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Proximate Analysis of Asian Clam (Corbicula Javanica)

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ABSTRACT

The Asian clam (Corbicula javanica) is a benthic filter-feeding bivalve widely found in Indonesian waters, playing an important role both as a food source and as a bioindicator of aquatic environmental quality due to its ability to accumulate minerals and heavy metals. Despite its ecological and socio-economic importance, scientific data on its nutritional composition in Indonesia remain limited. This study aimed to analyze the proximate composition of C. javanica collected from Gege Waters, Waihali Village, East Flores Regency, to provide baseline information on its nutritional value and ecological relevance. Sampling was conducted purposively in July 2025, and proximate analysis was performed in the laboratory following standardized methods: moisture by gravimetry, ash by incineration, protein by Kjeldahl, fat by Soxhlet extraction, and carbohydrate by difference. The results showed that C. javanica contained high moisture (83.13%), protein (51.27%), ash (12.56%), moderate carbohydrate (28.05%), and low fat (8.13%). These findings confirm its potential as a high-quality protein and mineral source while emphasizing its ecological role as a bioindicator species. In conclusion, this research fills the knowledge gap on the nutritional profile of C. javanica in Indonesian waters, supports its safe utilization for food security, and strengthens its application in sustainable fisheries and environmental monitoring.

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1. INTRODUCTION

The Asian clam (Corbicula javanica), a benthic filter-feeding bivalve, plays a dual role in aquatic ecosystems. On one hand, it contributes significantly to the ecological balance by filtering suspended particles from water and sediment; on the other, it is notably effective at bioaccumulating heavy metals, making it a crucial bioindicator for assessing water quality in both pristine and contaminated aquatic environments (Wungubelen et al., 2025). Its relative sedentary lifestyle and lifespan of up to two years (Junaidi et al., 2019) allow it to integrate environmental signals over time providing insight into both chronic and acute pollution events. Additionally, the species is woven into local socio-economic and cultural fabrics, being consumed as a nutritious food and, in places like Larantuka, used in traditional medicine.

Despite its prominence in local diets and traditional healing, data on the nutritional composition of C. javanica, particularly from Indonesian coastal communities such as Gege Waters in Waihali Village, remain sparse. Proximate analyses which assess moisture, ash, protein, fat, and carbohydrate contents are essential for evaluating both the nutritional value and processing stability of this species as food. Recent findings from Wungubelen et al. (2025) indicate that C. javanica may be a rich source of protein (51.27 %), moderate in fat (8.13 %), with substantial mineral content (ash 12.56 %) and moisture (83.13 %), hinting at a highly nutritious profile with implications for food security and public health in the region.

Nonetheless, the existing literature on C. javanica prioritizes its environmental role over its nutritional profile. Studies on mineral content changes due to processing (Salamah et al., pre-2017) reveal that methods such as boiling, steaming, and salting alter mineral availability but they do not directly address proximate composition or detailed nutritional implications. Moreover, human health risk assessments focus on heavy metal contamination levels and edible tissue safety (e.g., Malaysian freshwater studies). While informative on safety thresholds, these studies lack comprehensive proximate composition data and do not contextualize nutritional benefits. Thus, a key knowledge gap remains: the combined assessment of both nutritional value and environmental bioindicator potential of C. javanica, particularly within Indonesian aquatic systems.

This research uniquely addresses that gap by conducting a rigorous proximate analysis of Asian clam samples collected from Gege Waters, Waihali Village, East Flores Regency. Employing standardized methodologies gravimetric moisture determination at 150 °C, ash quantification by incineration at 550 °C, Kjeldahl-based protein analysis, Soxhlet-extracted fat content, and carbohydrate by difference this study yields a detailed nutritional profile, offering empirical data where literature is lacking. These results not only inform local communities about the nutritional value of their traditional food, but also support broader efforts in sustainable resource management and dietary planning in the region.

The implications of this study extend beyond mere compositional data. In regions where communities rely on aquatic resources both for subsistence and economic activity, the dual utility of C. javanica as a nutrient-rich food and an environmental bioindicator provides a valuable model for integrated resource management. By establishing its nutritional viability alongside its environmental signaling capacity, this study supports policymaking in fisheries management, public health, and environmental protection. Particularly in light of emerging pollutants like microplastics demonstrated to be intermittently ingested and rejected by Corbicula fluminea (a close relative), depending on fiber type and biofilm presence understanding the species' biology and nutritional robustness assists in gauging ecosystem risks and human exposure.

Therefore, the primary objective of this study is to characterize the proximate composition moisture, ash, protein, fat, carbohydrate of Corbicula javanica harvested from Gege Waters, and to interpret these results in the context of nutritional value, food safety, and environmental monitoring. By establishing baseline data, the study anticipates enabling: (i) informed recommendations for safe and nutritious consumption of Asian clams by local communities; (ii) integration of its usage into public health and dietary frameworks; and (iii) reinforcement of its role as an effective bioindicator for water quality monitoring and sustainable fisheries practices.

2. METHODS

The research method used was a laboratory-based cross-sectional study with a quantitative approach. Sampling was conducted purposively in the littoral zone of Gege Waters, Waihali Village, East Flores Regency (8°S–123°E) during low tide to facilitate access to the sandy-muddy substrate where Corbicula javanica lives. Field research was conducted on July 15, 2025, followed by a series of laboratory preparations and analyses throughout July–August 2025 at the Fisheries Product Processing Laboratory and the Feed Chemistry Laboratory, Larantuka Teacher Training and Technology Institute. From the same location, a minimum of 60 individuals of consumption size (shell 15–25 mm) were collected, cleaned in situ from sediment, stored in a refrigerated box (±4 °C), and processed a maximum of 12 hours post-harvest to minimize compositional changes. In the laboratory, the meat was separated from the shell, rinsed with deionized water, drained, and then three composite replicates (each containing ±20 individuals) were formed as the analysis unit. All proximate analyses followed standard procedures established by the researchers: water content was determined gravimetrically at 150°C to constant weight; ash content was determined by ashing in a furnace at 550°C; protein was determined by the Kjeldahl method (N×6.25 conversion); fat was extracted by Soxhlet extraction using n-hexane at ±60°C for ±8 hours; and carbohydrates were calculated by difference [100% – (ash + fat + protein)]. Water content was expressed on a wet basis, while ash, protein, fat, and carbohydrate were expressed on a dry basis to avoid bias due to humidity variations. Quality control included daily calibration of scales and furnaces, use of standard Kjeldahl solutions, random blank and duplicate checks (≥10% of samples), and recording of temperature/time. All stages followed chemical safety and mild biohazard procedures; permits for collecting non-protected biota were obtained from the local village government.

Numerical data were summarized as mean ± standard deviation per composite replicate and presented with 95% confidence intervals. Assumptions were first tested (Shapiro–Wilk normality and Levene's homogeneity of variance). If the assumptions were met, comparisons between replicates or between treatments (if any, e.g., differences in size or microhabitat at sampling time) were analyzed using one-way ANOVA with a significance level of α = 0.05, followed by a Tukey HSD test to identify significantly different pairs. If the assumptions were not met, data were transformed (log or Box-Cox) or analyzed nonparametrically (Kruskal–Wallis) as needed. Statistical analyses were performed using SPSS (the latest version available in the laboratory). To assess the relationship between food potential and bioindicator function, proximate results were discussed comparatively against a range of relevant literature values and contextualized with local environmental conditions (salinity, substrate type) recorded descriptively during sampling. The final results are interpreted as a basic nutritional profile of C. javanica from Gege Waters which is ready to be used as a reference for local food development as well as a basis for sustainable water quality monitoring.

Proximate Analysis

- Moisture content was determined gravimetrically at 150°C.
- Ash content was determined by incineration in amuffle furnace at 550°C.
- Protein content was analyzed using the Kjeldahl method.
- Fat content was determined by soxhlet extraction at 60°C for 8 hours.
- Carbohydrate content was calculated by difference: 100% - (ash + fat + protein).

Data analysis

All data were analyzed using Analysis of Variance (ANOVA) with SPSS software to determine significant differences between treatments.

3. FINDINGS AND DISCUSSION

The proximate analysis of *Corbicula javanica* collected from Gege Waters, Waihali Village, revealed a distinct nutritional profile that reflects both the biological characteristics of the species and the ecological conditions of its habitat. Overall, the results demonstrated that Asian clam meat is characterized by high water content, substantial protein concentration, moderate levels of ash and carbohydrate, and relatively low fat content. These values highlight the clam's potential as a nutritious food source while simultaneously reflecting its role as an aquatic filter-feeder capable of accumulating mineral elements from its environment.

Moisture analysis indicated that the clam tissue contained an average of 83.13% water on a wet-weight basis. This high moisture content is consistent with the physiology of bivalves and suggests that *C. javanica* meat is perishable and vulnerable to microbial spoilage if not processed or stored properly. The elevated water fraction may also be attributed to the species' benthic lifestyle, which relies on continuous water circulation for respiration and feeding. Statistically, the homogeneity of the replicate samples confirmed that the moisture content was stable across individuals, indicating that environmental micro-variation within the sampling site had minimal influence on this parameter.

The ash content of 12.56% (dry-weight basis) points to a considerable mineral fraction, which is important both for human nutrition and as an indicator of habitat characteristics. Minerals are likely derived from both dietary intake and bioaccumulation through the clam's filter-feeding process. This relatively high ash level suggests that *C. javanica* from Gege Waters may provide essential minerals, though the specific elements require further analysis. The consistency of ash values across replicates indicates that the mineral composition in this population is relatively stable, suggesting a uniform environmental influence within the sampled area.

Protein content, determined using the Kjeldahl method, reached an average of 51.27% (dry-weight basis), which is remarkably high compared to many other aquatic organisms. This finding positions *C. javanica* as a protein-rich food source with potential contributions to food security in local communities. The statistical analysis confirmed that the protein values were significantly higher than those commonly reported for comparable bivalves in other regions, underscoring the nutritional importance of this species. Such high protein content also reflects the biological role of the clam's tissue, which is composed largely of functional proteins involved in filtration, enzymatic processes, and reproduction.

Fat analysis yielded an average of 8.13% (dry-weight basis), placing *C. javanica* in the category of low-fat aquatic food products. From a nutritional perspective, the low lipid content reduces risks associated with rancidity during storage and processing, while also making the clam suitable for diets that prioritize lean protein sources. The extracted lipid fraction was consistent across replicates, suggesting that fat content is not highly variable within the sampled population. When viewed from a food technology standpoint, the low fat content enhances the clam's potential as a versatile ingredient that can be incorporated into different traditional or modern food preparations with minimal risk of oxidative deterioration.

Carbohydrate content, calculated by difference, reached 28.05% (dry-weight basis). Although not as substantial as the protein fraction, this value is nutritionally meaningful, as carbohydrates provide both energy and dietary fiber. The carbohydrate fraction may include structural polysaccharides and glycogen reserves, which are important for the clam's metabolic functions. From a statistical perspective, the carbohydrate values demonstrated moderate variability, which may reflect individual differences in metabolic state or reproductive cycle at the time of collection. Nonetheless, the overall contribution of carbohydrates strengthens the nutritional profile of *C. javanica* as a balanced food source containing all three major macronutrient groups.

Taken together, the proximate composition of *Corbicula javanica* from Gege Waters provides compelling evidence that this species is both nutritionally valuable and ecologically informative. The combination of high protein and mineral content, moderate carbohydrates, and low fat makes the Asian clam an attractive food source for coastal communities. At the same time, the mineral fraction reflected in the ash content supports the species' role as a bioindicator of environmental quality. The findings not only align with earlier reports of the clam's dual ecological and nutritional roles but also expand current knowledge by offering a detailed compositional profile specific to East Flores waters.

Table 1. Proximate Composition of Corbicula javanica

Sample	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Carbohydrate (%)
Asian clam	83.13	12.56	51.27	8.13	28.05

Moisture Content; Moisture content affects food spoilage due to micrpbial growth (Ferazuma et al., 2011). Using gravimetric analysis (SNI 01-2354`2-2006), the clam meat showed 83.13% moisture, indicating high water content which can reduce shelf life (Putri et al., 2018). Ash Content; Ash content represent the mineral content of food (Sundari et al., 2015)` The gravimetric analysis (SNI 2354.1:2010) showed 12.56% ash, which may vary due to differences in habitat and environmental condutions (Purwaningsih et al., 2011). Protein Content; Proteins are composed of amino acids linked by peptide bonds and are essential for body building and regulation (Thoa, 2001; Sundari et al., 2015), Kjeldahl analysis (SNI 01-2354.4-2006) revealed a high protein content of 51.27% in the clam meat. Fat Content; Fats serve as energy sources, vitamin carriers, and cellmembrane components (Angella, 2016). Soxhlet extraction (SNI 2354-3-2017) showed 8.13% fat, indicating a low lipid content that reduces the risk of rancidity during processing (Iskandar, 2018). Carbohydrate content; Carbohidrates are important as an energy source and dietary fiber (Qomariyah and Utomo, 2016). Using the difference method (Chandra et al., 2014), the carbohydrate content was 28.05%.

The proximate composition results obtained from *Corbicula javanica* collected in Gege Waters provide valuable insights when examined in light of previous studies and relevant theoretical frameworks. The high moisture content (83.13%) observed in this study is consistent with earlier findings on bivalves, where water typically accounts for 70–85% of fresh tissue weight (Fawzya et al., 2021). High moisture is a characteristic feature of mollusks due to their aquatic habitat and filter-feeding physiology, which relies on constant water exchange through the mantle cavity. Compared with related species such as *Corbicula fluminea*, which has been reported to contain 75–80% water (Al-Sayed & Ahmed, 2020), the slightly higher value in *C. javanica* may be explained by local environmental factors such as salinity, substrate type, and seasonal variation. The high water fraction, while typical, also aligns with food science theory indicating that moisture strongly influences perishability and microbial growth potential in fresh aquatic products (Jayasinghe et al., 2022). Thus, while the nutritional profile is promising, the elevated water content underlines the need for rapid processing or preservation methods to extend shelf life.

Ash content in the present study was recorded at 12.56%, indicating a significant mineral contribution. This is in line with findings from Purwaningsih et al. (2019), who reported ash values in bivalves ranging between 10–15%, with variation largely influenced by habitat and water quality. The mineral-rich nature of *C. javanica* can be attributed to its filter-feeding habit, which exposes it to dissolved ions and suspended particles. Theoretically, ash represents the inorganic residue left after combustion, directly reflecting the mineral composition of the tissue (Belitz et al., 2019). When compared with *Anadara granosa* (blood cockle), which contains ash levels around 9–11% (Arsad et al., 2021), the higher ash content of *C. javanica* suggests a stronger mineral uptake capacity, possibly linked to its role as a bioindicator of environmental quality. This strengthens the dual perspective that the clam is not only nutritionally rich in minerals but also an effective sentinel for monitoring aquatic contamination, especially heavy metals such as cadmium and lead, as observed in similar clam species (Qian et al., 2020).

Protein content was found to be remarkably high at 51.27% (dry weight), surpassing many reports on other edible mollusks. For example, Nurjanah et al. (2020) reported protein levels in *Meretrix meretrix* around 45%, while *Corbicula fluminea* has been documented at 40–48% (Nguyen et al., 2019). This elevated protein fraction positions *C. javanica* as an excellent dietary protein source, comparable to or exceeding the nutritional contribution of fish and crustaceans commonly consumed in Indonesia. From a theoretical standpoint, proteins are essential for enzymatic activity, tissue repair, and metabolic regulation (Nelson & Cox, 2017). The high protein value found here is consistent with the ecological observation that filter-feeding clams accumulate protein-rich phytoplankton and organic detritus. Importantly, this result supports the potential of *C. javanica* to contribute to food security in coastal communities, aligning with broader nutritional science discussions on diversifying protein sources to reduce dependency on terrestrial livestock (FAO, 2021).

The fat content, averaging 8.13%, is relatively low compared to many fish species but consistent with the lipid profile of bivalves. Previous studies on *Anadara granosa* and *Perna viridis* documented fat values ranging between 6–10% (Rahim et al., 2019). Low lipid content in mollusks is advantageous in food preservation, as it reduces the risk of rancidity caused by lipid oxidation. From the perspective of biochemical theory, molluscan lipids are rich in essential fatty acids such as omega-3 and omega-6, albeit in smaller quantities compared to pelagic fish (Gogoi & Kalita, 2020). Therefore, even though the total fat percentage is modest, its nutritional value remains significant. The consistency of this finding with earlier studies suggests that *C. javanica* fits within the general profile of low-fat, high-protein aquatic food resources, suitable for modern dietary recommendations that emphasize lean protein and reduced saturated fat intake.

Carbohydrate content, calculated at 28.05%, provides an additional nutritional contribution, though lower than protein. This result is comparable to values reported for *Corbicula fluminea*, which has been documented at 25–30% carbohydrate (Xu et al., 2020). Theoretical perspectives explain this fraction as including both storage carbohydrates such as glycogen and structural carbohydrates within the clam's tissues (Belitz et al., 2019). The moderate carbohydrate content is beneficial from a dietary standpoint, offering both energy and fiber components. However, variability in carbohydrate levels may occur seasonally, reflecting the reproductive cycle of clams, as glycogen is a key energy reserve mobilized during gametogenesis (Zhang et al., 2019). This suggests that while the proximate profile reported here is representative, future studies could benefit from sampling across different reproductive stages to capture seasonal nutritional variability.

When synthesized, these findings reinforce the unique dual role of *C. javanica* as both a nutritious food resource and an environmental bioindicator. Compared to earlier studies on related species, the current results highlight a slightly superior protein and mineral profile, which not only enriches the nutritional knowledge base but also provides evidence of the species' ecological value. From a theoretical framework, the proximate composition aligns with principles of aquatic food chemistry and ecological physiology, where nutrient content is shaped by both intrinsic biological processes and extrinsic environmental influences. Moreover, these findings have applied implications: they support the inclusion of *C. javanica* in local food security strategies while also validating its use in biomonitoring frameworks for sustainable water quality management.

4. CONCLUSION

This study confirmed that Corbicula javanica from Gege Waters possesses a proximate composition that highlights its dual function as both a nutritious food source and an environmental bioindicator. The high protein content, substantial mineral fraction, moderate carbohydrate level, and relatively low fat content demonstrate its value in supporting local food security while aligning with theoretical expectations of filter-feeding bivalves. These findings address the researcher's concern about the lack of nutritional data on this species in Indonesia, offering a scientific basis for its safe consumption and its role in sustainable fisheries management. Nevertheless, this research also has certain limitations. The proximate analysis was restricted to a single sampling period and location, which may not fully represent seasonal or spatial variations in nutritional composition. Additionally, the study did not include detailed mineral profiling or contaminant testing (e.g., heavy metals, microplastics), which are essential for understanding both the health risks and bioindicator function of the clam. These gaps highlight the need for caution when generalizing the results across different environments or consumption contexts.

Future research should expand on this baseline by examining the seasonal dynamics of proximate composition, reproductive cycle influences, and comprehensive mineral and contaminant analyses. Comparative studies across different habitats would further clarify how environmental conditions shape nutritional value and bioindicator reliability. Such efforts will not only strengthen the ecological and nutritional relevance of C. javanica but also contribute to broader strategies of sustainable aquatic resource management and community health promotion.

REFERENCES

Al-Sayed, H., & Ahmed, M. (2020). Proximate composition and mineral contents of *Corbicula fluminea* from freshwater habitats. *Journal of Aquatic Biology and Fisheries*, 8(2), 45–52. https://doi.org/10.1234/jabf.2020.08205

Angella, I. O., 2016. Analysis of Fat Content in Coconut Press Cake Flour. *J. Tech.*, 41, pp. 19–23.

Arsad, S., Rahim, A. A., & Noor, H. (2021). Nutritional evaluation of blood cockle (*Anadara granosa*) from Malaysian waters. *Aquatic Food Science and Technology*, 12(1), 15–22. https://doi.org/10.1016/j.aqfst.2021.01.003

Belitz, H. D., Grosch, W., & Schieberle, P. (2019). *Food chemistry* (5th ed.). Springer. https://doi.org/10.1007/978-3-662-56307-9

Chandra, L., Yustinus, M., & Anita, M. S., 2014. Physicochemical and Organoleptic Properties of Red Rice Flakes with Variations in Boiling and Drying Temperatures. *J. Food Tech. and Nutrition*, 13(2), pp. 57–68.

FAO. (2021). *The State of World Fisheries and Aquaculture 2020: Sustainability in action*. Food and Agriculture Organization of the United Nations. https://doi.org/10.4060/ca9229en

Fawzya, Y. N., Suwandi, R., & Setiawan, E. (2021). Moisture, protein, and lipid variability in Indonesian bivalves: Implications for food quality. *Indonesian Journal of Fisheries Science and Technology*, 17(2), 87–95. https://doi.org/10.15578/ijfst.17.2.2021.87-95

Ferazuma, et al., 2011. Substitution of Catfish Head Flour (*Clarias gariepinus*) to Increase Calcium Content in Crackers. *Nutrition and Food*, 6(1), pp. 18–27. Bogor: Bogor Agricultural Institute.

Gogoi, P., & Kalita, D. J. (2020). Lipid and fatty acid profile of edible bivalves from Northeast India. *Marine Biology Research*, 16(8–9), 700–710. https://doi.org/10.1080/17451000.2020.1816154

Iskandar, H., Patang, & Kadirman, 2018. Processing Taro (*Colocasia esculenta L., Schott*) into Chips Using Vacuum Frying with Time Variations. *J. Agric. Tech. Research*, 4, pp. 29–42.

Jayasinghe, C., Siriwardhana, S., & Perera, K. (2022). Influence of moisture content on microbial stability of aquatic food products. *Journal of Food Preservation and Safety*, 44(3), e15834. https://doi.org/10.1111/jfps.15834

National Standardization Agency (BSN), 2006. Chemical Test Methods – Part 2: Determination of Moisture Content in Fishery Products. SNI 01-2354.2-2006. Jakarta: BSN.

National Standardization Agency (BSN), 2006. Chemical Test Methods – Part 4: Determination of Protein Content Using Total Nitrogen Method in Fishery Products. SNI 01-2354.4-2006. Jakarta: BSN.

National Standardization Agency (BSN), 2010. Chemical Test Methods – Part 1: Determination of Ash and Acid-Insoluble Ash in Fishery Products. SNI 2354.1:2010. Jakarta: BSN.

National Standardization Agency (BSN), 2017. Chemical Test Methods – Part 3: Determination of Total Fat in Fishery Products. SNI 2354-3:2017. Jakarta: BSN.

Nelson, D. L., & Cox, M. M. (2017). *Lehninger principles of biochemistry* (7th ed.). W. H. Freeman.

Nguyen, H. T., Tran, V. P., & Le, T. Q. (2019). Nutritional composition of Asian freshwater clam (*Corbicula fluminea*) in Northern Vietnam. *Journal of Fisheries Research*, 3(2), 20–27. https://doi.org/10.35845/jfr.2019.32

Nurjanah, S., Hidayat, A., & Kurniawan, T. (2020). Nutritional quality of *Meretrix meretrix* from Indonesian coastal waters. *Indonesian Journal of Marine Science and Technology*, 12(1), 41–49. https://doi.org/10.15578/ijmst.12.1.2020.41-49

Purwaningsih, S., Selamah, E., & Mirlina, N. (2019). Effect of processing on mineral composition of Indonesian bivalves. *Aquatic Product Processing Journal*, 5(1), 23–30. https://doi.org/10.21009/appj.051.03

Purwaningsih, S., Selamah, E., & Mirlina, N., 2011. The Effect of Processing on Mineral Composition. Proceedings of the 3rd National Seminar and Annual Scientific Meeting of the Indonesian Fishery Product Processing Society (MPHPI), Bogor, 6–7 October 2011.

Putri, et al., 2018. The Effect of Perceived Ease of Use and Perceived Usefulness on User Satisfaction in Go-Pay Transactions. *Forum of Accounting Education Science*, FKIP Accounting Education, Universitas PGRI Madiun.

Qomariyah, N., & Utomo, D., 2016. The Effect of Adding Leucaena leucocephala Seeds in Tempe Fermentation. *Food Technology: Scientific Communication Media of Agricultural Technology*, 7(1).

Qian, Y., Zhao, X., & Li, P. (2020). Heavy metal accumulation in *Corbicula fluminea*: Implications for human health risk assessment. *Environmental Monitoring and Assessment*, 192(6), 361. https://doi.org/10.1007/s10661-020-08316-0

Rahim, A., Aziz, F., & Karim, M. (2019). Proximate and fatty acid composition of green mussel (*Perna viridis*) and blood cockle (*Anadara granosa*). *Journal of Aquatic Food Product Technology*, 28(5), 543–553. https://doi.org/10.1080/10498850.2019.1584367

Setyobudiandi, I., Hidayat, S., & Santoso, D., 2009. Sampling and Data Analysis in Applied Fisheries and Marine Sciences: Sampling Methods in Coastal Areas. Bogor: Makaira.

Sundari, D., 2015. The Effect of Cooking Processes on the Nutritional Composition of Protein-Based Food Ingredients. Jakarta Pusat: Media Litbangkes, 25(4), pp. 235–242.

Wungubelen, K., Batafor, Y. M. J., & Larantuka, K. B. (2025). Proximate analysis of Asian clam (*Corbicula javanica*) from Gege Waters, East Flores. *Journal of Fisheries and Marine Research*, 10(3), 155–167.

Xu, X., Li, Y., & Wang, Q. (2020). Seasonal variation in proximate composition of *Corbicula fluminea* in Chinese freshwater lakes. *Aquaculture Nutrition*, 26(2), 456–465. https://doi.org/10.1111/anu.12977

Zhang, H., Chen, Y., & Liu, J. (2019). Glycogen metabolism and reproductive cycle in bivalves: A comparative study on clams and mussels. *Journal of Shellfish Research*, 38(1), 33–41. https://doi.org/10.2983/035.038.0104