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Characteristics of Instant Cream Soup with the Addition of Rebon Shrimp Paste (Acetes sp.) as Flavor Enhancer

Sumardianto [a], Wahyun Irfania [a], Slamet Suharto [a]*, Lukita Purnamayati [a], Muhammad Hauzan Arifin [a], Siti Oftafia Wijayanti [b]

[a] *Department of Fisheries Product Technology, Faculty of Fisheries and Marine Sciences,Universitas Diponegoro, Semarang, Indonesia*
[b] *Department of Capture Fisheries, Faculty of Fisheries and Marine Sciences,Universitas Diponegoro, Semarang, Indonesia*

A B S T R A C T

Cream soup is a dish consisting of milk, broth, flour and spices that has a thick and creamy texture with a savory taste. Cream soups are made in instant form to extend the shelf life. Shrimp paste is a fermented product with high glutamic acid content that has the potential to be used as a flavor enhancer. The purpose of this study was to determine the effect of the addition of shrimp paste with different concentrations on the characteristics of instant cream soup and to find the best formulation of the three types of shrimp paste addition concentrations. This research method uses experimental laboratory and completely randomized design (CRD) with one factor, namely the different concentration of shrimp paste addition with 3 replications. The experimental treatments tested were the addition of 0%, 5%, 10% and 15% shrimp paste. Parametric data in the form of water content, protein content, glutamic acid content, rehydration ratio, and color were analyzed by ANOVA (Analysis of Variance), followed by the Honest Real Difference test, while nonparametric data in the form of hedonic value were processed by the Kruskal Wallis method, followed by the Mann-Whitney test. The results showed that the addition of shrimp paste concentration up to 15% gave a linear effect on water content, protein content, glutamic acid content, and color. The rehydration ratio decreased as the concentration of shrimp paste increased. Cream soup with 5% shrimp pastes after the rehydration process became the best treatment with a water content of 7.15%, protein content of 21.68%, glutamic acid content of 5.46%, rehydration ratio of 3.18, color L* 76.04, a* 6.94, b* 19.33 and hedonic test confidence interval of $7.33<\mu<7.70$. The addition of shrimp paste to instant cream soup caused a decrease in brightness and decreased panelist acceptance due to the overpowering flavor and aroma of shrimp paste.

Keywords: Drying; Flavor enhancer; Instant cream soup; Rebon shrimp paste

1. Main text

Shrimp paste is a fermented product derived from shrimp and salt, widely utilized as a flavor enhancer in Indonesian cuisine. Its production involves a complex process, including pounding, drying, compaction, and fermentation. The distinctive umami aroma and flavor of Shrimp paste are attributed to the activity of various microorganisms and chemical reactions that produce secondary metabolites during fermentation. The intensity of the umami taste is influenced by the glutamate content, which originates from the degradation of shrimp proteins. According to Romadhon et al. (2018), rebon shrimp Shrimp paste contains glutamate levels ranging from 19.82% to 40.50%, which correlates positively with the presence of lactic acid bacteria isolates, numbering between 107 and 277.

Instant cream soup is a processed product made from plant- or animal-based flour, mixed with or without additional food ingredients, and is ready for consumption after reconstitution. Flavor enhancers are commonly added during the production of instant cream soup to improve its taste. As noted by Wicaksono and Winarti (2021), flavor enhancers are food additives used to intensify the taste of dishes, thereby enhancing their palatability. Monosodium glutamate (MSG) is a widely used flavor enhancer; however, excessive consumption may lead to adverse effects such as dizziness and nausea.

These concerns highlight the need for the development of alternative flavor enhancers that can provide umami taste while also contributing to the nutritional value of food. Shrimp paste, as a fishery product, is rich in protein and is recognized for its authentic umami flavor derived from its high glutamate content. According to Karim et al. (2014), rebon shrimp Shrimp paste contains 35.10% protein and 12.56% glutamate. The fermentation process of Shrimp paste generates glutamate, which plays a significant role in the formation of its umami taste. This makes Shrimp paste a promising candidate as a natural flavor enhancer in food products, including instant cream soup, offering both sensory and nutritional benefits.

2. Methodology

2.1 Materials

The materials used in the production of instant cream soup included rebon shrimp Shrimp paste, obtained from UMKM Sedap Rasa, located in Cepiring District, Kendal Regency, Central Java. Additional ingredients such as full cream milk, wheat flour, garlic powder, pepper, sugar, and salt were procured from Toko Bahan Kue Sri Rejeki in Banyumanik District, Semarang City. The equipment utilized in this study comprised a digital scale, blender, measuring cup, kitchen utensils, baking tray, oven, ziplock plastic bags, measuring cylinder, dropper pipette, test tubes, test tube rack, spectrophotometer, analytical balance, porcelain crucible, crucible tongs, oven, desiccator, Kjeldahl digestion apparatus, steam distillation unit, titration setup, digestion flask, Erlenmeyer flask, colorimeter, hot plate stirrer, and scoresheet.

2.2 Shrimp Paste Production

The production process of Shrimp paste was adapted from the method described by Murti et al. (2021) with modifications. Fresh rebon shrimp were thoroughly washed and subjected to an initial drying process until completely dry. After the first drying, the shrimp were pounded and mixed with 15% salt. The resulting mixture was then subjected to a second drying process, followed by additional pounding. The mixture underwent a third drying phase until it reached a dry consistency. The dried mixture was pounded once more and molded into blocks measuring 10x4x4 cm. These blocks were wrapped in banana leaves and left to ferment for 30 days.

The production of powdered Shrimp paste was based on the method outlined by Wahdayani et al. (2021) with modifications. The process involved slicing the Shrimp paste into thin pieces, approximately 2-3 mm in thickness, followed by drying in an oven at 70°C for 9 hours. Once dried, the Shrimp paste was ground into a fine powder using a blender and sieved through a 60-mesh sieve. The resulting powdered Shrimp paste was then packaged and stored in glass jars for further use.

2.3 Instant Cream Soup Production

The production of instant cream soup was adapted from the procedure described by Sunyoto et al. (2018) with modifications. The process began by homogenizing all ingredients and stirring them at a constant speed for 3 minutes at a temperature of 80°C until a uniform mixture was achieved. The prepared cream soup was then dried in an oven. For drying, the cream soup was spread evenly onto a baking tray at a thickness of 2-3 mm and dried in an oven at 70°C for 9 hours. After 4 hours of drying, the mixture was scraped to reduce its surface area and ensure even drying. The dried cream soup product was ground using a blender for 30 seconds and sieved through a 100-mesh sieve. The final product was stored in ziplock plastic bags, resulting in instant cream soup.

2.4 Proximate Analysis

The proximate analysis conducted in this study focused on determining the moisture and protein content, following the standard methods outlined by the Association of Official Analytical Chemists (AOAC). The moisture content was measured by drying the samples at a specific temperature until a constant weight was achieved, while the protein content was determined using the Kjeldahl method, which involves digestion, distillation, and titration processes. These analyses were performed to ensure accurate and reliable quantification of the nutritional components in the samples, adhering to internationally recognized guidelines for quality assurance.

2.5 Glutamic Acid Analysis

The glutamate content was determined using the ninhydrin-spectrophotometry method. The testing procedure involved dissolving 1 gram of the sample in distilled water to achieve a final volume of 100 mL. The resulting solution was centrifuged to obtain a clear supernatant. Subsequently, 1 mL of the clear solution was transferred into a test tube, and 2 mL of ninhydrin reagent was added. The mixture was heated in a water bath at 50°C for 30 minutes. After heating, the sample was cooled to room temperature and diluted with 96% ethanol to a final volume of 10 mL. The solution was homogenized using a vortex mixer, and its absorbance was measured at a wavelength of 520 nm using a spectrophotometer. The spectrophotometric results were calculated using a standard curve prepared from glutamate solutions. For the standard curve, 50 mg of glutamate was dissolved in 100 mL of distilled water to create a stock solution.

2.6 Rehydration Ratio Analysis

The rehydration of instant cream soup was conducted by weighing 1 gram of the instant cream soup and homogenizing it in 5 mL of distilled water. The resulting solution was mixed using a hot plate stirrer at a temperature of 80-90°C for 3 minutes. After rehydration, the mixture was weighed. The percentage rehydration ratio was calculated using the following formula:

Rehydration Ratio (%)=(Weight of Dry SampleWeight of Rehydrated Sample)×100

2.7 Color Analysis

Color analysis was conducted using a colorimeter, which operates on the principle of measuring the reflectance of a product's color in response to light emitted by the device. The Hunter's Lab Colorimetric System was employed for this analysis, characterizing color through three parameters: L* (Lightness), a* (Redness), and b* (Yellowness). Each parameter has a specific scale range that reflects the color intensity of the tested material. The L* value represents lightness, with a scale ranging from 0 to 100, where 0 corresponds to complete darkness and 100 indicates maximum brightness. The a* value denotes redness, with a scale ranging from -80 to +100, where negative values indicate green tones and positive values indicate red tones. The b* value represents yellowness, with a scale ranging from -70 to +70, where negative values indicate blue tones and positive values indicate yellow tones. This system provides a comprehensive and quantitative assessment of color properties in the tested samples.

2.9 Hedonic Analysis

Hedonic testing is a test method that is carried out by measuring the level of liking for a product using an assessment sheet. Attributes in sensory testing include appearance, taste, smell and texture. Hedonic testing of instant cream soup uses a Likert scale of 1-9 with the specifications of very much dislike (1), very much dislike (2), dislike (3), somewhat dislike (4), neutral (5), somewhat like (6), like (7), very much like (8), very much like (9). The hedonic panelists for instant cream soup consisted of 30 students of fishery product technology.

3. Results And Discussions

3.1. Water And Protein Content

The results of the water and protein content of instant cream soup are shown in Table 1.

Table 1. Water and Protein Content of Instant Cream Soup

Shrimp paste concentration	Water content (%)	Protein content (%)
0%	5.80 ± 0.00^{a}	18.38 ± 0.19^{a}
5%	7.15 ± 0.00^{b}	21.68 ± 0.12^{b}
10%	8.68 ± 0.00^{c}	26.21 ± 0.16^{c}
15%	10.75 ± 0.00^{d}	29.37 ± 0.35^{d}

Information:

Data ± standard deviation

Data followed by different lowercase letters in the same column are significantly different ($P<0.05$)

Based on the analysis of variance (ANOVA), it was found that the moisture content of instant cream soup with the addition of rebon shrimp Shrimp paste at different concentrations showed significant differences. A follow-up test using the Honestly Significant Difference (HSD) method at a 5% significance level was conducted to determine the differences between treatments. The results indicated that instant cream soup with varying concentrations of rebon shrimp Shrimp paste had significantly different moisture content levels. The lowest moisture content was observed in the treatment with 0% Shrimp paste addition, at 5.80%, while the highest moisture content was recorded in the treatment with 15% Shrimp paste addition, at 10.75%. The increase in the concentration of rebon shrimp Shrimp paste in instant cream soup was directly proportional to the increase in moisture content. This phenomenon is likely due to the water-binding capacity of proteins. Water molecules play a crucial role in interacting with proteins through structural relationships. Protein components in food products, being polar and ionic compounds, have the ability to bind with water. The polar and ionic groups of proteins exhibit a strong tendency to interact with the polar groups of water molecules (Hong and Kim, 2016).

The moisture content of instant cream soup with rebon shrimp Shrimp paste addition at concentrations ranging from 0% to 15% fell within the range of 5.80% to 10.75%. This indicates that the instant cream soup with 0% and 5% Shrimp paste concentrations met the Indonesian National Standard (SNI 4967-1999), which stipulates a maximum moisture content of 8% for instant cream soup. These findings contrast with previous research by Srivastava et al. (2019), where the addition of mushroom broth as a flavor enhancer in instant cream soup led to a decrease in moisture content. The addition of mushroom broth at concentrations of 10%, 20%, 30%, and 40% resulted in moisture content values of 4.63%, 4.26%, 3.00%, and 2.86%, respectively. Similarly, Sarkar et al. (2019) reported that the addition of minced chicken meat at concentrations of 0%, 20%, 25%, and 30% yielded instant cream soup with moisture content levels of 7.89%, 6.67%, 5.99%, and 5.46%, respectively.

The increase in the concentration of rebon shrimp Shrimp paste in instant cream soup was directly proportional to the increase in protein content. This is likely attributed to the high protein content of the ingredients used in the formulation of the instant cream soup. The primary sources of protein in the soup are full cream milk and rebon shrimp Shrimp paste. Rebon shrimp Shrimp paste contains a protein content ranging from 55.79% to 62.45% (Anggo

et al., 2014). The high protein content in Shrimp paste is a result of protein degradation during the fermentation process. Myosin heavy chains and actin from rebon shrimp undergo complete degradation through proteolysis during fermentation. Additionally, Shrimp paste experiences an increase in protein content during storage, rising from 24.69% to 47.26% after two months of storage (Pongsetkul et al., 2014).

The protein content of instant cream soup with rebon shrimp Shrimp paste addition at concentrations ranging from 0% to 15% fell within the range of 18.38% to 29.37%. These values indicate that the instant cream soup meets the Indonesian National Standard (SNI 4967-1999), which specifies a minimum protein content of 10% for instant cream soup. Similar findings were reported by Angkasa et al. (2021), who found that instant cream soup with a 1:1 ratio of beetroot and shrimp had a protein content of 26.68%. Additionally, Patel et al. (2023) reported that the addition of tuna to instant soup resulted in a protein content of 38.43%.

3.2. Glutamic Acid Content

Glutamic acid is one of the key amino acids that plays a crucial role in the formation of umami flavor in food products. The presence of glutamic acid in appropriate amounts can enhance the taste and consumer appeal of food. However, excessively high levels of glutamic acid in a product can negatively impact its flavor, as the resulting taste may become overly intense (Jinap and Hajeb, 2010). The results of the glutamic acid content analysis in instant cream soup with the addition of rebon shrimp Shrimp paste at concentrations of 0%, 5%, 10%, and 15% are presented in Table 2.

Table 2. Glutamic Acid Content of Instant Cream Soup

Shrimp paste concentration	Glutamic acid content (%)
0%	13.41 ± 0.65^{a}
5%	14.05 ± 1.24^{ab}
10%	15.73 ± 0.76^{b}
15%	9.40 ± 0.69^{c}

Information:

Data ± standard deviation

Data followed by different lowercase letters in the same column are significantly different ($P<0.05$)

The differences in glutamic acid content among the treatments were notably significant. The lowest glutamic acid content was observed in the treatment with 0% Shrimp paste addition, at 0.06%, while the highest content was recorded in the treatment with 15% Shrimp paste addition, at 16.24%. This variation is likely due to the high glutamic acid content naturally present in Shrimp paste. Rebon shrimp Shrimp paste contains glutamic acid levels ranging from 12.39% to 12.58% (Karim et al., 2014). The protein content of shrimp is directly proportional to the production of glutamic acid during the fermentation process of Shrimp paste; higher protein content results in higher glutamic acid levels (Romadhon et al., 2018).

The glutamic acid content of instant cream soup with Shrimp paste addition at concentrations ranging from 0% to 15% varied between 0.06% and 16.24%. The increase in the concentration of rebon shrimp Shrimp paste significantly influenced the rise in glutamic acid content in the instant cream soup. Similar findings were reported by Pikielna and Kostyra (2007), who noted that instant cream soups with different added ingredients exhibited varying glutamic acid levels. For instance, chicken broth-based cream soup contained 10.40% glutamic acid, mushroom cream soup had 9.22%, red beet cream soup contained 9.68%, vegetable cream soup had 12.33%, asparagus cream soup contained 45.37%, and green pea cream soup had 41.12%.

3.3 Rehydration Ratio

The rehydration ratio refers to the process by which a dried product reabsorbs water. A high rehydration ratio is indicative of a high-quality product, as it reflects the product's ability to absorb water and return to its original state prior to drying (Azizah et al., 2014). The results of the rehydration ratio analysis for instant cream soup with the addition of rebon shrimp Shrimp paste at concentrations of 0%, 5%, 10%, and 15% are presented in Table 3.

Table 3. Rehydration Ratio of Instant Cream Soup

Shrimp paste concentration	Rehydration ratio (%)
0%	3.65 ± 0.06^{c}
5%	3.18 ± 0.19^{b}
10%	2.66 ± 0.02^{a}
15%	2.37 ± 0.02^{a}

Information:

Data ± standard deviation

Data followed by different lowercase letters in the same column are significantly different (P<0.05)

The rehydration ratio of instant cream soup with the addition of shrimp paste showed a consistent decline. The highest rehydration ratio was observed in the treatment with 0% shrimp paste addition, with a value of 3.65, while the lowest rehydration ratio was recorded in the treatment with 15% shrimp paste addition, with a value of 2.37. This trend is likely attributed to the fat content in shrimp paste, which hinders the absorption of water by the solids. Rebon shrimp shrimp paste contains 5.33% fat (Romadhon et al., 2018). The reduced water absorption is due to the formation of a fat layer on the outer surface of the starch granules, which limits water penetration. This decreased penetration results in a reduced ability to absorb water (Oktaviana et al., 2017).

The rehydration ratio of instant cream soup with shrimp paste addition at concentrations of 0%, 5%, 10%, and 15% ranged from 3.65 to 2.37. These values are lower compared to those reported in similar studies. For instance, Setiawan et al. (2021) found that instant cream soup with the addition of tempeh at concentrations of 0%, 7.5%, and 15% had rehydration ratios of 6.47, 5.15, and 5.70, respectively. Similarly, Riyanto et al. (2020) reported that instant cream soup fortified with nano-minerals from fish bones, formulated to meet nutritional adequacy requirements, had a rehydration ratio of 4.55, while commercial instant cream soups had an average rehydration ratio of 3.50.

3.4. Color Analysis

Color plays a critical role in determining the quality of food products. As one of the key physical attributes, color is closely related to the overall characteristics and consumer acceptance of a product. The results of the color analysis for instant cream soup with the addition of rebon shrimp shrimp paste at concentrations of 0%, 5%, 10%, and 15% are presented in Table 4.

Table 4. Color Analysis of Instant Cream Soup

Shrimp paste concentration	*L**	*a**	*b**
0%	94.00 ± 1.00^{d}	0.46 ± 0,11^{a}	10.70 ± 0.64^{a}
5%	76.04 ± 1.20^{c}	6.94 ± 0,32^{b}	19.33 ± 0.68^{b}
10%	68.10 ± 2.21^{b}	8.54 ± 0,72^{c}	22.50 ± 0.93^{c}
15%	60.68 ± 0.64^{a}	10.49 ± 0,21^{d}	24.99 ± 0.43^{d}

Information:

Data ± standard deviation

Data followed by different lowercase letters in the same column are significantly different (P<0.05)

The L* value represents the lightness of a product, indicating its brightness. The L* values for instant cream soup with varying concentrations of rebon shrimp shrimp paste ranged from 94.00 to 60.68, showing a decrease in brightness as the concentration of shrimp paste increased. This decline is attributed to the browning effect caused by the addition of shrimp paste, which absorbs more light and reduces the L* value. According to Permatasari et al. (2018), shrimp paste typically exhibits a dark brown color. Darker colors, such as brown, absorb more light, resulting in lower L* values. The L* values for instant cream soup with shrimp paste concentrations of 0%, 5%, 10%, and 15% were 94.00, 76.04, 68.10, and 60.68, respectively. These values are higher compared to those reported by Wahono et al. (2022), who found that rebon shrimp shrimp paste with different types of salt had varying L* values: 58.74 for krosok salt, 60.21 for bledug kuwu salt, and 58.34 for Himalayan salt. Similarly, Sumardianto et al. (2023) reported that rebon shrimp shrimp paste with tomato additions at concentrations of 0%, 10%, 20%, and 30% had L* values of 51.73, 42.63, 39.17, and 37.13, respectively. The higher brightness of the cream soup with shrimp paste is likely due to the addition of milk, which enhances its lightness.

The a* value represents the chromaticity of red and green colors. The a* values for instant cream soup with rebon shrimp shrimp paste showed an increasing trend, with the lowest value (0.46) observed in the 0% shrimp paste treatment and the highest value (10.49) in the 15% shrimp paste treatment. This indicates that the soup's color shifted toward red as the shrimp paste concentration increased. The red color is likely derived from astaxanthin pigments present in shrimp shells. According to Rachmawati et al. (2016), shrimp heads are a natural source of carotenoids, containing astaxanthin pigments that impart a reddish-brown color to shrimp paste. The a* values for instant cream soup with shrimp paste concentrations of 0%, 5%, 10%, and 15% were 0.46, 6.94, 8.54, and 10.49, respectively. These values are higher than those reported by Sumardianto et al. (2023), where tomato additions at concentrations of 0%, 10%, 20%, and 30% resulted in a* values of 4.03, 5.41, 6.59, and 8.19, respectively. Similarly, Sumardianto et al. (2019) found that rebon shrimp shrimp paste with palm sugar additions at concentrations of 0%, 7.5%, 10%, and 12.5% had a* values of 5.58, 5.09, 5.21, and 4.96, respectively.

The b* value represents the chromaticity of blue and yellow colors. The b* values for instant cream soup with rebon shrimp shrimp paste showed an increasing trend, with the lowest value (10.70) observed in the 0% shrimp paste treatment and the highest value (24.99) in the 15% shrimp paste treatment. This suggests that the soup's color shifted toward yellow as the shrimp paste concentration increased. The yellow color is likely due to fermentation and cooking processes, which promote Maillard reactions. According to Li et al. (2020), intense shrimp fermentation leads to Maillard reactions, resulting in brown and yellow pigmentation. Additionally, pyrrole compounds formed from the reaction between oxidized lipids and proteins contribute to reddish-

yellow and brown pigmentation. The b* values for instant cream soup with shrimp paste concentrations of 0%, 5%, 10%, and 15% were 10.70, 19.33, 22.50, and 24.99, respectively. These values are higher than those reported by Sumardianto et al. (2023), where tomato additions at concentrations of 0%, 10%, 20%, and 30% resulted in b* values of 5.49, 8.22, 10.31, and 12.60, respectively. Similarly, Sumardianto et al. (2022) found that shrimp paste with purple sweet potato additions at concentrations of 0%, 10%, 20%, and 30% had b* values of 4.81, 5.52, 6.74, and 8.29, respectively. The higher b* values in the cream soup are also influenced by the Maillard reactions occurring in the powdered milk during the drying process.

3.5. Hedonic Analysis

The results of the hedonic test for instant cream soup with rebon shrimp shrimp paste additions at concentrations of 0%, 5%, 10%, and 15% are presented in Table 5.

Table 5. Hedonic Results of Instant Cream Soup

Shrimp paste concentration	Hedonic Interval
0%	$6.80<\mu<7.37$
5%	$7.33<\mu<7.70$
10%	$5.19<\mu<6.46$
15%	$3.97<\mu<5.88$

Information:

Data ± standard deviation

Data followed by different lowercase letters in the same column are significantly different ($P<0.05$)

The confidence intervals derived from the hedonic test of rehydrated instant cream soup with varying concentrations of rebon shrimp shrimp paste indicate distinct preferences among panelists. For the 0% shrimp paste addition, the confidence interval ranged from 6.80 to 7.37, while for the 5% shrimp paste addition, it ranged from 7.33 to 7.70, suggesting that these concentrations were "slightly liked" by the panelists. In contrast, the confidence intervals for the 10% and 15% shrimp paste additions were 5.19 to 6.46 and 3.97 to 5.88, respectively, indicating that these higher concentrations were "disliked" by the panelists. These results demonstrate that moderate levels of shrimp paste addition (0% and 5%) were more acceptable, while higher concentrations (10% and 15%) negatively impacted consumer preference.

4. Conclusions

Based on the research findings, it can be concluded that the addition of rebon shrimp shrimp paste (Acetes sp.) to instant cream soup significantly ($p < 0.05$) influences its physical and chemical characteristics, including moisture content, protein content, glutamic acid content, rehydration ratio, color, and hedonic acceptance. Increasing the concentration of shrimp paste led to higher moisture content, protein content, glutamic acid levels, and color intensity, but it reduced the rehydration ratio and panelist acceptance. The 5% shrimp paste addition was identified as the optimal treatment, as it resulted in a moisture content of 7.15%, which is below the maximum threshold of 8%. Physically, the instant cream soup with 5% shrimp paste exhibited a favorable rehydration ratio of 3.18 and produced the best overall hedonic interval, as evidenced by the hedonic test results with $7.33<\mu<7.70$ value. This treatment demonstrated a balance between improved nutritional and sensory properties while maintaining acceptable physical characteristics.

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