biomedical sciences. Journal of Agricultural and Food Chemistry. 2004;52(3):385–406.

   DOI: 10.1021/jf030490p

8. [AOAC] Association of Official Analytical Chemist. Official method of analysis. Maryland: AOAC International; 2005.

9. Wrolstad RE, Smith DE. Color analysis. Food Analysis. 2017;545–55.

10. [AOAC] Association of Official Analytical Chemist. Official method of analysis of the Association of Official Analytical Chemists. Arlington: The Association of Analytical Chemists, Inc.; 2007.

11. [NSA] National Standarization Agency. SNI 2346:2015. Guidelines for sensory testing of fishery products. Jakarta: Badan Standarisasi Nasional; 2015.

12. Karim FA, Swastawati F, Anggo AD. The effect of different raw materials on glutamic acid content in shrimp shrimp. Jurnal Pengolahan dan Bioteknologi Hasil Perikanan. 2014;3(4):51–8.

    Available:https://ejournal3.undip.ac.id/index.php/jpbhp/article/view/7778

13. Sarkar T, Mukherjee M, Roy S, Chakraborty R. Palm sap sugar: An unconventional source of sugar exploration for bioactive compounds and its role on functional food development. Heliyon. 2023;9(4).

    DOI: 10.1016/j.heliyon.2023.e14788

14. Prayitno AH, Meswari R, Diauddin M. The study of chemical contents, daily values, and microbiology of chicken chili sauce. Canrea Journal: Food Technology, Nutritions, and Culinary Journal. 2020;3(1):49–56.

    Available:https://doi.org/10.20956/canrea.v3i1.257

15. Suhartini W, Yang F, Xia W. Physiochemical properties, volatile compounds and sensory evaluation of chili sauce shrimp paste from different regions in Indonesia. Food and Nutrition Sciences. 2019;10(3):333–48.

    DOI: 10.4236/fns.2019.103026

16. Gorissen SH, Crombag JJ, Senden JM, Waterval WH, Bierau J, Verdijk LB, et al. Protein content and amino acid composition of commercially available plant-based protein isolates. Amino Acids. 2018;50:1685–95.

    Available:https://doi.org/10.1007/s00726-018-2640-5

17. Helmi H, Astuti DI, Dungani R, Aditiawati P. A comparative study on quality of fermented shrimp paste (*terasi*) of pelagic shrimp from different locations in Indonesia. Squalen Bull Mar Fish Postharvest Biol Technol. 2022;17: 23–34.

    Available:https://doi.org/10.15578/squalen.631

18. Li X, Wang Y, Sun Y, Ji L, Liu T, Li H, et al. Nutritional evaluation, flavor characteristics and microbial community of shrimp paste made from different materials and variance analysis. Food Chemistry Advances. 2023;2:100268.

19. Pratiwi CL, Lestari S, Widiastuti I. Characteristics of squid offal sauce with added carrageenan as a stabilizer. Jurnal Fishtech. 2021;10(2):120–32.

    Available:https://doi.org/10.36706/fishtech.v10i2.15418

20. Park JN, Fukumoto Y, Fujita E, Tanaka T, Washio T, Otsuka S, et al. Chemical composition of fish sauces produced in Southeast and East Asian countries. Journal of Food Composition and Analysis. 2001;14(2):113–25.

    Available:https://doi.org/10.1006/jfca.2000.0963

21. Agustini TW, Amalia U. Investigation of the quantity effect of NaCl salt on generating glutamic acid contents during shrimp paste production by fermentation method. Advanced Science Letters. 2017;23(7):6513–5.

    Available:https://doi.org/10.1166/asl.2017.9669

22. Maskan M, Göğüş F. Effect of sugar on the rheological properties of sunflower oil–water emulsions. Journal of Food Engineering. 2000;43(3):173–7.
Available:https://doi.org/10.1016/S0260-8774(99)00147-8

23. Rahman MS, Hasan MS, Nitai AS, Nam S, Karmakar AK, Ahsan MS, et al. Recent developments of carboxymethyl cellulose. Polymers. 2021;13(8):1345.
Available:https://doi.org/10.3390/polym13081345

24. Shin MH, Park JG, Kim CJ, Lee JW. Development of ready-to-eat bulgogi sauce with no change of sensory properties after high-dose irradiation. Food Science of Animal Resources. 2011;31(3):366–71. DOI:10.5851/kosfa.2011.31.3.366

25. Usman NB, Herawati N, Fitriani SB. Quality of sauce with basic ingredients of tomatoes, carrots and red palm oil. Jurnal Teknologi Pangan. 2019;13(2):1–11.
Available:https://doi.org/10.33005/jtp.v13i2.1700

26. Asaithambi N, Singha P, Singh SK. Recent application of protein hydrolysates in food texture modification. Critical Reviews in Food Science and Nutrition. 2023;63(30):10412–43.
Available:https://doi.org/10.1080/10408398.2022.2081665

27. Witono Y, Windrati WS, Taruna I, Afriliana A, Assadam A. Characteristics and sensory analysis of ketchup and sauce products from “bibian” fish hydolysate. American Journal of Food Science and Technology. 2014;2(6):203–8. DOI:10.12691/ajfst-2-6-6

28. Sumardianto S, Wijayanti I, Swastawati F. Characteristics of shrimp taste (*Acetes* sp.) with different concentration of purple sweet potato (*Ipomoea batatas* L.) as natural coloring. Jurnal Pengolahan Hasil Perikanan Indonesia. 2019;22(2): 287–98.
Available:https://doi.org/10.17844/jphpi.v25i3.43432

29. Goisser S, Wittmann S, Fernandes M, Mempel H, Ulrichs C. Comparison of colorimeter and different portable food-scanners for non-destructive prediction of lycopene content in tomato fruit. Postharvest Biology and Technology. 2020;167:111232.
Available:https://doi.org/10.1016/j.postharvbio.2020.111232

30. Herrera M, Viera I, Roca M. Study of the authentic composition of the novel green foods: Food colorants and coloring foods. Food Research International. 2023;170: 112974.
Available:https://doi.org/10.1016/j.foodres.2023.112974
Setiawan Y. Physicochemical analysis of liquid palm sugar. Agroscience. 2020;10(1):69-78.

31. Jumiati J, Suprapti Y. Petis sensory performance from crab broth with additions palm sugar and flour combination. Jurnal Miyang: Ronggolawe Fisheries and Marine Science Journal. 2023;3(2):53–7.
Available:https://doi.org/10.55719/j.miy.v3i2.906

32. Andersen BV, Brockhoff PB, Hyldig G. The importance of liking of appearance, odour, taste and texture in the evaluation of overall liking: A comparison with the evaluation of sensory satisfaction. Food Quality and Preference. 2019;71:228–32.
Available:https://doi.org/10.1016/j.foodqual.2018.07.005

33. Yao Y, Zhou X, Hadiatullah H, Zhang J, Zhao G. Determination of microbial diversities and aroma characteristics of Beitang shrimp paste. Food Chemistry. 2021;344:128695.
Available:https://doi.org/10.1016/j.foodchem.2020.128695

34. Berčík J, Gálová J, Vietoris V, Paluchová J. The application of consumer neuroscience in evaluating the effect of aroma marketing on consumer preferences in the food market. Journal of International Food & Agribusiness Marketing. 2023;35(3):261–82.
Available:https://doi.org/10.1080/08974438.2021.1989102

35. Varelis P, Melton L, Shahidi F. Encyclopedia of food chemistry. Elsevier; 2018.
Available:https://doi.org/10.1016/B978-0-08-100596-5.03412-0

36. Rolls ET. The texture and taste of food in the brain. Journal of Texture Studies. 2020;51(1):23–44.
Available:https://doi.org/10.1111/jtxs.12488

37. Shokraneh N, Alimi M, Shahidi SA, Mizani M, Bameni Moghadam M, Rafe A. Textural

and rheological properties of sliceable ketchup. Gels. 2023;9(3):222.
Available:https://doi.org/10.3390/gels9030222

38. Aussanasuwannakul A, Pondicherry K, Saengprakai J. Rheological and tribological characterization of herbal sweet sauce with different stabilizing systems. CyTA-Journal of Food. 2022;20(1):158–71.
Available:https://doi.org/10.1080/19476337.2022.2107706

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