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CHEMICAL CHARACTERISTICS OF FISH STICKS FROM DIFFERENT PARTS OF CATFISH

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Abstract

Catfish is a widely cultivated freshwater fish because of its quick and easy farming and stable market price. Catfish is consumed by frying, grilling, or processing into meatballs, nuggets, shredded meat, and fish sticks. This study aimed to assess the best treatment for different parts of catfish used to make fish sticks based on their calcium and phosphorus content. A Completely Randomized Design (CRD) was employed with three treatments: minced catfish (MC), HFC (head and fishbone catfish (HFC), and WGGC (whole gilled and gutted catfish (WGGC). The parameters analyzed included proximate, calcium, and phosphorus content. The tests showed significantly different results (p<0.05) in terms of moisture, ash, fat, carbohydrate, calcium, and phosphorus content of the three treatments. Meanwhile, the protein content of fish sticks in this study was not significantly different, namely 10.67-10.92%. Fish sticks made from gilled and gutted whole fish (meat and bones) had a calcium content of 0.68±0.02% and a phosphorus content of 0.083±0.00%, thus having the potential to be an alternative processed product with minimal waste (zero-waste).

Keywords: calcium, phosphorus, product diversification, proximate, zero-waste

Karakteristik Kimia Stik Ikan dari Bagian Ikan Lele (*Clarias* sp.) yang Berbeda

Abstrak

Ikan lele merupakan salah satu jenis ikan air tawar yang banyak dibudidayakan oleh masyarakat karena waktu panen yang cepat, mudah, serta harga yang stabil. Konsumsi lele tidak hanya dalam bentuk ikan goreng atau bakar, namun dapat dijadikan produk olahan di antaranya bakso, nuget, abon, dan juga stik ikan. Penelitian ini bertujuan untuk menentukan perlakuan terbaik perbedaan bagian ikan lele yang digunakan pada pembuatan stik ikan berdasarkan kandungan kalsium dan fosfor. Penelitian ini menggunakan rancangan acak lengkap (RAL) dengan tiga perlakuan bagian ikan, yaitu MC (bagian daging), HFC (bagian tulang dan kepala ikan) dan WGGC (ikan utuh yang telah disiangi). Parameter yang dianalisis meliputi proksimat, kandungan kalsium, dan fosfor. Hasil penelitian menunjukkan bahwa perbedaan bagian ikan yang digunakan, menunjukkan pengaruh nyata (p<0,05) terhadap kadar air, abu, lemak, karbohidrat, kalsium dan fosfor. Perbedaan bagian ikan tidak berpengaruh terhadap kadar protein stik ikan, yaitu berkisar 10,67-10,92%. Stik ikan pada perlakuan penambahan seluruh bagian ikan yang telah disiangi (daging dan tulang ikan) mempunyai kadar kalsium paling tinggi, yaitu 0,68±0,02% dan fosfor 0,083±0,00%. Penambahan seluruh bagian ikan (daging dan tulang) dapat menjadi alternatif pengolahan produk dengan meminimalkan limbah dalam penerapan *zero waste.*

Kata kunci: diversifikasi produk, fosfor, kalsium, proksimat, *zero waste*

INTRODUCTION

Catfish are widely cultivated because they are easier to care for, have a short maintenance period of 3 months, and can be reared in a limited area (Ramadhani *et al*., 2021). The price of catfish on the market is also relatively stable and affordable. Catfish are generally harvested for family consumption by frying, grilling, smoking, or processing them into various dishes such as *mangut* (Abdel-Mobdy *et al*., 2021; Baryczka *et al*., 2019; Casallas *et al*., 2012; Hamad, 2021; Herawati *et al*., 2020; Yanar, 2007). The white flesh of catfish is soft and easy to digest, with a fairly high protein content of between 15-20% (Abdel-Mobdy *et al*., 2021; Casallas *et al*., 2012; Ubadillah & Hersoelistyorini, 2010). Despite being an easily available and affordable source of protein, the consumption of catfish is not yet fully popular among the public. Many people do not enjoy catfish because they still believe that catfish is unappetizing as it eats everything, lives in dirty habitat, and smells earthy like mud. This underlines the importance of diversifying various processed catfish.

Diversification of processed catfish aims to overcome people's boredom with the limited variety of processed catfish foods by offering alternatives to increase catfish consumption, particularly among children who dislike eating fish. Catfish contains nutrients needed for growth such as protein and calcium, making it a healthy snack for children. Processed catfish products include surimi, nuggets, meatballs, shredded meat, *pempek*, brownies, crackers, and fish sticks (Wijayanti *et al*., 2014; Tumion & Hastuti, 2017; Andayani & Ausrianti, 2021; Sulistiawati *et al.,* 2022).

People's fondness for snacks is one of the underlying reasons for determining product diversification in this study. Stick products that are often found on the market are garlic sticks. Similar to garlic sticks, fish sticks are extruded food with the addition of fish meat or fish parts to the mixture. According to SNI 2886:2015, extruded foods are ready-to-eat snacks made from sources of carbohydrates and/or proteins through an extrusion process with or without the addition of other food ingredients and permitted food additives with or without a frying process (*Badan Standardisasi Nasional* [BSN], 2015). Adding fish to garlic sticks can improve their nutritional value, especially by increasing protein and calcium content. Variations in the composition of raw materials in fish sticks result in different crispiness of the products (Siswanti *et al*., 2017).

Currently, product diversification generally uses catfish meat only, while the fish bones, heads, and innards are usually discarded as waste. Catfish can be processed into various products such as nuggets (Kaimudin *et al*., 2021; Ubadillah & Hersoelistyorini, 2010; Yusuf & Musali, 2021), sausages (Poernomo *et al*., 2011; Yakhin *et al*., 2013; Imran *et al*., 2016), meatballs (Gumilar *et al*., 2021), *kerupuk* or crackers (Suryaningrum *et al*., 2016), dan fish sticks (Amir *et al*., 2022; Handayani & Kartikawati, 2014; Siswanti *et al*., 2017). Processing fish by using all parts of the fish that have been gilled and gutted can reduce fish waste. This study aims to determine the best treatment among fish sticks made from different parts of catfish based on their calcium and phosphorus contents.

MATERIALS AND METHODS

To make the catfish sticks, catfish weighing around 250-300 g each were obtained from local farmers in Samarinda City, East Kalimantan. Other ingredients can be seen in Table 1. The method used for making the catfish sticks adopted the procedure of Sulistiawati *et al*. (2022), with parts of the catfish being used as raw material.

The process of making fish sticks was carried out through several stages, i.e., ingredient preparation, dough making, dough molding, frying, and packaging (Sulistiawati *et al*., 2022). Catfish were prepared according to the treatment designs, namely minced fish meat (MC), head and fishbone paste (HFC), and whole gilled and gutted fish paste (WGGC). Catfish meat has moisture, protein, fat, ash, and carbohydrate contents of 73.47%, 15.15%, 2.38%, 1.01%, and 12.8%, respectively (Bimantara, 2018). Catfish bones and heads contain 70.35% moisture content, 6.75% protein, 0.56% fat, 7.58% ash, and 5.14% carbohydrates (Pamungkas,

Table 1 Formulation of catfish stick
Tabel 1 Formulasi stik ikan lele

Ingredients	Treatments		
	Minced	Head & fishbone	Whole gilled
Minced fish (g)	200	-	-
Head and fishbone paste (g)	-	200	-
Whole gilled and gutted fish paste (g)	-	-	200
Wheat flour (kg)	1	1	1
Margarine (g)	70	70	70
Egg (g)	90	90	90
Garlic powder (g)	30	30	30
Chicken broth (g)	9	9	9
Monosodium glutamate (g)	3	3	3
Salt (g)	20	20	20
Water (mL)	110	110	110
Vegetable oil for frying (L)	1	1	1

2019). Meanwhile, the chemical composition of whole catfish includes 78.18% moisture content, 12.82% protein, 3.70% fat, 2.70% ash, and 2.60% carbohydrates (Mubarokah *et al.* 2021).

Preparation for MC treatment was done by filleting the fish, taking only the flesh (skinless), and grinding it until smooth using a meat grinder (Oxone OX-857, Indonesia). Preparation for HFC treatment was made by collecting catfish waste in the form of bones and heads, softening it using a pressure cooker (Vicenza, Indonesia) at 15 psi for 1.5 hours, letting it cool, and then grinding it until to a smooth paste using a meat grinder (Oxone OX-857, Indonesia). Preparation for WGGC treatment was done by putting the fish that have been gilled and gutted (gills and entrails removed) into a pressure cooker (Vicenza, Indonesia) to soften by pressure cooking (15 psi) for 1.5 hours and grinding them until smooth using a meat grinder (Oxone OX-857, Indonesia).

The next stage was to weigh the ingredients in Table 1 to make the dough. Each treatment uses 200 g of fish parts, while other ingredients include 1 kg of wheat flour, 90 g of eggs (2), 70 g of margarine, 30 g of garlic powder, 20 g of salt, 3 g of MSG, 9 g of stock, and 110 mL of water. All ingredients were mixed using a mixer (Oxone OX-857, Indonesia) until a smooth dough was formed. Then, the dough was flattened and molded using a pasta maker machine (Signora, Indonesia) with a stick sheet thickness of approximately 1.5 mm and fried in hot oil until golden brown. The fried sticks were drained and cooled, then packaged using a plastic pouch. Parameters observed in this study are moisture, ash, protein, fat (AOAC, 1995), carbohydrate (by difference), calcium (Sudarmaji *et al*., 1984), and phosphorus contents (Apriyantono *et al.*, 1989).

Data Analysis

This study used a Completely Randomized Design (CRD) with three replications for each treatment. The treatments in this study are different parts of catfish used in making catfish sticks, minced fish meat (MC), head and fishbone paste (HFC), and whole gilled and gutted fish paste (WGGC). Data analysis employed the analysis of variance (ANOVA) test using the SPSS Statistics 27 program. Results that showed significant differences between treatments

were examined using the least significant difference (LSD) test with a confidence level of 95%.

RESULTS AND DISCUSSION

Chemical Composition

Fish sticks with different parts of processed catfish were subjected to proximate testing. The proximate parameters tested in this study included moisture, ash, protein, and fat content (AOAC, 1995), and carbohydrates (by-difference). The proximate compositions of the catfish stick results are presented in Table 2.

Moisture

As shown in Table 2, the moisture content of the fish sticks was 2.21-2.75%. The results of the analysis of variance show that fish parts have a significant effect on moisture content (p<0.05). Further analyses were then performed using the Least Significant Difference (LSD) test. The results of the tests indicate that the moisture content of the fish sticks in this study is by the standard (SNI 01-2886-2000) which requires a maximum moisture content of fish sticks of 4% (BSN, 2015). Among the three treatments, MC treatment has significantly different moisture content because it uses minced fish meat, thus having higher moisture content than HFC and WGGC treatments. Both HFC and WGGC treatments were prepared by pressure cooking. Apart from softening the ingredients, the pressure-cooking process can also substantially reduce the moisture content (Dewi *et al*., 2019; Kusumaningrum *et al*., 2016). The use of high temperatures along with high vapor pressure forces more moisture out of the tissue.

Ash

The ash content of the catfish sticks was in the range of 3.11-3.98% (Table 2). The results of the analysis of variance signify an influence of fish parts on ash content (p<0.05). Treatments with the lowest to highest ash content are MC, WGGC, and HFC treatments, respectively. The addition of fish meat or other fish parts to the stick products significantly affects the ash content of the products. The highest ash content is found in the HFC treatment which uses fish heads and bones that contain high minerals. The findings of this study support Mestagensi *et al*. (2021) who reported that anchovy sticks have ash content ranging from 2.63% to 3.69%. Increasing the ash content in a product can provide added nutritional value in the form of calcium and phosphorus content which are essential for human health, especially for the maintenance of bones and teeth.

Protein

The protein content in the catfish sticks was in the range of 10.67-10.92% (Table 2). The results of the analysis of variance indicate no significant impact of fish parts on protein content (p>0.05), meaning that the addition of fish meat or fish parts to the stick product does not affect its protein content. The fish sticks that use all parts of the fish that have been gilled and gutted have the highest protein content compared to those made from fish

Table 2 Chemical composition of catfish stick (%)
Tabel 2 Komposisi kimia stik ikan lele (%)

Treatments	Minced	Head and fishbone	Whole	Standard (BSN, 2015)
Moisture	2.75±0.09^{a}	2.38±0.06^{b}	2.21±0.29^{b}	Max. 4
Ash	3.11±0.04^{a}	3.98±0.03^{b}	3.37±0.21^{c}	-
Protein	10.67±0.23^{a}	10.81±0.08^{a}	10.92±0.03^{a}	-
Fat	27.48±0.36^{a}	28.06±0.11^{b}	30.92±0.01^{c}	Max. 38
Carbohydrate	56.00±0.08^{a}	54.79±0.27^{b}	52.59±0.10^{c}	-
Calcium	0.35±0.01^{a}	0.47±0.01^{b}	0.68±0.02^{c}	-
Phosphorus	0.056±0.00^{a}	0.062±0.00^{b}	0.083±0.00^{c}	-

meat only or fish heads and bones. However, the differences in the parts used do not have a statistical effect on the protein content of the product. Primawestri *et al*. (2023) also stated that catfish sticks with the addition of more fish meat have higher protein content than those with a mixture of fish meat and bones. This is because the protein in fish meat is higher, namely around 18.79%, while the protein in catfish head and bone waste only reaches 6.75% (Handayani & Kartikawati, 2015).

The study found lower protein content than those of anchovy sticks as reported by Mestagensi *et al*. (2021) which ranges from 12.27% to 13.21%. This means that the type of fish used affects the protein content of the product. Most fish processing still produces waste in the form of heads, bones, scales, and innards. Utilizing all parts of the fish that have been gilled and gutted (without the entrails and gills) into value-added products can minimize waste from the production process, thereby supporting the zero-waste concept in the production process of fishery products (Mubarokah *et al*., 2021).

Fat

The fat content of the fish sticks ranged from 27.48-30.92% (Table 2). This complies with the standard (SNI 01-2886-2015) which sets a maximum limit for fat content of 38% (BSN, 2015). The results of the analysis of variance show an influence of fish parts on fat content (p<0.05). The results of the LSD test reveal that the fat content of the MC treatment is significantly different from the other two treatments. MC, HFC, and WGGC treatments have fat content values of 27.58%, 28.06%, and 30.92% respectively. This varying fat content in fish sticks is influenced by the frying process using oil and the parts of the fish used in each treatment. Fish parts significantly affect the fat content of the product because each part of the fish has a different fat content. Mutiara *et al*. (2022) found that the fat content of *lundu* fish (*Macrones gulio*) was highest in whole fish, amounting to 4.7%, whereas the meat part (fillet with skin) had a lower fat content of 3.7%.

Carbohydrate

The measurements of carbohydrates in this study employed the by-difference method. The carbohydrate content in the fish sticks ranged from 52.59-56.00% (Table 2). The results of the analysis of variance show that fish parts influence carbohydrate content (p<0.05). Furthermore, the results of further LSD tests indicate that MC treatment is significantly different from the other treatments. The highest to lowest carbohydrate content values were found in MC, HFC, and WGGC treatments, with respective values of 56%, 54.79%, and 52.59%. Fera *et al*. (2019) made snakehead fish sticks in their study and found that the carbohydrate content of the sticks decreased with increasing amount of fish used. Fish has an extremely low carbohydrate content of less than 2.5% (Suwandi *et al*., 2014). The carbohydrate content in fish sticks mainly comes from the main raw material, namely wheat flour. In this study, all treatments used the same amount of wheat flour. The difference in carbohydrate content in the fish sticks is because the flesh of the fish still contains higher carbohydrates than the bones and the whole fish that have been gilled and gutted. The carbohydrate content of catfish meat is around 12.8% (Bimantara, 2018), while whole catfish contains lower carbohydrates, namely around 2.60% (Mubarokah, *et al*., 2021).

Calcium

In this study, the calcium the calcium content of the fish sticks ranged from 0.35-0.68% (Table 2). The results of the analysis of variance show a significant effect of fish parts on calcium content (p<0.05). The results of further LSD tests reveal that the fish parts used in the three treatments affect the calcium content of the catfish sticks. The lowest to highest calcium content values were found in MC, HFC, and WGGC treatments with values of 0.35%, 0.47%, and 0.68% respectively.

The results of this study are in line with a previous study by Fitri *et al*. (2016) which reported that milkfish sticks with the addition of whole fish had the highest calcium content of 0.19%. The calcium content values of the catfish sticks in this study are higher than

those of milkfish sticks in the study by Fitri *et al*. (2016) and catfish sticks in the study by Handayani & Kartikawati (2015). The differences in the results of calcium levels in sticks from different parts of the fish are due to the different calcium levels in each part of the fish. Handayani & Kartikawati (2015) reported that the calcium content of fish meat sticks is also lower than sticks made from whole fish or bone and head waste.

Phosphorous

The phosphorus content of the fish sticks in this study ranged from 0.056-0.083% (Table 2). The results of the analysis of variance and further LSD tests indicate an influence of fish parts used in the three treatments on phosphorus content (p<0.05). MC, HFC, and WGGC treatments have the lowest to highest phosphorus content values of 0.056%, 0.062%, and 0.083%, respectively.

The phosphorus content values in three treatments are lower than the calcium content values. This is in line with the finding of a study by Primawestri *et al*. (2023) that the calcium content of catfish sticks is greater than the phosphorus content, so it does not interfere with the absorption of calcium when digested in the body.

CONCLUSION

Whole gilled and gutted catfish (WGGC) is the best treatment as it has the highest calcium content compared to other treatments. Utilizing all parts of fish that have been gilled in making stick products can reduce processing industry waste and support the concept of zero-waste product processing.

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