

CONSUMER ACCEPTANCE OF SENSORY CHARACTERISTICS IN POWDERED BROTH EXTRACTS FROM VANNAMEI SHRIMP (*Litopenaeus vannamei*) SHELLS WITH DIFFERENT FILLERS

Toga Mahaji^{1*}, Bagus Hadiwinata², Muhamad Latiful Khobir¹, Nelvia Mai Susanti³, Nurul Aulia³, Irmayadi Sastra³, Robert Martua Simanjuntak⁴

¹ Matuli College of Fisheries and Marine Sciences, North Sumatra

² Polytechnic of Fisheries Business, Jakarta

³ Simeulue Islands Polytechnic, Aceh

⁴ Master's Program in Fisheries Management, Indonesia Open University

Email: togamahaji231@gmail.com

ABSTRACT

To date, shrimp shell waste has not been fully utilized and often causes environmental problems. This study aims to determine the optimal filler formulation for producing shrimp shell powder broth based on consumer preference and product quality characteristics. This study used four filler formulations (total 10 g) in the shrimp shell extract, namely: F1 (10 g wheat flour), F2 (5 g wheat flour + 5 g cornstarch), F3 (5 g wheat flour + 5 g tapioca starch), and F4 (5 g wheat flour + 5 g rice flour). The tests conducted included a hedonic test (30 panellists), a descriptive test (spider web), a chemical analysis (proximate composition), and a microbiological test (Total Plate Count/TPC). The hedonic test results showed that formula F3 (a mixture of wheat flour and tapioca) was the best and most preferred by the panellists, with an average liking score of 4.11. Product F3 showed superior characteristics in colour, aroma, taste, texture, and solubility compared with the other formulations.

Keywords: Powdered Broth; Shrimp Shell Waste; Flour Formulation; Sensory Characteristics

INTRODUCTION

The increase in demand for shrimp is directly proportional to the increase in the volume of shrimp waste produced. Shrimp products generally undergo peeling and deveining, resulting in waste in the form of shrimp shells and skins. The increase in demand for shrimp is directly proportional to the increase in the volume of shrimp waste produced. According to the Ministry of Marine Affairs and Fisheries (2022), Indonesia's marine and fisheries sector continues to experience significant production growth, which simultaneously leads to an increased generation of processing by-products such as shrimp shells and heads. Disposing of this waste directly into the environment can cause unpleasant odors and potentially become a source of disease. Besides its flavor-enhancing capabilities, shrimp shell waste contains valuable bioactive compounds with biological and antioxidant potential, which are widely studied for their cellular protective mechanism against oxidative stress and neurodegenerative pathways (Obulesu and Lakshmi, 2014).

According to Amini (2023), shrimp waste in Indonesia primarily originates from the shrimp freezing industry. Although shrimp come in various types and sizes, only the meat is used as food, while the skin, shells, and exoskeletons become waste that can pollute the environment if not properly managed (Dipuja *et al.*, 2023). To date, shrimp shell waste has not been fully utilized and often causes environmental problems. The utilization and empowerment of processing communities through the processing of shrimp shell waste into value-added products can reduce environmental burdens while creating economic opportunities (Luzyawati & Hamidah, 2021).

The utilization of food industry processing by-products as functional ingredients in food systems significantly enhances resource efficiency while influencing final product quality and functional characteristics (Naibaho & Korzeniowska, 2021). According to Rathore (2018), shrimp shells contain approximately 43.12% protein. Shrimp shells have a relatively high nutritional content and can therefore still be utilized. According to Saleh *et al.* (2017), the proximate composition of shrimp shells is as follows: moisture 80.15%, protein 14.67%, fat 0.93%, and ash 2.64%. These nutritional components can be utilized by processing them into a powdered seasoning. Shrimp shells can be processed into a broth that imparts a savory flavor to dishes. This study aims to determine the optimal filler formulation for producing shrimp shell powder broth based on consumer preference and product quality characteristics. The utilization of nutrient-rich local ingredients and processing waste provides accessible options for promoting nutritional intake and healthy food choices (Diana *et al.*, 2024).

Broth is a type of flavoring added to food products to enhance aroma and improve taste. Natural flavor derived from shrimp shells is processed by boiling them in water to produce a liquid broth. The utilization of shrimp cooking water and shell extracts as flavor enhancers in powder form serves as an effective approach to processing shrimp waste into functional seasonings (Meiyani *et al.*, 2014). Liquid broth is impractical to store, so a method is needed to convert it from liquid to powder form to extend its shelf life (Suparmi *et al.*, 2020). Fillers can be obtained from various types of flour, which act as thickeners or stabilizers for the mixture. The starch content in flour plays a crucial role in water binding (Muchtar *et al.*, 2022). The concentration and combination of various flour types as fillers

significantly govern the chemical, physical, and sensory quality of products processed from seafood extract solutions (Mumtazah *et al.*, 2021). According to Arsyad *et al.* (2021), the most commonly used filler in the production of powdered broth is wheat flour. The starch content in wheat flour can bind water and increase the broth's solids content. However, when used as a filler, wheat flour results in a coarse texture and tends to clump. Therefore, other fillers are added to improve the quality of the powdered broth. The processing of shrimp waste (shells and skins) into natural powdered seasonings offers a healthy, MSG-free broth alternative that optimizes fishery by-product utilization (Putri Hermanto *et al.*, 2019).

This powdered broth uses fillers such as wheat flour, cornstarch, tapioca, and rice flour, which act as binders or thickening agents that stabilize, thicken, or increase the viscosity of food; when mixed with water, they form a specific consistency. Several previous studies have used fillers, including wheat flour and tapioca, in producing vannamei shrimp shell flavor powder (Atika & Handayani., 2019). Suparmi *et al.* (2020) studied the quality of shrimp shell powder broth with various concentrations of wheat flour. Based on this, this study aims to determine which treatment yields the best results using these four flour variants as flavor powders.

RESEARCH METHODS

Time and Location of the Study

This study was conducted from January 10 to June 10, 2025, at the Fisheries Product Processing Engineering Laboratory, Jakarta Fisheries Business Polytechnic.

Equipment and Materials

The equipment used to produce powdered broth from vannamei shrimp shells with different fillers includes a thermometer, plastic cups, labels, a frying pan, a spatula, and a stove. The ingredients used to produce powdered broth from vannamei shrimp shells with different fillers are vannamei shrimp shells (the main ingredient), mineral water, pepper, salt, sugar, garlic, wheat flour, tapioca flour, rice flour, and cornstarch.

Research Design

The composition of the additional ingredients garlic, pepper, and salt is based on Maulina *et al.*, (2024) study and has been modified. The utilization of vannamei shrimp shell broth as a natural flavoring agent was adapted from previous studies on fishery product processing (Akbar, 2017). The broth was then poured into a stainless steel baking pan, and fillers were added according to the treatment. Table 1 shows the composition of the powdered broth.

This study began by converting shrimp shells into powdered broth using various fillers: wheat flour, wheat flour mixed with tapioca flour, wheat flour mixed with cornstarch, and wheat flour mixed with rice flour. The evaluation of sensory characteristics and organoleptic acceptance of fishery products subjected to different processing conditions was conducted following sensory testing standards (Maulani *et al.*, 2022). The processing of shrimp shell waste into functional seasonings represents a key innovation in expanding the utilization and value-addition of fishery processing by-products (Dianiswara *et al.*, 2023). Afterward, a hedonic test was conducted with a panel of tasters, followed by a descriptive analysis to determine the product's quality characteristics. Finally, a de Garmo test was performed to select the optimal formulation.

Table 1. Composition for Making Powdered Broth

Treatment	Shrimp waste (g)	Water (mL)	Additional Seasonings (g)				Filler (10 g)
			Garlic	Pepper	Salt	Sugar	
F1	50	100	10	0.20	10	5	10 g wheat flour
F2	50	100	10	0.20	10	5	5 g wheat flour + 5 g cornstarch.
F3	50	100	10	0.20	10	5	5 g wheat flour + 5 g tapioca flour
F4	50	100	10	0.20	10	5	5 g wheat flour + 5 g rice flour

Research Procedure

The shrimp shells were first washed under running water until clean, then weighed on a digital scale according to the formulation (50 g each). Standard handling and sanitation principles for raw *Litopenaeus vannamei* materials were applied during preparation to ensure cleanliness and prevent quality degradation, in accordance with Good Manufacturing Practices (GMP) and Sanitation Standard Operating Procedures (SSOP) for shrimp processing (Hafina *et al.*, 2021). Ensuring quality, safety, and raw material origin in fishery processing requires systematic handling, which are essential for maintaining food safety and product consistency in fisheries processing industries (Putra & Mangunsong, 2019). Afterward, the shrimp shells were boiled at 70°C for 2 minutes. The preparation and initial handling procedures of shrimp raw materials play a critical role in preserving their physical and sensory characteristics prior to further processing (Elisa *et al.*, 2022).

Next, the boiled material was blended with 10 g of garlic. It was then blended while adding 10 g of garlic. After boiling, the mixture was strained using a coconut milk strainer to separate the filtrate (broth) from the substrate (pulp). Afterward, wheat flour was added to the strained broth according to the formula, along with seasonings (salt, sugar, and pepper), and the mixture was stirred until homogeneous. Wheat flour, cornstarch, tapioca, and rice flour serve as binding agents for the shrimp shell broth product. After adding the thickening agents, the liquid broth was homogenized until it formed a thick batter and poured into a stainless steel baking pan; it was then dried in an oven at 70°C for 6 hours. The application of tray drying mechanisms to evaporate moisture content from thick paste/solution mixtures into dried powdered form was performed in accordance with thermal drying principles for food materials (Hariyadi, 2019). Methods for evaluating physical and processing characteristics of dried fishery products were adapted from established procedures in fishery product processing (Akbariansyah *et al.*, 2018).

Meanwhile, the composition of the additional ingredients, garlic, pepper, and salt, was based on a modified study by Maulina *et al.*, (2024). The broth was then poured into a stainless steel baking pan, and the thickening agents were added according to the treatment. Consumer acceptance of the powdered broth products made with various thickening agents was determined using a hedonic test. Sensory testing procedures, panelist instructions, and scale evaluations were conducted following standard guidelines for sensory evaluation in food testing (Kemp *et al.*, 2009). The hedonic test was conducted in triplicate for four treatments with 30 panelists, namely students from the Jakarta Polytechnic of Fisheries Business. The hedonic test used parameters such as color, aroma, taste, texture, and solubility on a 1–5 rating scale with the following values: (1 = strongly dislike, 2 = dislike, 3 = neutral, 4 = like, and 5 = strongly like). The 1–5 rating scale was based on Putri (2023).

Quantitative descriptive sensory analysis (Quantitative Descriptive Analysis) followed SNI 2718 1:2013 regarding shrimp paste; testing was conducted in three replicates with the same panelists. The resulting data will then be analyzed using the spider web method. In this method, 6 trained panelists conducted sensory testing of the powdered broth across 3 replicates; each panelist received samples of 4 different formulations and a descriptive evaluation sheet covering color, aroma, taste, and texture. Each parameter uses an unstructured linear scale; panelists will draw a line and stop at the length corresponding to their assessment, based on the provided instructions. The data from the 6 panelists across the 3 replicates will then be averaged and analyzed using the spider web method. This method aims to determine the physical characteristics of the powdered broth based on the evaluations of the 6 trained panelists.

The de Garmo test is a method for determining the optimal formula through a hedonic test of four formulas (1, 2, 3, and 4) of vannamei shrimp shell powdered broth based on the attributes/parameters of taste, odor, texture, color, and solubility, which are considered important by the panelists. The first step in using the de Garmo test method is to assign parameter weights to the trained panelists; each criterion is weighted according to its level of importance, with weights assigned on a 1–5 scale: 1 (not at all important), 2 (unimportant), 3 (neutral), 4 (important), and 5 (extremely important). The weighting data from the panelists are then summed, and the total is divided by the number of scores. Next, determine the highest and lowest average values for each formula, then calculate the effectiveness score to identify the highest-scoring formula among the four; the formula with the highest score is deemed the best.

RESULTS AND DISCUSSION

Consumer Acceptance Levels of Powdered Broth Based on Hedonic Testing

The parameters used for the powder samples were color, aroma, and texture. Meanwhile, the parameters used for the solution samples were color, aroma, taste, and solubility. The hedonic scale used was (1) strongly dislike, (2) dislike, (3) somewhat like/neutral, (4) like, (5) strongly like. Table 2 shows the results of the hedonic test.

Based on the average values in Table 2 above, treatment F3 had the highest score for the color parameter (4.26). For the aroma parameter, treatment F3 had the highest score (4.03). For the taste parameter, treatment F3 had the highest score (3.94). For the texture parameter, treatment F3 had the highest score (4.30). For the solubility parameter, treatment F3 had the highest score (4.02). Formulations and specific processing treatments significantly govern the sensory attributes, overall quality, and chemical properties of processed fishery products, which aligns with findings reported by Hutomo *et al.* (2015) on quality parameters in processed fish products.

Table 2. Results of the Hedonic Test for Powdered Broth

Parameter	Treatment			
	F1	F2	F3	F4
Color	3.72	3.92	4.26	3.81
Aroma	3.71	3.86	4.03	3.71
Taste	3.64	3.61	3.94	3.83
Texture	3.97	3.96	4.30	3.81
Solubility	3.71	3.74	4.02	3.74
Average	3.75	3.82	4.11	3.78

Based on the average results in Table 2, the highest overall score from the hedonic test was found in treatment/formula F3, with a score of 4.11 specifically, powdered broth with wheat flour and tapioca as fillers. The successful transformation of shrimp shells and skins into an acceptable natural flavoring powder provides a health-conscious, MSG-free alternative for food seasoning, which aligns with the findings of Hermanto & Nengseh (2020) on the utilization of shrimp waste for broth powder substitution. The addition and substitution of different flour variants significantly affect consumer acceptance and organoleptic properties, which aligns with findings by Camelia & Tamaroh (2021) regarding the influence of flour substitution on product acceptance and chemical-sensory characteristics. The sensory evaluation of powdered seasoning products from fishery sources is critical to determine consumer acceptance and physical attributes, which is consistent with the quality assessment of fish-based powdered seasonings evaluated by Botutihe & Rasyid (2018). Meanwhile, the lowest score was found in treatment/formula F1, with a score of 18.75 powdered broth with wheat flour as the filler. Thus, the results can be explained based on each parameter: color, aroma, taste, texture, and solubility.

Color is the fastest-responding parameter and most easily conveys a positive impression. Consumers may not necessarily prefer foods that are tasty, nutritious, and have a good texture if they have an unappealing color or deviate from their expected color (Linangsari *et al.*, 2022). The resulting color is influenced by the ingredients used (Subamia *et al.*, 2020). The Maillard reaction during baking increases brown color intensity. The Maillard reaction occurs due to the presence of reducing sugars and amino groups in food (Kaahoa *et al.*, 2017). According to Pramudya *et al.* (2022), the Maillard reaction is a food browning reaction caused by heating and the reaction between free amino acids or free amino groups from amino acids which are part of protein chains and reducing sugars (primarily D-glucose). Heating temperature affects the rate of the Maillard reaction; as the drying temperature increases, the resulting color becomes less preferred by panelists. The browning reaction

(Maillard reaction) that occurs during drying can reduce brightness and degrade color.

Based on the results shown in Figure 3, it can be concluded that the F3-treated powdered broth with wheat flour and tapioca as fillers received the highest hedonic score compared to the other treatments; this is likely because tapioca flour imparts attractive characteristics to the broth, such as a bright color when combined with wheat flour. Meanwhile, the F1 treatment powdered broth with wheat flour as the filler received the lowest hedonic score; this is likely because the broth has a brownish-yellow color that is somewhat dark. Color is also a crucial element in assessing the quality or acceptability of a food product; an appealing color can enhance consumer acceptance (Aprillia *et al.*, 2025). The correlation between physical attributes and sensory acceptance highlights that ingredient formulations directly shape the overall sensory profile and consumer preference of processed food products, which is consistent with findings by Leighton (2008).

Powdered broth made from shrimp shells has a savory shrimp aroma and the distinctive aromas of each filler ingredient. Treatment F3, which had the highest score powdered broth with wheat flour and tapioca as fillers possesses a distinctive aroma and a very strong, characteristic shrimp scent. The sense of smell detects distinctive aromas based on the constituent ingredients and additives in food (Arsyad *et al.*, 2021). The food industry considers odor testing important because it can quickly provide results on consumer preference for a product (Kusumaningrum & Setiawan, 2018). Aroma can indicate product spoilage (Pradipta, 2011). The aroma or odor perceived by the nose is a mixture of four distinct scents: fragrant, sour, rancid, and burnt (Widyadnyani, 2022).

Fillers such as wheat flour and tapioca flour do not significantly mask the savory flavor of the shrimp broth, whereas a mixture of wheat flour, cornstarch, and rice flour masks it slightly. Taste is a crucial factor in food because acceptance or rejection of a food item is determined by its taste. The high acceptance of shrimp shell broth flavor is contributed by the rich protein and amino acid content inherently present in shrimp processing waste, which holds great potential for functional flavor and protein processing (Cahyani *et al.*, 2024). Food flavor is a combination of taste and smell. Flavor assessment relies on the five senses specifically the tongue which evaluates food and beverages (Nafsiyah *et al.*, 2022). This indicates that the fillers used influence the flavor of the powdered broth. Consistent with research by Kereh *et al.* (2022), ingredients added during processing can influence the flavor of powdered broth.

Texture is a characteristic of a material that can be perceived by the sense of touch, taste, and sight (Midayanto & Yuwono, 2014). The physical attributes and solubility of flour-based mixtures are strongly dictated by the functional and physicochemical characteristics of the constituent starches, as highlighted by Nafi *et al.* (2015). The processing conditions and material formulations significantly influence the final physical characteristics and composition of dried fishery products, which aligns with findings by Argo *et al.* (2018) on processed fish flakes and dried products. Based on the hedonic test, the most preferred parameter was found in treatment F3, specifically the powdered broth with wheat flour and tapioca as fillers, because it had a fine, granular texture and did not clump easily compared to the other formulations, whereas in treatment F4 the powdered broth with wheat flour and rice as fillers the texture was coarser

and clumpy. These results are in agreement with Astuti *et al.* (2019), who highlighted that the addition and formulation of different starches and flour sources significantly affect both the physical and sensory characteristics of dry food products. Texture is also influenced by moisture content, which makes it softer, as well as the ingredients used, mold thickness, and high oven temperature (Nanda *et al.*, 2020). Monitoring and measuring the moisture content of food ingredients during processing is critical to ensuring product stability and preventing caking or clumping in powdered products (Prasetyo *et al.*, 2019).

Solubility, as tested in the hedonic evaluation, refers to visual solubility that is, the ability of powdered broth to dissolve in water to form a homogeneous solution without any coarse particles, clumps, or sediment visible to the naked eye. The choice of drying conditions and processing methods significantly influences the structural characteristics, reconstitution properties, and final quality attributes of dried instant food products, which is consistent with the findings reported by Husain *et al.* (2006). The drying process and temperature play a crucial role in maintaining product stability and reconstitutability in instant processed foods, which aligns with findings by Ayu *et al.* (2016) regarding the thermal drying of instant sauce products. This property allows it to readily bind water after mixing with dextrin and boiling water.

Determining the Characteristics of Powdered Broth Based on Qualitative Descriptive Analysis (Spider Web)

Descriptive sensory analysis is a sensory analysis method in which the sensory attributes of a product or food ingredient are identified, described, and quantified using specially trained panelists (Setyaningsih, 2010). The organoleptic characteristics of shrimp waste-based flavoring powders confirm their high potential as viable natural flavoring alternatives to synthetic seasonings (Maryam, 2023). The raw material's nutritional profile, which contains essential minerals and high protein levels as characterized in shrimp species from various coastal regions (Nurjanah & Kustiyariyah, 2005). A key feature of this method is that panelists rate a sample's sensory attributes using an unstructured 15-cm line scale, where a score of 0 represents the lowest rating (Kusumaningrum *et al.*, 2014). The data obtained are then averaged and plotted as a spider web chart in Microsoft Excel (Purba *et al.*, 2013). The tests conducted included a hedonic test, a descriptive test (spider web). The evaluation of seafood-based flavoring preparations during processing and storage was conducted following standard quality assessment protocols for fishery products (Rahmi *et al.*, 2018).

The results are defined in the form of data per formula, namely F1: powdered broth with wheat flour as the filler; F2: wheat flour and cornstarch as fillers; F3: wheat flour and tapioca starch as fillers; F4: wheat flour and rice flour as fillers; and also in a combined form. The results in the graph will resemble a spider web; lines that extend toward the corners indicate higher scores or superior performance at those points. We provided samples and descriptive test sheets to 6 panelists; Figure 1 shows the four powdered broth formulas.

A spider diagram that illustrates all the characteristic/sensory attributes of each powdered broth product according to treatments/formulations F1, F2, F3, and F4, as evaluated by trained panelists. The further outward the points extend on the spider diagram, the higher the quality characteristics of the powdered broth. The spider web diagram

illustrates the sensory characteristic profiles of each powdered broth product under treatments F1, F2, F3, and F4, based on evaluations by trained panelists. A wider spider web indicates higher values for the product's sensory characteristics. Sensory characteristic evaluations were conducted using a 1–5 scale, with higher values indicating stronger intensity of the characteristics. Table 5 presents the descriptive test results from six trained panelists. Using a scale ranging from 0 to 5 cm, the panelists drew lines based on their assessments. The results of the spiderweb chart are shown in Figure 2.



Figure 1. Powdered broth

Table 3. Descriptive Test Results

Code	Color	Aroma	Taste	Texture
F1	1.4	1.5	1.6	1.3
F2	2	1.8	2.2	1.5
F3	2.1	2.8	2.2	2.4
F4	2.1	1.4	1.5	1.4

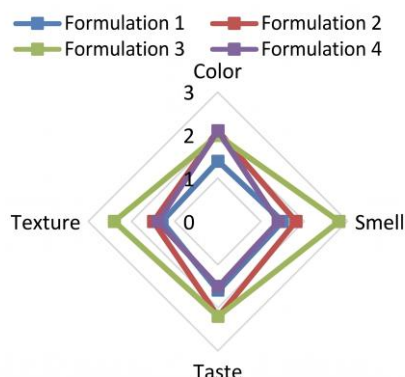


Figure 2. Overall *Spiderweb* Test

Based on the graph in Figure 2, the farther a line extends from the center point on the spider web graph, the higher the intensity of that attribute according to the panelists' ratings. Formula F3 ranked highest because it had the best aroma, flavor,

and texture, even though its color was slightly less intense than F4's. Furthermore, the addition of tapioca flour in *Litopenaeus vannamei* shrimp shell processing significantly enhances sensory acceptance, particularly in improving product texture and overall organoleptic profiles, which is in line with the findings of Johan *et al.* (2020). Meanwhile, F4 stood out for its very bright color but lacked flavor and aroma; F1 had a golden-brown color, with less dominant texture and flavor; and F2 excelled in its strong, shrimp-like flavor but had the coarsest texture and weakest aroma.

Based on a study (Arsyad *et al.*, 2021), wheat flour is not suitable for use as a sole filler because it produces a coarse, powdery texture that clumps easily, resulting in poor color appearance. Formula F1 exhibited a golden-brown color; compared to the other formulas, it was slightly darker, yet its characteristics were still acceptable to the panelists. In terms of aroma, F1 was assessed as having a very faint or nearly undetectable shrimp-like aroma; similarly, its flavor was described as bland and lacking savory notes, and its texture remained coarse and clumpy. Consequently, F1 has not yet delivered optimal sensory scores compared to the other formulas. Broth is a type of flavoring added to food products to enhance aroma and improve taste. Developing instant broth products using nutrient-rich materials provides a viable alternative seasoning option to enhance daily food quality and nutrition (Malichati & Adi, 2018).

For formula F2, or powdered broth with wheat flour and cornstarch as fillers, the results of the descriptive test conducted in triplicate with 6 trained panelists are shown in Figure 3.

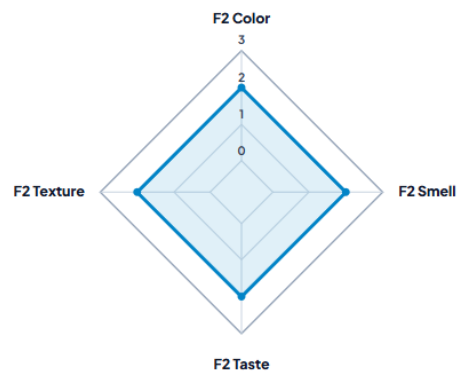


Figure 3. F2 *Spiderweb* Test

Based on Figure 3 above, Formula F2 has a creamy, appealing color that suggests a fresher, cleaner product. In terms of aroma, a faint shrimp scent is detectable, and the flavor has a fairly strong, distinctive shrimp aroma; however, the texture does not balance this, as it is slightly clumpy and feels somewhat coarse. For formula F3, or powdered broth with wheat flour and tapioca starch as fillers, the results of the descriptive test conducted in triplicate with 6 trained panelists are shown in Figure 4.

Based on Figure 4 above, it can be concluded that Formula F3 powdered broth with wheat flour and tapioca starch as fillers is the most outstanding formula overall because it delivers the best scores in terms of aroma, taste, and texture. The extraction and utilization of shrimp carapace components play a

key role in dictating the physical, chemical, and organoleptic properties of the resulting powdered broth, which aligns with findings by Karomah *et al.* (2021) regarding the influence of shrimp carapace extract concentrations on broth powder quality. The aroma is stronger, distinctly shrimp-like, and appealing; the flavor is dominant and delivers a delicious, savory shrimp taste; and the broth has a smooth texture without lumps, making F3 the most preferred formula among the panelists. Although the product's color is slightly less intense than F2 and F4, the balance among the other sensory parameters gives F3 an advantage in overall consumer acceptance. A good powdered broth has uniform granules, is not strikingly colored, and has a distinctive aroma (Ramadhani, 2015).

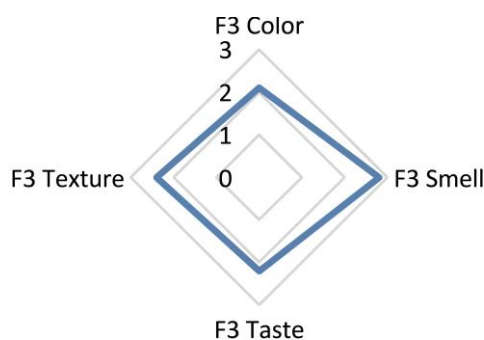


Figure 4. F3 Spiderweb Test

For formula F4, or powdered broth with wheat flour and rice flour as fillers, the results of the descriptive test conducted in triplicate with 6 trained panelists are shown in Figure 5. Based on Figure 5, the F4 formula (wheat flour: rice flour) produced the brightest and most appealing color but had low taste and aroma scores and a moderate texture. Thus, F4 excels visually but is not yet optimal in sensory qualities, so taste and aroma need improvement. Color variations are believed to be influenced by increased filler concentration, which makes the color paler, as well as by the Maillard reaction during drying between reducing sugars and amine groups (Kereh *et al.*, 2022).

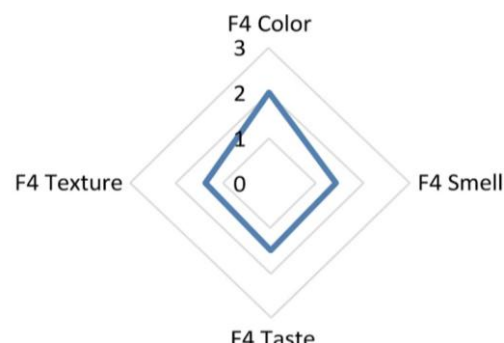


Figure 5. F4 Spiderweb Test

Determination of the Best Product Based on the De Garmo Test

The first step was to determine the weighting of the parameters: color, aroma, taste, texture, and solubility. Six trained panelists, including professors and broth users (meatball vendors), determined the weights. Table 6 shows the results of the weighting test.

Table 6. Weighting

Weight	Parameter				
	Color	Aroma	Taste	Texture	Solubility
	0.16	0.30	0.28	0.09	0.18

The panelists rated each parameter on a scale of 1–5 based on its level of importance, and the ratings were then weighted using the average score. The highest score was 5 and the lowest was 1. The interview results showed that aroma was the most important parameter, especially for meatball soup. The data from the six panelists were then totaled, averaged per parameter, and used to calculate an effectiveness score to determine the best formula. The highest and lowest scores are presented in Table 7.

Table 7. Highest and Lowest Values

Parameter	Highest N			Average	Lowest Value			Average
	U1	U2	U3		U1	U2	U3	
Color	4.15	4.17	4.47	4.26	3.75	3.80	3.58	3.71
Aroma	4.08	3.87	4.13	4.03	3.78	3.57	3.60	3.65
Taste	4.03	3.83	3.97	3.94	3.60	3.67	3.30	3.52
Texture	4.1	4.37	4.43	4.30	3.83	3.73	3.70	3.75
Solubility	4	4	4.07	4.02	3.67	3.77	3.47	3.64

The highest and lowest scores were derived from the average results based on three repetitions for each formula (F1, F2, F3, and F4). The highest and lowest scores obtained were then averaged by parameter. The next step was to determine the final results to identify the highest score based on the effectiveness score. Table 8 shows the effectiveness scores.

Based on Table 8, the effectiveness value is obtained by subtracting the lowest value from all treatments from the treatment value for each parameter, then dividing by the difference. The difference is calculated by subtracting the lowest

value from the highest value. After obtaining the effectiveness values for each formula, the results are calculated by multiplying the effectiveness value by its weight; then, the values for each formula are summed, and the formula with the highest total value is selected as the optimal formula. In the table above, the highest value was obtained for treatment F3, with a value of 1.00. Thus, among the powdered broth treatments F1, F2, F3, and F4, the best formula is treatment F3: powdered broth with wheat flour and tapioca as fillers.

Table 8. Effectiveness Values

Parameter	NT	NR	S	Effectiveness Value				Result Value			
				F1	F2	F3	F4	F1	F2	F3	F4
Color	4.26	3.71	0.55	0.02	0.39	1.01	0.18	0.00	0.06	0.16	0.03
Aroma	4.03	3.65	0.38	0.14	0.57	0.99	0.15	0.04	0.17	0.30	0.04
Taste	3.94	3.52	0.42	0.29	0.13	1.01	0.75	0.08	0.04	0.28	0.21
Texture	4.30	3.75	0.55	0.39	0.37	1.00	0.11	0.04	0.03	0.09	0.01
Solubility	4.02	3.64	0.38	0.19	0.28	1.01	0.28	0.03	0.05	0.18	0.05
Average								0.20	0.35	1.00	0.34

Legend: NT = Highest Value; NR = Lowest Value; S = Difference

CONCLUSION

Based on the results of the hedonic test and the Kruskal-Wallis test with a post-hoc Mann-Whitney test of the four formulas evaluated by the parameters of color, aroma, taste, texture, solubility, and the de Garmo test, the powdered broth most preferred by consumers is the wheat flour: tapioca flour (F3) formulation.

ACKNOWLEDGMENTS

The authors would like to thank the Polytechnic of Fisheries Business for granting permission to use the facilities of the Teaching Factory and the Sensory Laboratory.

REFERENCES

Akbar, Z. (2017). Utilization of Vannamei Shrimp (*Litopenaeus vannamei*) Shell Broth as a Flavoring Agent in the Processing of Dumbo Catfish (*Clarias gariepinus*) Kemplang Crackers. *Journal of Fisheries Sciences and Aquaculture* 12(1), 27–33.
<https://doi.org/10.31851/jipbp.v12i1.1411akbar>

Akbardiansyah, A., Desniar, D., & Uju, U. (2018). Characteristics of salted “kambing-kambing” fish (*Canthidermis maculata*) using the dry salting method. *Indonesian Journal of Fishery Product Processing*, 21(2), 345–355.

Amini, K. (2023). Physicochemical and Flavor Characteristics of Vanamei Shrimp (*Litopenaeus vannamei*) Shell Powder with Different Maltodextrin Concentrations Using the Foam Mat Drying Method. *Journal of Fisheries Science and Technology* 5(2).

Aprillia, N. I. (2025). Chemical, Organoleptic, and Microbiological Characteristics of Shrimp Shell Crackers with Added Moringa Leaves. 10(1), 8166–8183.

Argo, B. D., Yusron, S., and Alvian, B. I. 2018. Analysis of the Composition of Catfish (*Pangasius pangasius*) Flakes Using the “Spinner Pulling Oil” Device as an Automatic Oil Extractor. *Journal of Tropical Agricultural Engineering and Biosystems*. Vol. 6, No. 1, pp. 52–62.

Arsyad, R., Asikin, A. N., & Zuraida, I. (2021). Consumer acceptance of powdered broth made from tiger prawn (*Penaeus monodon*) heads using various types of fillers.

Fishery Product Technology Media, 9(3), 124–130.
<https://doi.org/10.35800/mthp.9.3.2021.34146>

Astuti, S., AS, S., & Anayuka, S. A. 2019. Physical and Sensory Properties of Garut Cassava Starch and Red Bean Flakes with the Addition of Cassava Tiwul. *Journal of Applied Agricultural Research*, 19(3), 225–235.

Atika, S., & Handayani, L. (2019). Production of Vannamei shrimp (*Litopenaeus vannamei*) head flavor powder as a substitute for MSG (monosodium glutamate). *Proceedings of SEMDI-UNAYA (UNAYA National Multidisciplinary Seminar)*, 3(1), 18–26. Universitas Abulyatama, Aceh.

Ayu, M., Rosidah, U., & Priyanto, G. (2016). Production of instant green chili sauce using the foam mat drying method. In *Proceedings of the National Seminar on Suboptimal Lands* (pp. 20–21).

Botutihe, F., & Rasyid, N. P. (2018). Chemical, organoleptic, and microbiological quality of powdered seasoning made from smoked roa fish (*Hermihamphus far.*). *Perbal: Journal of Sustainable Agriculture*, 6(3), 16–30.

Cahyani, R. T., Alawiyah, T., Fadillah, N., & Ramadani, A. 2024. The Potential of *Penaeus monodon* Shrimp Genjer Waste as Raw Material for the Processing of Protein Isolates and Hydrolysates. 15(36): 112–119.
<https://jurnal.yudharta.ac.id/v2/index.php/teknologipangan/article/view/4296/2753>

Camelia, & Tamaroh, S. 2021. Chemical Properties and Acceptance of Cookies Substituted with Purple Uwi Flour (*Dioscorea alata* L.). In *Mercubuana University Yogyakarta* (pp. 1–16). <http://www.digg.com>

Diana, S. N., Octavia, P., Azizah, V. A., Firmani, U., Rahim, A. R., Widiharti, & Sukaris. (2024). Outreach on the Use of Household Medicinal Plants for Stunting Prevention. *DedikasiMU (Journal of Community Service)*, 6(1), 105–111.

Dianiswara, A., Nurmawati, Harahap, G. R., Putri, L. D., Wirawan, K. M., & Huda, C. A. (2023). Innovations in Shrimp Shell Waste Processing in RT.34, Karang Joang Village, North Balikpapan. *Journal of the Center for Community Service (Sinar Sang Surya)*, 7(1), 109–116.

Dipuja, D. A., Munassar, A. A., & Azzahra, H. (2023). Outreach on Shrimp Waste Processing as a Business Opportunity for the Community of Guntung Village. *NUSANTARA: Journal of Community Service*, 3(4), 3–7.

Elisa, S., Putri, D., Warkoyo, & Suhaimi, Y. (2022). The Effect

- of Soaking Time on the Physical and Sensory Characteristics of Shrimp. *Journal of Halal Agroindustry*, 8(April), 21–32.
- Hafina, A., Sipahutar, Y. H., & Siregar, A. N. (2021). Implementation of GMP and SSOP in the Processing of Frozen Raw Peeled and Deveined (PD) Vannamei Shrimp (*Litopenaeus vannamei*). *Aurelia Journal*, 2(3457), 117–131.
- Hariyadi, T. 2019. Application of the foam-mat drying method in the tomato drying process using a tray dryer. 10th Industrial Research Workshop and National Seminar, 250–257.
- Hermanto, E. M. P., & Nengsch, K. N. A. (2020). Utilization of Shrimp Waste (Shrimp Shells and Skins) as a MSG-Free Broth Powder Substitute in Medalem Village, Sidoarjo. *Abadimas Adi Buana*, 3. <https://lifestyle.okezone.com/read/2016>.
- Husain, H., T. R. Muchtadi, Sugiyono, and H. Bambang B. 2006. The Effect of Freezing and Drying Methods on the Characteristics of Instant Corn Grits. *Journal of Food Technology and Industry*. Vol. 17: 189–196.
- Hutomo, H. D., Swastawati, F., & Rianingsih, L. (2015). The Effect of Liquid Smoke Concentration on the Quality and Cholesterol Content of Smoked Eels (*Monopterus albus*). *Journal of Fisheries Product Processing and Biotechnology*, 4(1), 7–14.
- Johan, A., Asnani, A., & Rejeki, S. (2020). The effect of using Sargassum sp. and tapioca flour on the sensory properties and proximate composition of vannamei shrimp (*Litopenaeus vannamei*) shell paste. *Jurnal Fish Protech*, 3(1), 133–142.
- Kaahoa, A., Herawati, N., & Ayu, D. F. (2017). Utilization of tofu residue flour in the production of cookies containing red palm oil. *Jom Fapera*, 4(2), 1–15.
- Karomah, S., Haryati, S., and Sudjatinah. 2021. The effect of varying concentrations of shrimp carapace extract on the physicochemical properties of the resulting powdered broth. *Journal of Food Technology and Agricultural Products*, 16(1): 10–17
- Ministry of Marine Affairs and Fisheries. (2022). *Marine Affairs and Fisheries in Figures*.
- Kemp, S.E., Hollowood, T., & Hort, J. 2009. *Sensory Evaluation: A Practical Handbook*. United Kingdom: John Wiley & Sons.
- Kereh, E. C., Dien, H. A., Kaparang, J. T., Timbowo, S. M., Palenewen, J. C. V., Onibala, H., & Sanger, G. (2022). Organoleptic analysis of Indian oil sardine (*Sardinella* sp.) seasoning granules. *Fishery Product Technology Media*, 10(1), 11–16. <https://doi.org/10.35800/mthp.10.1.2022.31642>
- Kusumaningrum, I., & Setiawan, N. (2018). Formulation of high-potassium, high-fiber snack bars made from seaweed, kepok bananas, and mocaf as an alternative snack for people with hypertension. *Jurnal Uhamka*, 3(2), 102–220.
- Kusumaningrum, I., C. H. Wijaya, F. Kusnandar, Misnawi, and A. B. T. Sari. 2014. Aroma profile and sensory quality of premium cocoa paste from several regions in Indonesia. *Journal of Food Technology and Industry*. 25 (1): 106–116.
- Leighton, C. S. (2008). *Nutrient and sensory quality of orange-fleshed sweet potato* (Doctoral dissertation, University of Pretoria).
- Linangsari, T., Sandri, D., Lestari, E., & Noorhidayah. (2022). Sensory evaluation of *talipuk* snack bars with the addition of kepok banana flour (*Musa paradisiaca forma typica*) by child and adult panelists. *Halal Agroindustry Journal*, 8(2), 213–221. <https://doi.org/10.30997/jah.v8i2.6560>
- Luzyawati, L., & Hamidah, I. (2021). Empowerment of the Karangsang Village Community through the Utilization of Tuna and Shrimp Shell Waste. *SOLMA Journal*, 10(3), 423–430. <https://doi.org/10.22236/solma.v10i3.6464>
- Malichati, A.R., & Adi, A.C. (2018). Instant chicken broth with chicken liver flour substitution as an alternative seasoning to prevent anemia. *Amerta Nutr*: 74–82
- Maryam, A. (2023). Chemical and Organoleptic Analysis of Shrimp Waste-Based Flavoring Powder as a Natural Flavoring Alternative. *Jurnal Agroindustri Pangan*, 2(2), 68–85. <https://doi.org/10.47767/agroindustri.v2i2.549>
- Maulani, A. (2022). Sensory Characteristics of Gulamah Fish (*Pseudociena amovens*) at Different Salt Levels. *Jaulim Sirait**, Wahyu P. Ariyadi, Simson Masengi, Yuliati H. Sipahutar. *Airaha Journal*, 11(01).
- Maulina, D. E., Nurwati, & Hasdar, M. (2024). Shrimp waste as powdered stock: Analysis of moisture content, water activity, and organoleptic evaluation using the roasting method. *Journal of Technology and Food Processing (JTFFP)*, 4(2), 18–29. <https://doi.org/10.46772/jtffp.v4i02.1542>
- Meiyani, D.N.A.T., Riyadi, P.H., and Anggo, A.D. 2014. Utilization of white shrimp (*Penaeus merguensis*) shell cooking water as a flavor enhancer in powder form with the addition of maltodextrin. *Journal of Fisheries Product Processing and Biotechnology*, 3(2): 67–74.
- Midayanto, D., & Yuwono, S. 2014. Determination of texture quality attributes of tofu to be recommended as additional requirements in Indonesian national standards. *Journal of Food Agroindustry*, 2(4), 259–267.
- Muchtar, F., Hastian, & Ruksanan. 2022. Organoleptic Properties and Protein Content of Snakehead Fish Nuggets Made with Different Types of Flour. *Proceedings of the 2022 National Agribusiness Seminar*, 2(2), 32–38.
- Mumtazah, S., Romadhon, R., & Suharto, S. 2021. The Effect of Concentration and Combination of Flour Types as Fillers on the Quality of Shrimp Paste from Crayfish Boiling Water. *Journal of Fisheries Science and Technology*, 3(2), 105–112. <https://doi.org/10.14710/jitpi.2021.13147>
- Nafi, A., Diniyah, N., & Hastuti, F. T. (2015). Physicochemical and technical-functional characteristics of modified koro kratok (*Phaseolus lunatus* L.) flour produced through spontaneous fermentation. *Jurnal Agointek*, 9(1), 24–32.
- Nafsiyah, I., Diachanty, S., Guttifera, Sari, S.R., Rizki, R.R., Lestari, S., & Syukerti, N. 2022. “Hedonic Profile of Traditional Palembang-Style Grilled Kemplang.” *Journal of Freshwater Fisheries Science (Clarias)*, Vol. 3, No. 1.
- Naibaho, J., & Korzeniowska, M. (2021). Brewers’ spent grain in food systems: Processing and final product quality as a function of fiber modification treatment. *Journal of*

- Food Science, 86(5), 1532–1551.
- Nanda, Y. P., Amalia, H., & Ulfah, A. (2020). Analysis of fiber content and hedonic testing of snack bars made from red rice flour (*Oryza Nivara* L) and green beans (, *Phaseolus Radiates* L). *Journal of Holistic and Health Sciences*, 4(2), 129–136.
- Nurjanah Z, and Kustiyariyah. 2005. Mineral Content and Proximate Composition of Shrimp from Boalemo Regency, Gorontalo. [Bulletin of Fisheries Product Technology 8(2): 15–24]
- Obulesu, M., & Lakshmi, M. J. (2014). Apoptosis in Alzheimer's disease: an understanding of the physiology, pathology, and therapeutic avenues. *Neurochemical Research*, 39, 2301–2312.
- Pradipta, I. (2011). Physicochemical and Sensory Characteristics of Tempeh Snack Bars with the Addition of Dried Pondoh Salak. [Thesis, Sebelas Maret University]. UNS Institutional Repository.
- Pramudya, A. P., Fahmi, S. A., & Rianingsih, L. (2022). Optimization of Temperature and Drying Time for Nori Made from *Ulva lactuca* and *Gelidium* sp. with the Addition of Shrimp Shell Powder Flavoring Using Response Surface Methodology. *Journal of Fisheries Science and Technology*, 4(2), 100–110.
- Prasetyo, T. F., Isdiana, A. F., & Sujadi, H. 2019. Implementation of an Internet of Things-Based Moisture Content Detector for Food Ingredients. *SMARTICS Journal*, 5(2), 81–96.
<https://doi.org/10.21067/smartics.v5i2.3700>
- Purba, M., P. P. Ketaren, E. B. Laconi, and C. H. Wijaya. 2013. The Effectiveness of Santoquin and Vitamin E as Feed Additives on the Sensory Quality of Local Duck Meat. *JITV*. 18 (1): 42–53.
- Putra, I. G. S. E., & Mangunsong, S. (2019). Tuna Processing Information System for Traceability in Small-Scale Fisheries. *Journal of Science and Technology for the Utilization of Fisheries Resources*, 6(11), 90–101.
- Putri Hermanto, E. Mustikawati, & Nengseh, K. N. A. (2019). Utilization of Shrimp Waste (Shrimp Shells and Skins) as a MSG-Free Broth Powder in Medalem Village, Sidoarjo. *Jurnal Abadimas Adi Buana*, 3(2), 7–10.
<https://doi.org/10.36456/abadimas.v3.i2.a2165>
- Rahmi, A. D., Dien, H. A., & Kaparang, J. T. (2018). Microbiological and Chemical Quality of a Natural Flavoring Paste (Intermediate Product) Stored at Room Temperature and Refrigerated Temperatures. *Media Teknologi Hasil Perikanan*, 6(2), 42–47.
- Ramadhani, A. R. 2015. Organoleptic Characteristics of Mackerel Skin Flavor Powder with Wheat Flour as a Filler. [Thesis]. UNPAD, Jatinangor.
- Rathore, S. S., & Yusufzai, S. I. (2018). Changes in hematological and serum biochemical indices of Nile tilapia (*Oreochromis niloticus*) fry fed a diet containing shrimp head meal. *Journal of Entomology and Zoology Studies*, 4(4).
<https://www.entomoljournal.com/archives/2018/vol6issue4/PartL/6-4-53-303.pdf>
- Saleh, M., Ahyar, A., Murdinah, and Haqa, N. 2017. Extraction of Shrimp Shells into Liquid Shrimp Flavoring. *Indonesian Journal of Aquaculture Research*, 2(1): 60–68.
- Setyaningsih, D. 2010. Sensory Analysis for the Food and Agro Industries. *Bharata Karya Aksara*, Jakarta.
- Subamia, N. P. D. C., Nocianitri, K. A., & Permana, I. D. G. M. (2020). Utilization of Tofu Dregs Flour in the Production of Snack Bars for Patients with Diabetes Mellitus. *Scientific Journal of Food Technolog.*, 7(1), 27–38. DOI: 10.24843/MITP.2020.v07.i01.p04.
- Suparmi, Edison, Sari, N. I., Sumarto, and Susilo, R. 2020. Study on the Quality of Natural Flavor Powder Made from Shrimp Waste. IOP Publishing. 430 pp. Pekanbaru.
- Widyadnyani. (2022). Acceptance of Snack Bars Substituting Purple Sweet Potato Flour (*Ipomea batatas* var. *Ayamurasaki*) and Mung Bean Flour (*Vigna radiata* L.) for Wheat Flour. Ministry of Health of the Republic of Indonesia. Department of Nutrition, Nutrition Study Program. Denpasar.