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Formulation of Seruit Indigenous Food from Lampung with the Addition of Snakehead Fish (*Channa striata*) as a Source of Protein

Formulasi Makanan Khas Seruit dari Lampung dengan Penambahan Ikan Gabus (Channa striata) Sebagai Sumber Protein

Bertalina Bertalina[1]*, Reni Indriyani[1], Sudarmi Sudarmi[2], Arie Nugroho[1], Andi Eka Yunianto[3]

[1]Nutrition Study Program, Poltekkes Kemenkes Tanjung Karang, Lampung, Indonesia
[2]Midwifery Study Program, Poltekkes Kemenkes Tanjung Karang, Lampung, Indonesia
[3]Nutrition Study Program, Faculty of Medicine, University of Lampung, Lampung, Indonesia

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Correspondent:
Bertalina Bertalina
bertalina@poltekkes-tjk.ac.id

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ABSTRACT

Background: *Seruit* is an indigenous food in Lampung. The dish typically consists of a combination of seafood, vegetables, and spices that are stir-fried together to create a savory and aromatic dish beloved by locals and visitors alike. The key ingredient in *seruit* is the use of fresh seafood such as shrimp, squid, and fish.
Objectives: The study aimed to determine a formula based on acceptability and macronutrient content, especially proteins.
Methods: The study used a completely randomized experimental design. *Seruit* was a typical Lampung chili sauce, consisting of shrimp paste chili sauce supplemented with grilled snakehead fish meat. The *seruit* formulation used in this study consisted of a mixture of 30, 40, and 50 g of chili sauce and 70, 60, and 50 g of snakehead fish. Duncan's Multiple Range Test (DMRT) was used to analyze organoleptic. Proximate test was used to determine the content of water, ash, crude fiber, carbohydrates, protein, and fat.
Results: The acceptability was conducted by 30 semi-trained panelists with the selected formula, namely F3 with a mixture of 50 g of snakehead fish with color indicators (3.50±1.09), aroma (3.72±0.88), taste (3.87±0.94), and texture (3.62±1.02). 100g of harpoon contains 19.67% water content, 1.18% ash content, 2.63% crude fiber, 12.36% protein, 3.17% fat, and 60.98% carbohydrates. *Seruit* with F3 formula was chosen by the panelists and is a high source of protein.
Conclusions: *Seruit* formula F3 with the addition of 50 g grilled snakehead fish is the selected formula and has potential as a local food source of protein that can be served in the daily diet according to a balanced nutritional diet.

INTRODUCTION

Seruit is a traditional dish that originates in Lampung, a province located on the southern tip of Sumatra in Indonesia[1]. This local delicacy is known for its rich flavors and unique cooking methods that have been passed down through generations. The dish typically consists of a combination of seafood, vegetables, and spices that are stir-fried together to create a savory and aromatic dish that is beloved by locals and visitors alike. The key ingredient in *seruit* is fresh seafood, such as shrimp, squid, and fish, which results in a burst of oceanic flavors[2]. The vegetables used in *seruit* are typically produced locally, such as eggplant, carrots, cabbage, and other fresh vegetables, adding a healthy and colorful element to the dish[3].

Snakehead fish *(Channa striata)*, also known as *ikan gabus,* is a popular source of protein in many Asian countries, especially in Indonesia. Lampung Province is one of the habitats of snakehead fish, with a production in 2021 of 414.92 fish is a good option for maintaining a balanced diet because it is high in protein, omega-3 fatty acids, vitamins, and minerals[4,5]. The protein content of snakehead fish is 16.2 g per 100 g of fish meat[6]. In addition, snakehead fish contains 66.74 mg/g of albumin in snakehead meat, which can help accelerate wound healing, increase body immunity, and have analgesic, antifungal, and antibacterial[7–10]. It is also rich in omega-3 fatty acids, which are important for heart health and brain function[11,12]. Snakehead fish in *seruit* are typically processed by grilling, frying, or steaming[3]. Incorporating snakehead fish as a regular diet, can help ensure the body receives essential nutrients for optimal functioning[13–15].

Studying the making of *seruit* using snakehead fish as one of the fish widely consumed by the people of Lampung and an important source of protein for several reasons. First, snakehead fish is a sustainable and locally available protein source that can help support the local economy and reduce reliance on imported ingredients. Additionally, snakehead fish are known for their unique

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taste and texture, which can add a new dimension to the traditional *seruit* dishes. Understanding the preparation and cooking techniques specific to snakehead fish can help preserve the authenticity and cultural significance of the beloved Lampung dish. This study aimed to find a formula based on acceptability and macronutrient content, especially proteins.

METHODS

Design, Place and Time of Research

This was an experimental study with a randomized complete design conducted from March to November 2023. Product manufacturing was conducted at the Food Science Laboratory, Nutrition Department, Poltekkes Kemenkes Tanjung Karang, Bandar Lampung. *Seruit* Proximate Analysis was conducted at the Agricultural Product Quality Testing Laboratory, Universitas Lampung accredited by the National Accreditation Committee (KAN) no. LP-1113-IDN by implementing (ISO/IEC 17025:2017). The hedonic test was conducted at the Taste Testing Laboratory, Nutrition Department, Poltekkes Kemenkes Tanjungkarang. Ethical approval was obtained from the Health Research Ethic Committee Polytechnic of the Ministry of Health of Tanjung Karang No. 329/KEPK-TJK/V/2023 on May 12, 2023.

Material and Tools

The materials used to make the *seruit* include red chilies, cayenne pepper, shrimp paste, salt, and sugar. The tools used to make the *seruit* include digital scales, pestles (to grind raw materials), spoons, and plates. The tools used for the acceptance level test include attendance lists, plates and spoons, chairs, and pens. The snakehead fish used in this study was baked in a conventional oven with a temperature set 140°C for 45 minutes.

The materials required for chemical analysis were $CuSO_4$, H_2SO_4, HCl, Na_2CO_3, petroleum ether, and NaOH. Tools for proximate analysis (water, ash, fat, protein, and carbohydrate contents). Tools used for proximate tests: Erlenmeyer flask, distillation flask, bracket glass, glass funnel, Bucher funnel, burette, separating funnel, long-necked measuring flask, measuring cylinder, condenser, filler, measuring pipette, volumetric pipette, dropper, stirrer, test tube, spatula, desiccator, universal indicator, filter paper, tripod, wire gauze, test tube rack, clamp, stirrer, crucible, evaporating dish, clamp and stand, heater, hit plate, oven, furnace, and incubator.

Recipe for Making *Seruit*

Seruit is a traditional chili sauce originating from Lampung. Its pungency is derived from the primary ingredient, *sambal*, which exhibits spiciness due to the presence of chili. The process of making *seruit* was mixing all the ingredients consisting of chili, shrimp paste, salt, and sugar. The following is a recipe for *seruit*, which is shown in Table 1.

Table 1. Recipe for making *seruit*

Ingredients	Weight
Red chilies	75 g
Cayenne pepper	25 g
Shrimp paste	10 g
Salt	10 g
Sugar	10 g
Total	130 g

(a) (b) (c) (d) (e)

(a) Digital scales (b) Grinder (c) Oven (d) Small plate and Spoon (e) Small bowl

Figure 1. Tools of making *seruit*

Figure 1 shows the tools used in making *seruit*. Digital scales were used to weigh the raw materials used to make chili sauce and snakehead fish. Grinders were used to grind the ingredients to make chili sauce. Ovens were used to grill snakehead fish. Plates and spoons were used to prepare chili sauce. The bowls were used to mix chili sauce and grilled snakehead fish meat.

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(a) (b) (c) (d) (e)

(a) Red chilies (b) Cayenne pepper (c) Shrimp paste (d) Salt (e) Sugar

Figure 2. Chili sauce *(sambal)* making process

Figure 2 shows the process of making chili sauce. Ingredients consisting of red chili, cayenne pepper, shrimp paste, sugar, and salt were ground until they were smooth and homogeneous.

(a) (b) (c) (d) (e)

(a) Making *sambal* (b) Grilled snakehead fish (c) Separate fish meat and bones (d) Mix both formulas (e) Mixed formula

Figure 3. Flow of making *seruit*

Figure 3 shows the flow of making *seruit*. Finely ground chili sauce was added to the grilled snakehead fish, and then the meat and bones were separated. Next, the chili sauce and fish meat were mixed until homogeneous.

Formula

This study used a completely randomized design with three formula variations, specifically, the ratio of *sambal* and snakehead fish. The three formula comparisons were F1 (30%: 70%), F2 (40%: 60%), and F3 (50%: 50%). Formula 1 consisted of 30 g *sambal* with the addition of 70 g snakehead fish. Formula 2 consisted of 40 g *sambal* with 60 g snakehead fish, and Formula 3 consisted of 50 g *sambal* with 50 g snakehead fish. The composition of the *seruit* formula is as follows:

Table 2. *Seruit* formula

***Seruit* Composition**	**F1**	**F2**	**F3**
Sambal	30 g	40 g	50 g
Snakehead Fish	70 g	60 g	50 g

F1 F2 F3

Figure 4. The process of mixing chili sauce and grilled snakehead fish

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Figure 4 shows the process of making a *seruit* consisting of mixing *sambal* and grilled snakehead fish whose meat had been shredded. The mixing of *sambal* and grilled snakehead fish is in accordance with Table 2, based on each composition in formulas F1 to F3. The mixing of chili sauce and fish should be homogeneous.

Acceptance Level Test Procedure

The acceptance level test using the hedonic method was conducted on 30 semi-trained panelists, involving students of the Nutrition Science study program, Poltekkes Kemenkes Tanjung Karang who had received hedonic test materials. Hedonic testing was repeated 3 times. The test began by filling in the attendance list for each panelist. The panelists then sat at a distance of approximately 2 meters between each other. The panelists were given a hedonic test form, a pen, and samples of three *seruit* formulas placed on a small plate, and then the panelists tasted the *seruit* using a small spoon. The panelists were also given mineral water to neutralize the tongue while tasting one formula with another formula[16]. The panelists gave a hedonic score (1 = disliked very much, 2 =disliked, 3 = neutral, 4 = Like, 5 = liked very much)[17]. The assessment consisted of four hedonic attributes, including color, aroma, taste, and texture. The tested formulas included three formulas of the addition of grilled snakehead fish (70 g, 60 g, and 50 g).

Proximate Test Procedure

Selected *seruit* products derived from organoleptic test results were then subjected to proximate analysis (water, ash, fat, protein, and carbohydrates), and Aw value. Analysis of water content (thermogravi method), ash content (dry ashing method), fat content (Soxhlet method) was carried out in accordance with SNI (Indonesian National Standard) No. 01-2891-1992 (SNI 1992), protein content (micro Kjedahl method) was determined in accordance with the Association of Official Analytical Collaboration (AOAC) No. 960.52-1961 (AOAC, 2005), and carbohydrates (by different), and Aw value (isothermic sorption method).

Shelf-Life Analysis of *Seruit*

The shelf life of *seruit* was analyzed using the accelerated shelf-life test (ASLT) for all formulas. The accelerated shelf-life test (ASLT) was performed by observing the total bacteria on days 7, 14, 21, and 28. By analyzing shelf life, we could determine the time limit for a product to be safe for consumption by consumers.

Statistical Analysis

The data collected in this study included acceptance-level and proximate analysis results. Acceptance level test data were analyzed using SPSS software version 22, starting with the Shapiro-Wilk normality test. Anova was used to analyze the differences between formulas; if there were differences, Duncan's Multiple Range Test (DMRT) was used.

RESULTS AND DISCUSSIONS

Acceptability Test of *Seruit*

Based on the acceptability test in terms of color, aroma, taste, and texture, most panelists preferred the *seruit* formula with added snakehead fish. Formula F3 is the best formula based on acceptability preferred by most panelists with a mixture of 50 g of snakehead fish. Organoleptic results based on color, aroma, and taste in the *seruit* formula showed significant differences (p-value<0.05), but the texture was not significantly different (p-value>0.05).

Table 3. Evaluation of organoleptic properties of *seruit*

Indicator	Formula			p-value
	F1	F2	F3	
Color	3.28±1.06[b]	3.67±0.97[a]	3.50±1.09[a,b]	0.045*
Aroma	3.19±0.86[b]	3.30±0.86[b]	3.72±0.88[a]	0.000*
Taste	3.19±0.81[b]	3.21±0.77[b]	3.87±0.94[a]	0.000*
Texture	3.39±0.95[a]	3.60±0.93[a]	3.62±1.02[a]	0.139

Note: Numbers followed by different letters (a, b) on the same line indicate significant differences
*DMRT test, significant if p-value<0.05

F1 F2 F3

Figure 5. All of *Seruit* formula

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Color is an indicator that influences the perception and preferences of panelists in tasting the product to be tested[18]. The color of the F3 formula was not significantly different from that of formulas F1 and F2, but the colors of formulas F1 and F2 were significantly different. The color of the *seruit* was influenced by the amount of snakehead fish added to the *seruit*. Previous studies have shown that adding 50 g of snakehead fish is preferred over adding more than 50 g of fish[3]. Giving too many snakehead fish results in panelists being less attracted to the appearance of the product[19]. In addition, the color of the *seruit* is influenced by the composition of the *sambal*. The more *sambal*, the redder the color. This is caused by the carotenoid content of chili, which can give color to the *seruit*[20–22].

Aroma attributes showed that formula F1 was not significantly different from formula F2, but was different from formula F3. This was because the provision of snakehead fish in formula F3 was lower than in formulas F1 and F2. Providing more snakehead fish would make the fishy aroma of fish more dominant compared to providing less snakehead fish[23]. Snakehead fish had a Trimethylamine content, which gives a fishy aroma, so the addition of too much snakehead fish was not liked by panelists[24]. Besides, ammonia content affects the fishy aroma of snakehead fish[25].

The taste attributes in formula F1 were not significantly different from formula F2, but formula F3 was significantly different. Previous studies have shown that the taste of snakehead fish is influenced by two umami amino acids: glutamic acid and aspartic acid. It was also influenced by four sweet amino acids: threonine, alanine, glycine, and serine. Then, also influenced by nine bitter amino acids, namely lysine, leucine, valine, arginine, threonine, phenylalanine, isoleucine, histidine, and methionine[26].

In terms of texture, the *seruit* formulas F1, F2, and F3 were not significantly different. This was influenced by the dominant administration of the snakehead fish in each formula; therefore, it was not significantly different. The texture of snakehead fish is influenced by the cooking method. Previous studies have shown that snakehead fish cooked by steaming makes the snakehead fish meat easier to tear compared to other cooking methods such as grilling or frying[26].

Seruit Nutrient Content

The processing method of snakehead fish affects its nutritional content. Snakehead fish can be processed using several cooking methods such as boiling, baking, frying, and grilling[27,28].

Table 4. Proximate analysis results of *seruit* formula F3

Parameter	Content	SNI (Indonesian National Standard)
Water (%)	19.67	60%
Ash (%)	1.18	-
Crude fiber (%)	2.63	-
Protein (%)	12.36	-
Fat (%)	3.17	-
Carbohydrate (%)	60.98	-

Based on Table 4, the nutritional content per 100 g of *seruit* in the selected formula, namely formula F3, had a water content of 19.67%, an ash content of 1.18%, crude fiber of 2.63%, protein of 12.36%, fat of 3.17%, and carbohydrate of 60.98% by grilling snakehead fish at a temperature of 140°C for 45 minutes. This was different from a previous study that found that snakehead fish grilled at a temperature of 200°C for 20 minutes had an ash content of 1.3%, protein of 14.2%, and fat of 7.8%, shorter grilling time affected the content of higher ash, protein, and fat[27]. Compared with SNI 7967:2014, our product met the standards for grilled fish, where it still had a lower water content (below 60 %)[29].

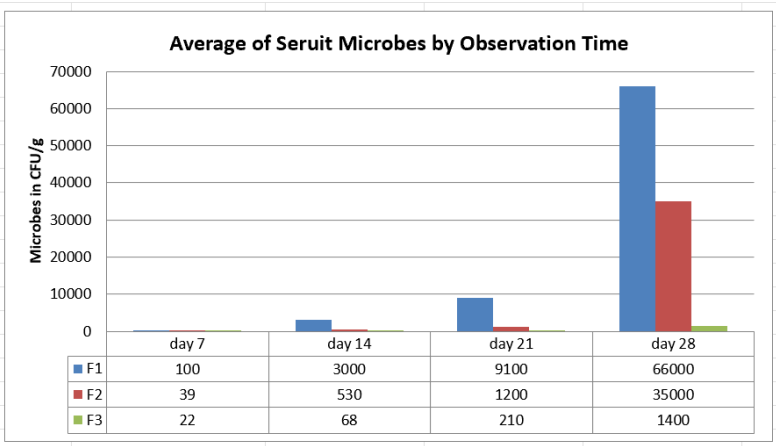

Figure 6. Average of *seruit* microbes according to observation time

Based on Figure 6, formula 1 shows an increase in the number of microbes in proportion to the shelf life, possibly because formula 1 contains more snakehead fish than formulas 2 and 3. It can be concluded that the

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smaller the snakehead fish formula, the longer its shelf life. Based on SNI 7967:2014, the total number of microbes in grilled fish per 1 g was $5.0x10^4$, so it is best to consume *seruit* within 7 days[29]. The fish packaging process affects the quality of grilled fish. Grilled fish that are vacuum-packed and set at a temperature of 5°C will have a shelf life of 23 days, and -5°C will have a shelf life of 74 days[30].

The strength of this study is that this seruit product is made from local food ingredients that have high protein and can be enjoyed by all age groups. However, there needs to be more in this study, as the resulting product has a short shelf life of less than 1 week. This is because the ingredients, used are mostly fresh food ingredients such as chili sauce.

CONCLUSIONS

The *seruit* formula with the addition of snakehead fish has color, aroma and taste. Organoleptic tests showed that panelists preferred *seruit* formula F3 based on color, aroma, taste, and texture with the addition of 50 g of snakehead fish. The results of the proximate test on *seruit* formula F3 have a high protein content. *Seruit* is a typical Lampung food that has enormous potential as a source of high protein and a sustainable healthy diet for the people of Lampung. Further research should develop appropriate technology so that the *seruit* can be stored for a longer time and used as a souvenir for tourists visiting Lampung.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

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AUTHOR CONTRIBUTIONS

B: conceptualization executing and collecting the study; RI: shaping the research concept, monitoring their condition throughout the study; S: determining technical research methods; AN: monitoring their condition throughout the study; AEY: analyzing data, writing and editing manuscript.

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