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Protein and Fat Content of Sili Fish (Macrognathus aculeatus) from the Bengawan Solo River

Dwi Marisa Fatma, Eko Budi Minarno, Mukhlis Fahruddin
Universitas Islam Negeri Maulana Malik Ibrahim Malang

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ABSTRACT:
Background: The sili fish (Macrognathus aculeatus), a freshwater fish, is a specialty and a popular side dish in Lamongan's Nasi Boran cuisine. Fish is a good source of animal protein, while its fat content is predominantly unsaturated, which is beneficial as an efficient energy source, as well as for growth and lowering blood cholesterol.
Aims: This study aims to determine the protein and fat content of Sili fish in the Bengawan Solo River, Jelakcatur Village, Kalitengah District, Lamongan Regency.
Methods: This research is quantitative descriptive. Sili fish samples were taken from three different stations (Plarisan Station, Gangin Station, and Jelak Station). Protein content was determined using the Kjeldahl method and fat content using the acid hydrolysis method.
Result: Protein and fat content varied among the three stations. The highest protein content was found at Jelak station at 13.51%, followed by Gangin station at 11.60%, and Plarisan station at 11.38%. The average protein content across the three samples was 12.16%. The highest fat content was also found at Jelak station at 1.01%, followed by Gangin station at 0.72%, and Plarisan station at 0.70%. The average fat content across the three samples was 0.81%.
Conclusion: Sili fish samples from Jelak Station had the highest protein (13.51%) and fat (1.01%) content. Overall, Sili fish from all three locations had good protein and fat nutritional content.

Keywords: Sili Fish (Macrognathus aculeatus), Protein Test, Fat Test, Jelakcatur Village, Kjeldahl Method, and Acid Hydrolysis Method

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INTRODUCTION

Fish is widely recognized as an important source of high-quality animal protein and essential fatty acids that play a critical role in human growth, metabolism, and overall health(Almandoz et al., 2024; Amawi et al., 2024; Emmanuel Ifeanyi Obeagu1 et al., 2024; Organization, 2000). Protein has a vital function as a building block for cell tissue, a regulator of the metabolic system, and also as a source of energy (Gong et al., 2024; Hadidi et al., 2024; Tufail et al., 2024). Consumption of animal protein, such as that found in fish, is highly emphasized because it can meet the need for essential amino acids that the body cannot synthesize on its own. In addition to protein, fat is also an essential nutrient, serving as an efficient energy source and a solvent for fat-soluble vitamins (Alkhaldi & Alrubaie, 2025; Estrem et al., 2025; Kambanis et al., 2025). The unsaturated fat content in fish is specifically beneficial for growth and can help lower blood cholesterol levels(Mohdeb et al., 2025; Semenoglou et al., 2025; Tacon, 2023).

Ideally, people need to consume good and nutritious food (halalan thayyiban) for health and to fulfill the body's physiological functions(Almoraie et al., 2025; Forde & Decker, 2022; Kokkoris & Stavrova, 2021). Sili fish is a good source of local animal protein and is known as a typical side dish in Lamongan's Nasi Boran cuisine. However, the reality shows a nutritional gap, with stunting remaining a national problem and in Lamongan Regency. Furthermore, the problem of malnutrition is exacerbated by the abundance of fast food, which makes people less concerned about the quality and nutritional content of the food they consume(Ahmed et al., 2024; Kencanaputri et al., 2024; Leocádio et al., 2021; Wadivkar et al., 2025). Although Sili fish is widely enjoyed, local people are not yet fully aware of its nutritional content and value.

These conditions created a significant opportunity for this quantitative descriptive study. Sili fish were collected directly from their natural habitat in the Bengawan Solo River, Jelakcatur Village, Kalitengah District, Lamongan Regency. Sampling was conducted at three different stations: Plarisan Station, Gangin Station, and Jelak Station, each with different environmental characteristics, with Jelak Station being more natural and far from human activity. These different locations provided an opportunity to analyze variations in nutritional content (protein and fat) within the Sili fish population in the region.

The identified research gap is the lack of information on the nutritional content of Sili fish, which is widely used as a traditional food in Lamongan, which this study aims to fill. The novelty of this study lies in the testing of proximate content, namely protein and fat, in Sili fish from three specific locations in the Bengawan Solo River using standard methods such as the Kjeldahl Method for protein and the Acid Hydrolysis Method for fat. Accurate data on this nutritional content is important considering that Sili fish is categorized as a species that is difficult to cultivate, so this study can provide a scientific basis for conservation efforts and sustainable use.

The main reason for selecting the research object, namely the Sili Fish (Macrognathus aculeatus), is its role as an endemic freshwater fish and a typical aquatic biota that is a favorite side dish in Nasi Boran culinary in Lamongan. This fish is a potential source of animal protein. Meanwhile, the research location was chosen in the Bengawan Solo River, Jelakcatur Village, Kalitengah District, Lamongan Regency, because this place is the location where local fishermen obtain Sili Fish and is expected to represent the fish population in the River Basin (DAS).

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The purpose of this study is to determine and analyze the protein and fat content of Sili Fish in the Bengawan Solo River, Jelakcatur Village, Kalitengah District, Lamongan Regency. The contribution of this study is very significant, namely providing scientific data on the nutritional value of Sili Fish. By knowing the good nutritional content, such as an average of 12.16% protein and 0.81% fat, the results of this study are expected to motivate the community and related agencies to increase fish consumption in order to prevent nutritional problems such as stunting, while at the same time encouraging efforts to cultivate and preserve Sili Fish as a valuable natural resource.

METHOD

Research Design

This research uses a quantitative descriptive research type (Riyanto & Hatmawan, 2020). The purpose of this study was to determine and describe the proximate content, namely the protein content test and the fat content test, of Sili Fish (Macrognathus aculeatus) samples.

Samples (Specimens)

The research samples consisted of Sili fish (Macrognathus aculeatus) specimens obtained directly from fishermen's catches in the Bengawan Solo River, Jelakcatur Village, Kalitengah District, Lamongan Regency, Indonesia. Only freshly caught fish that met the morphological characteristics of *Macrognathus aculeatus* were included in the analysis.

Population and the methods of sampling

The population of this study was all Sili Fish (Macrognathus aculeatus) that live in the Bengawan Solo River, Jelakcatur Village, Kalitengah District, Lamongan Regency.

The sampling method used was purposive sampling, which determines sampling locations based on specific considerations from researchers and observations with fishermen. The sampling locations were divided into three different stations in Jelakcatur Village, Kalitengah District, Lamongan Regency:

No	Station	Location	Coordinate
1	Plarisan	Plarisan Hamlet, Jelakjatur Village, Kalitengah District, Lamongan Regency	7°2'28.98"S 112°22'41.97"E[8]
2	Gangin	Gangin Hamlet, Jelakjatur Village, Kalitengah District, Lamongan Regency	7°2'29.61"S 112°22'50.49"E[9]
3	Bored	Jelak Hamlet, Jelakjatur Village, Kalitengah District, Lamongan Regency	7°2'23.11"S 112°23'5.85"E[10]

Instrument:

Because this research is quantitative descriptive with a focus on proximate content, the "instrument" used is the standard laboratory method:

1. Protein content test was carried out using the Kjeldahl method.
2. Fat Content Test was carried out using the Acid Hydrolysis Method.

The following is a summary of the tools and materials used:

Test	Main Tools	The main ingredient
Protein	Spectrophotometer, Distiller, Oven, Analytical Balance[13]	Sili Fish, Selenium Solution, Boric Acid Solution, Bromocresol Green Solution 0.1%, HCl Solution, NaOH Solution 30%[14]
Fat	Soxhlet apparatus, Electric heater, Oven, Analytical balance[15]	Sili Fish, 2% HCl, Hexane Solution, 12% KOH[16]

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Procedures and Time Frame (Procedures and Time Frame)

Time andResearch Location: The research was conducted starting in April 2024, with sampling taking place in the Bengawan Solo River basin, Jelakcatur Village, Kalitengah District, Lamongan Regency. Laboratory testing was conducted at a relevant location (not explicitly stated).

Research Procedure:

1. Determination of Sampling Locations: Locations were determined based on the purposive sampling method at three stations (Plarisan, Gangin, and Jelak) in the Bengawan Solo River flow.
2. Sample Preparation: Sili fish caught by fishermen at each station were separated from their fins and spines. Only the fish flesh was used as a sample. The fish flesh was then weighed to 100g wet for protein and fat testing.
3. Protein Content Test (Kjeldahl Method): The sample is analyzed to determine the nitrogen content, which is then multiplied by a conversion factor of 6.25 to obtain the protein content.
4. Fat Content Test (Acid Hydrolysis Method): Samples are analyzed to determine their fat content.

Analysis Plan

The protein and fat content data from Sili fish were analyzed using quantitative descriptive analysis. The results are presented in narrative and tabular form to describe the protein and fat content obtained from each sampling station (Plarisan, Gangin, and Jelak). The final protein and fat content values were also averaged.

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RESULTS AND DISCUSSION

Result

The results of quantitative descriptive analysis of protein and fat content in Sili Fish (Macrognathus aculeatus) from three different stations in the Bengawan Solo River, Jelakcatur Village, Lamongan Regency, are summarized in the following table:

Sampling Station	Protein Content (%) (Kjeldahl Method)	Fat Content (%) (Acid Hydrolysis Method)
Plarisan	11.38	0.70
Gangin	11.60	0.72
Bored	13.51	1.01
Total Average	12.16	0.81

The results showed that the highest protein content (13.51%) and the highest fat content (1.01%) were found in samples taken from Jelak Station. Plarisan Station showed the lowest levels for both nutritional components, namely 11.38% protein and 0.70% fat. The overall average protein content of Sili Fish was 12.16%, and the average fat content was 0.81%.

Discussion

The finding that the protein and fat content of Sili fish varies between sampling locations indicates the influence of the habitat environment on the nutritional quality of the fish. The increase in protein and fat levels at Jelak Station (Protein: 13.51%; Fat: 1.01%) compared to the other two stations (Plarisan and Gangin) is most likely due to the environmental conditions at Jelak Station, which are hypothetically more natural and have minimal anthropogenic activity(Khawar et al., 2024; Mamun et al., 2024). Better habitat conditions can ensure the availability of more diverse and high-quality natural food, as well as influence the metabolic and physiological activities of fish in storing energy reserves and building muscle mass.

In general, the average protein content of Sili Fish (12.16%) is below the protein range of fish in general, but this value is still considered good and has high potential as a source of animal protein. According to nutritional standards, fish with protein above 10% are considered a quality protein source. Meanwhile, the low fat content (average 0.81%) indicates that Sili Fish is included in the category of low-fat fish (lean fish). This low fat content, which is dominated by unsaturated fatty acids, makes it a healthy food choice for the heart and good for diets. With sufficient protein content and low fat, Sili Fish can be an effective local solution in addressing nutritional problems in Lamongan, such as stunting, in line with its traditional role as a main dish of Nasi Boran.

At the research level, this study fills an important gap by providing location-specific proximate data on a freshwater fish species that is widely consumed but scientifically underreported. Previous nutritional studies have predominantly focused on marine or commercially farmed fish, whereas wild freshwater species that are difficult to cultivate, such as Sili fish, remain poorly documented. By applying standardized analytical methods to specimens collected directly from the Bengawan Solo River, this study contributes baseline nutritional data that can be used in future food composition databases, comparative nutrition studies, and policy-oriented research on local food utilization.

Nevertheless, several limitations should be acknowledged when interpreting these results. The analysis was limited to two proximate components protein and fat without assessing other nutritional parameters such as moisture, ash, carbohydrates, essential fatty acids, or micronutrients. In addition, environmental variables such as water quality, temperature, and natural feed availability were not quantitatively measured, which restricts the ability to draw definitive conclusions regarding the ecological drivers of nutrient variation. Furthermore, sampling was conducted during a single period, and seasonal variation in nutritional composition was not examined.

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Considering these limitations, future studies are recommended to adopt a more comprehensive analytical approach by including full proximate analysis and key micronutrients to better characterize the nutritional profile of Sili fish. Integrating environmental measurements and conducting seasonal sampling would also strengthen understanding of how habitat dynamics influence fish nutrition. Such research would not only enhance scientific knowledge but also support evidence-based strategies for sustainable fisheries management, conservation, and the promotion of local fish as nutritionally valuable food resources.

CONCLUSION

Based on the results of the analysis that has been carried out, it can be concluded that Sili Fish (Macrognathus aculeatus) from the Bengawan Solo River, Jelakcatur Village, Lamongan Regency, has good nutritional content, with an average protein of 12.16% and an average fat of 0.81%. The highest protein and fat content was found in samples from Jelak Station, namely 13.51% protein and 1.01% fat, indicating variations in nutritional quality that are influenced by the habitat environment. Overall, Sili Fish is included in the category of low-fat fish (lean fish) and is a local source of animal protein that has important potential in supporting efforts to improve community nutrition.

AUTHOR CONTRIBUTION STATEMENT

DMF was the primary contributor responsible for the initiation, conceptualization, and design of the study, on-site sampling, laboratory data analysis, and writing the initial draft and revising the manuscript. DPI and DPII collectively provided supervision, methodological validation, guidance on interpretation of results (particularly protein and lipid assays), and critical review of the manuscript. All authors have read and approved the final version of the manuscript.

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REFERENCES

Ahmed, A., Maham, K., Afzaal, M., Saleem, M.A., Nadeem, M., Saeed, F., Hussain, M., & Al Jbawi, E. (2024). The consequences of poor dietary patterns on the proliferation of non-alcoholic fatty liver disease. Cogent Food & Agriculture, 10(1), 2325206. https://doi.org/10.1080/23311932.2024.2325206

Alkhaldi, M., & Alrubaie, M. (2025). Roadmap for rebuilding the health system and scenarios of crisis path in Gaza. The International Journal of Health Planning and Management, 40(1), 241–253. https://doi.org/10.1002/hpm.3861

Almandoz, J.P., Wadden, T.A., Tewksbury, C., Apovian, C.M., Fitch, A., Ard, J.D., Li, Z., Richards, J., Butsch, W.S., Jouravskaya, I., Vanderman, K.S., & Neff, L.M. (2024). Nutritional considerations with antiobesity medications. Obesity, 32(9), 1613–1631. https://doi.org/10.1002/oby.24067

Almoraie, N.M., Alothmani, N.M., Alomari, WD, & Al-amoudi, AH (2025). Addressing nutritional issues and eating behavior among university students: A narrative review. Nutrition Research Reviews, 38(1), 53–68. https://doi.org/10.1017/S0954422424000088

Amawi, A., AlKasasbeh, W., Jaradat, M., Almasri, A., Alobaidi, S., Hammad, AA, Bishtawi, T., Fataftah, B., Turk, N., Saoud, H.A., Jarrar, A., & Ghazzawi, H. (2024). Athletes' nutritional demands: A narrative review of nutritional requirements. Frontiers in Nutrition, 10. https://doi.org/10.3389/fnut.2023.1331854

Emmanuel Ifeanyi Obeagu1, , Getrude Uzoma Obeagu2, , Edward Odogbu Odo3, , Matthew, Chibunna Igwe4, & , Okechukwu Paul-Chima Ugwu5. (2024). Nutritional Approaches for Enhancing Immune Competence in HIV-Positive Individuals: A Comprehensive Review. IDOSR JOURNAL OF APPLIED SCIENCES, 9(1), 40–50. https://doi.org/10.59298/IDOSRJAS/2024/1.7.8.295

Estrem, H.H., Pederson, J.L., Dodrill, P., Romeo, C., Thompson, K., Thomas, J.J., Zucker, N., Noel, R., Zickgraf, H., Menzel, J., Lukens, C.T., Goday, P.S., MacLaughlin, S., & Sharp, W.G. (2025). A US-Based Consensus on Diagnostic Overlap and Distinction for Pediatric Feeding Disorder and Avoidant/Restrictive Food Intake Disorder. International Journal of Eating Disorders, 58(3), 489–499. https://doi.org/10.1002/eat.24349

Forde, C. G., & Decker, E. A. (2022). The Importance of Food Processing and Eating Behavior in Promoting Healthy and Sustainable Diets. Annual Review of Nutrition, 42(Volume 42, 2022), 377–399. https://doi.org/10.1146/annurev-nutr-062220-030123

Gong, H., Zhong, H., Cheng, L., Li, L.-P., & Zhang, D.-K. (2024). Post-translational protein lactylation modification in health and diseases: A double-edged sword. Journal of Translational Medicine, 22(1), 41. https://doi.org/10.1186/s12967-023-04842-9

Hadidi, M., Aghababaei, F., & McClements, D. J. (2024). Sunflower meal/cake as a sustainable protein source for global food demand: Towards a zero-hunger world. Food Hydrocolloids, 147, 109329. https://doi.org/10.1016/j.foodhyd.2023.109329

Kambanis, P.E., Tabri, N., McPherson, I., Gydus, J.E., Kuhnle, M., Stern, C.M., Asanza, E., Becker, KR, Breithaupt, L., Freizinger, M., Shrier, L.A., Bern, E.M., Eddy, KT, Misra, M., Micali, N., Lawson, E.A., & Thomas, J.J. (2025). Prospective 2-Year Course and Predictors of Outcome in Avoidant/Restrictive Food Intake Disorder. Journal of the American Academy of Child & Adolescent Psychiatry, 64(2), 262–275. https://doi.org/10.1016/j.jaac.2024.04.010

Kencanaputri, SA, Bakhrul Ilmi, IM, & Simanungkalit, SF (2024). The Effect of Food Diversity, Junk Food, and High Sugar Products on the Incidence of Overnutrition in Adolescence of SMAN 6 Depok. Amerta Nutrition, 8, 115. https://doi.org/10.20473/amnt.v8i3SP.2024.115-126

Khawar, M., Masood, Z., Ul Hasan, H., Khan, W., De los Ríos-Escalante, P.R., Aldamigh, M.A., Al-Sowayan, N.S., Razzaq, W., Khan, T., & Said, M.B. (2024). Trace metals and nutrient analysis

DOI: https://doi.org/10.64780/jnph.v1i4.143

of marine fish species from the Gwadar coast. Scientific Reports, 14(1), 6548. https://doi.org/10.1038/s41598-024-57335-0

Kokkoris, M.D., & Stavrova, O. (2021). Meaning of food and consumer eating behaviors. Food Quality and Preference, 94, 104343. https://doi.org/10.1016/j.foodqual.2021.104343

Leocádio, PCL, Lopes, SC, Dias, RP, Alvarez-Leite, JI, Guerrant, RL, Malva, JO, & Oriá, RB (2021). The Transition From Undernutrition to Overnutrition Under Adverse Environments and Poverty: The Risk for Chronic Diseases. Frontiers in Nutrition, 8. https://doi.org/10.3389/fnut.2021.676044

Mamun, A.-A., Rifat, MA, Wahab, Md. A., Rahman, M.A., Nahiduzzaman, Md., Thilsted, S.H., & Kjellevold, M. (2024). Nutrient composition of dried marine small fish in Bangladesh and their potential to address hidden hunger. Journal of Food Composition and Analysis, 131, 106241. https://doi.org/10.1016/j.jfca.2024.106241

Mohdeb, R., Boutaoui, N., Merabet, L., Acila, M., Roula, A., Roula, S. D., & Kara, M. H. (2025). Comparative study of fat content, profile and quality of fatty acids in three species of Carangidae of southwestern Mediterranean. Journal of the Marine Biological Association of the United Kingdom, 105, e11. https://doi.org/10.1017/S0025315425000013

Organization, W.H. (2000). The Management of Nutrition in Major Emergencies. World Health Organization.

Riyanto, S., & Hatmawan, AA (2020). Quantitative Research Methods in Management, Engineering, Education, and Experimental Research. Deepublish.

Semenoglou, I., Katsouli, M., Giannakourou, M., & Taoukis, P. (2025). Effect of High-Pressure Homogenization and Wall Material Composition on the Encapsulation of Polyunsaturated Fatty Acids from Fish Processing. Molecules, 30(7), 1434. https://doi.org/10.3390/molecules30071434

Tacon, A.G. J. (2023). Contribution of Fish and Seafood to Global Food and Feed Supply: An Analysis of the FAO Food Balance Sheet for 2019. Reviews in Fisheries Science & Aquaculture, 31(2), 274–283. https://doi.org/10.1080/23308249.2022.2124364

Tufail, M., Jiang, C.-H., & Li, N. (2024). Altered metabolism in cancer: Insights into energy pathways and therapeutic targets. Molecular Cancer, 23(1), 203. https://doi.org/10.1186/s12943-024-02119-3

Wadivkar, P., Thomas, N., Jebasingh, F., Bacot-Davis, V.R., Maini, R., & Hawkins, M. (2025). Undernutrition-Associated Diabetes Mellitus: Pathophysiology of a Global Problem. Physiology, 40(5), 441–453. https://doi.org/10.1152/physiol.00065.2024

DOI: https://doi.org/10.64780/jnph.v1i4.143