Sensory and Chemical Characteristics of Koya Made from Snakehead Fish (Channa striata) and Soybean Flour (Glycine max)

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Abstract: The objectives of this study were to determine the best formula of fish koya made from snakehead fish and soybean flour based on its sensory characteristics and to determine chemical properties of the best fish koya formula. Koya powder is a savory powder used as a topping on food. Koya powder is usually added to Indonesian traditional foods such as soto and noodles. This study was using a completely randomized design with one variable, namely the variation of snakehead fish meat and soybean flour composition. The variations of snakehead fish meat and soybean flour were 40:60; 50:50; and 60:40. All treatments were carried out sensory evaluation using hedonic test. Chemical properties of the best formula based on sensory evaluation were determined using proximate analysis. The result showed that the best formula of fish koya based on sensory evaluation had composition of snakehead fish meat 60% and soybean flour 40%. The chemical properties of the best formula showed that its moisture, ash, protein, fat, and carbohydrate were 11.50 %; 3.45 %; 42.20 %; 18.73 %; and 22.92 % respectively.

1. Introduction
Protein is needed by the human body for growth, especially in childhood. Proteins, mainly the amino acids lysine and arginine, affect the release of growth hormones in the body [1]. There are often cases of protein malnutrition in children, especially the age under two years [2]. In addition to growth, the availability of protein in the body is also needed for daily activities [3]. One of the main resource protein with complete amino acid content is animal protein, especially fish protein.

Snakehead fish (Channa striata) contains high amount of protein. Prastari et al.,[4] states that snakehead fish protein hydrolysate contains more than 90% protein. The amount of protein content was also shown by Tan & Azhar [5] in powdered snakehead fish. These types of amino acids found in high amount are glutamate acid, arginine, lysine, leucine and tryptophan [6]. In addition there are also amino acids glycine, threonine and phenylalanine [7]. Snakehead fish also contains albumin which is necessary for health purposes, namely for surgical patients and hypoalbuminemia. Moreover, albumin is also beneficial for child’s growth [8,9,10].
Protein sources are not only derived from animals. Plant protein like grains are no less important than animal protein. Soybean (*Glycine max*) is one of source of plant protein. Soybean seeds contain 40% of protein. This protein is greater than sesame, peanuts and melon seeds [11]. The amino acid content in soy protein ranges from 31 - 49% which consists of essential and non-essential amino acids [12]. These amino acids are glutamate acid, isoleucine, leucine, lysine, aspartate acid and phenylalanine [13]. Besides having high amino acids, another advantage of soybean is that they contain bioactive components that are beneficial to health such as isoflavones, this bioactive component is necessary for those who have kidney function disorders, cancer, cardiovascular diseases and diabetes [14,15,16].

In Indonesia, snakehead fish and soybean are native food sources in Indonesia. Snakehead fish is commonly found in South Sumatra with production rate 5300 g/m²[17]. While soybean production in Indonesia is able to produce 2,4 tons/ha[18]. High production of snakehead fish and soybean in Indonesia promotes product diversification. Snakehead fish in Indonesia is usually processed into cooking and protein extracted. While soybean have been widely used as products such as bread, biscuits, soy milk, soy flour and fermentation products [19]. Snakehead fish and soybean have the potential to be used as processed food that is popular within the community in order to increase protein nutritional intake, both for children, adolescents, and also adults.

*Koya* is one of processed food, it is a savory powder used as a complementary food. *Koya* can be eaten directly or sprinkled as a topping on food such as *soto*. *Koya* is usually made from a mixture of softened prawn crackers along with garlic [20]. The application of fish as main ingredient to produce *koya* has never been done, hence the mixture of snakehead fish and soybean presumably impact consumer on sensory acceptance. In order to make *koya* that can be organoleptically acceptable, it was necessary to use the right composition of snakehead fish and soybean. Furthermore, it is also expected that the selected formula has a complete nutritional content that is able to increase the nutritional intake. Therefore, the purpose of this study was to determine the best formula *koya* based on sensory characteristics and to determine the chemical properties of the selected formula.

2. Research Methods

2.1. Result

The main ingredients used in this study were snakehead fish obtained from Waduk Cengklik, Central Java, Indonesia. Soybean and *koya* spices (onion, garlic, galangal, ginger, lemongrass, bay leaves, kaffir lime leaves, coriander, coconut milk, candlenut, brown sugar and salt) were collected from local market in Surakarta, Central Java, Indonesia.

2.2. Methods

2.2.1. Preparation of Soybean flour

Soybeans were roasted for 30 minutes then grounded using a blender and sieved with an 80 mesh sieve.

2.2.2. Preparation of Snakehead fish-soybean flour *koya*

Steamed snakehead fish fillet and soy flour with ratio 40:60 (B1); 50:50 (B2); and 60:40 (B3) respectively was added to the fine *koya* seasoning which had been boiled. The mixture was cooked until brown and dry, then smoothed using a blender to form fine *koya* powder [20,21]. *Koya* formula was shown in Table 1.

2.2.3. Analysis of snakehead fish-soybean flour *koya*

Snakehead fish-soybean flour *koya* analysis was carried out by sensory evaluation using a hedonic test with 30 panelists. A hedonic test used 7-point scale with scale of 1 to very much dislike, 2 to dislike, 3 to dislike slightly, 4 to neither like nor dislike, 5 to like slightly, 6 to like, and 7 to be very much like [22]. The chemical properties of *koya* include moisture, ash, protein, fat and carbohydrate content by different [23].
2.2.4. Statistical Analysis
The experimental design used in this study was a Completely Randomized Design (CRD) with one factor, namely the variation of the composition of soybean flour and snakehead fish fillet as the basic material for koya production. The data obtained were analyzed statistically by one way ANOVA method. If it showed significant results, then continue to proceed with a significant difference test using Duncan’s Multiple Range Test (DMRT) at significance level $\alpha = 0.05$.

Table 1. Formula of snakehead fish-soybean flour koya

| Materials                  | B1            | B2            | B3            |
|----------------------------|---------------|---------------|---------------|
| Snakehead fish fillet (g) | 108 / 40      | 135 / 50      | 162 / 60      |
| Soy flour (g) / (%)        | 162 / 60      | 135 / 50      | 108 / 40      |
| Onion (g)                  | 20            | 20            | 20            |
| Garlic (g)                 | 40            | 40            | 40            |
| Candle nut (g)             | 0.13          | 0.13          | 0.13          |
| Coriander (g)              | 0.01          | 0.01          | 0.01          |
| Coconut milk (ml)          | 150           | 150           | 150           |
| Ginger (g)                 | 4.3           | 4.3           | 4.3           |
| Galangal (g)               | 4.67          | 4.67          | 4.67          |
| Lemongrass (g)             | 3.33          | 3.33          | 3.33          |
| Bay leaf (lembar)          | 2             | 2             | 2             |
| Kaffir lime leaf (lembar)  | 4             | 4             | 4             |
| Brown sugar (g)            | 32            | 32            | 32            |
| Salt (g)                   | 0.056         | 0.056         | 0.056         |

3. Results and Discussion

Table 2. Chemical characteristics of Snakehead fishfillet and soybean flour

| No | Parameter       | Snakehead Fish Fillet | Soybean Flour |
|----|-----------------|------------------------|---------------|
| 1  | Moisture (%wb)  | 78.66 78.66            | 2.57          |
| 2  | Ash (%wb)       | 0.44                   | 6.24          |
| 3  | Fat (%wb)       | 0.01                   | 23.10         |
| 4  | Protein (%wb)   | 15.64                  | 33.88         |
| 5  | Carbohydrate    | 5.25                   | 34.18         |

3.1. Chemical characteristics of Snakehead fish meat and soybean flour
The chemical composition of snakehead fishfillet used in this study is presented in Table 2. Snakehead fish fillet has 15.64% protein, 0.01% fat and 5.25% carbohydrate. The protein content of snakehead fishfillet used in this study is lower than Firlianty et al., where snakehead fish has 20.83% of protein, 0.49% of fat and does not contain carbohydrates[24]. Similar results were also shown by Mustafa et al.,[8] which stated that the protein content of Snakehead fish was 16.2%.

Soybean flour contains 33.88% protein, 23.10% fat, and 34.18% carbohydrate. This protein content is lower than Ciabotti et al., where soybean contains protein ranging from 35 - 39%[15]. While the soybean fat and carbohydrate contents are 18-19.5%, and 23-25.65%, respectively. The same results were also shown by Akinola & Owoseni [25] which stated that soybean flour contain 37% of protein, 16.4% fat and 30.68% carbohydrate. The difference in the chemical composition of snakehead fishfillet and soy flour is associated with habitat differences.
3.2. Sensory evaluation of snakehead fish-soybean flour koya

Sensory evaluation of snakehead fish-soybean flour koya is shown in Table 3, it is known that from various formulations in the parameters of colour, aroma, taste, texture do not give a significantly different effect. All formulations are liked by panelists based on the results of sensory evaluation. Based on color, the koya produced in this study is brown. Addition of snakehead fish fillet and soy flour to koya contributes to the color of koya. The browning appears because of Maillard reaction during the process. Maillard reaction occurs between reducing sugars and amino acids in the presence of heat treatment process [26, 27, 28].

| Table 3. Sensory evaluations of snakehead fish fillet and soybean flour |
|-------------------------|----------------|----------------|----------------|----------------|
| No | Sample | Colour | Aroma | Taste | Texture | Overall |
|----|--------|--------|-------|-------|---------|---------|
| 1  | B1     | 5.07\textsuperscript{a} | 4.63\textsuperscript{a} | 4.83\textsuperscript{a} | 4.87\textsuperscript{a} | 4.83\textsuperscript{a} |
| 2  | B2     | 5.17\textsuperscript{a} | 5.07\textsuperscript{a} | 4.63\textsuperscript{a} | 4.43\textsuperscript{a} | 5.63\textsuperscript{b} |
| 3  | B3     | 4.90\textsuperscript{a} | 5.07\textsuperscript{a} | 4.93\textsuperscript{a} | 4.67\textsuperscript{a} | 5.97\textsuperscript{c} |

Note: The same superscript on the same column indicates not significant different (\(\alpha>0.05\))

The result of aroma is also related to the Maillard reaction through the process. Maillard reactions produce flavors and aromas of the product during the processing [29]. Maillard reactions that form also affect taste [30, 31]. Koya texture is influenced by the size of the koya powder granule. Sensory evaluation of snakehead fish-soybean flour koya overall gives a significantly different effect on each formula. Panelist likes sample B3 at most.

3.3. Chemical properties of snakehead fish-soybean flour koya

| Table 4. Chemical properties of selected koya formula |
|-------------------------|----------------|----------------|----------------|
| No  | Parameter | Snakehead fish + Soybean Flour \(\text{Koya(B3)}\) | Studies of koya from various type of fish* |
|----|----------|----------------|----------------|
| 1  | Moisture (%wb) | 11.50 | 13.10–21.21 |
| 2  | Ash (%wb) | 3.45 | 5.54–5.99 |
| 3  | Fat (%wb) | 18.73 | 15.55–21.76 |
| 4  | Protein (%wb) | 42.20 | 27.13–29.83 |
| 5  | Carbohydrate (%wb) | 22.92 22.92 | 30.28–31.92 |

Description: *Koya fish studies with various types of fish, namely mackerel, catfish, tilapia, tuna with the addition of soy flour [21].

Snakehead fish-soybean flour koya selected formula (B3) is analyzed by chemical properties using proximate analysis which includes moisture, ash, fat, protein, and carbohydrate content. The results of analysis were compared with the chemical properties of koya made from various types of fish [21]. The moisture, ash, and carbohydrates content of snakehead fish-soybean flour koya in B3 are 11.50%, 3.45% and 22.92% respectively. This result is lower than Regina et al. [21] which ranged from 13.10 - 21.21% for moisture content, 5.54 - 5.99% for ash content, and 30.28 - 31.92% for carbohydrate.

Protein and fat content of snakehead fish with soybean flour koya is higher than Regina et al. [21]. This is because the fillet of snakehead fish has a high protein and fat content respectively 15.64% and 5.25%. The addition of Snakehead fish fillet in B3 up to 60% contributed to enrichment in protein and fat content of koya produced in this study.
4. Conclusion
The formula for snakehead fish-soybean flourkoyab3is selected formula based on sensory evaluation. Formula B3 contains a chemical properties which are 11.50% moisture content; 3.45% ash; 18.73% fat; 42.20% protein and 22.92% carbohydrate.

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