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PROPOSED PROCESSING APPROACHES FOR INVASIVE MUSSELS (*Sinanodonta woodiana*): FROM MEAT CHARACTERISTICS TO MARKET FEASIBILITY

Strategi Pengolahan Kijing Taiwan (*Sinanodonta woodiana*): Karakteristik Daging dan Kelayakan Pasar

Ernawati*, Asep Sahidin, Junianto

Fisheries Study Program, Padjadjaran University

Bandung Sumedang Highway KM 21, Jatinangor, Sumedang Regency, West Java

*Corresponding author: ernawati2024@unpad.ac.id

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ABSTRACT

The Chinese pond mussel (*Sinanodonta woodiana*) is an invasive species in Indonesian waters with potential utilization as a food source, particularly as a by-product of freshwater pearl aquaculture in the future. However, most studies on clam processing in Indonesia have focused on the local species *Pilsbryoconcha exilis*, while research on *S. woodiana* remains limited. This article aims to review the meat characteristics of *S. woodiana* and to propose strategies for developing potential processed products. The study was conducted through a literature review complemented by preliminary observations of locally caught samples. The findings indicate that clam meat tends to become tough after heating and undergoes high cooking loss, consistent with previous studies. Earlier processing attempts, such as meatballs, nuggets, crackers, and shredded meat, have not penetrated modern markets due to technical constraints, negative consumer perceptions, and the absence of sustainable business models. To address these challenges, this article highlights four products considered most promising: clam meatballs and nuggets (previously explored) and two new proposals, namely ready-to-cook frozen clam and crispy whole clam. These products are considered aligned with market trends, technologically simple, and potentially supportive of MSME development within a zero-waste framework.

Keywords: Circular Economy, Food Processing, Freshwater Mussel, Invasive Mussel, Product Development

ABSTRAK

Kijing Taiwan (*Sinanodonta woodiana*) merupakan spesies invasif di perairan Indonesia yang berpotensi dimanfaatkan sebagai sumber pangan, terutama sebagai hasil samping budidaya mutiara air tawar di masa depan. Namun, sebagian besar penelitian pengolahan kijing di Indonesia masih berfokus pada spesies lokal (*Pilsbryoconcha exilis*), sementara kajian terhadap *S. woodiana* masih terbatas. Penelitian ini bertujuan meninjau karakteristik daging *S. woodiana* dan merumuskan strategi pengembangan produk olahan potensial. Kajian dilakukan melalui telaah literatur yang dilengkapi dengan observasi awal terhadap sampel tangkapan lokal. Hasil

pengamatan menunjukkan bahwa daging kijing cenderung liat setelah pemanasan serta mengalami susut masak yang tinggi, sebagaimana juga dilaporkan dalam penelitian terdahulu. Upaya pengolahan sebelumnya, seperti bakso, nugget, kerupuk, dan abon, belum mampu menembus pasar modern karena kendala teknis, persepsi konsumen yang negatif, dan ketiadaan model bisnis berkelanjutan. Untuk menjawab tantangan tersebut, artikel ini menyoroti empat produk yang dinilai paling prospektif: bakso dan nugget kijing (produk yang sudah dikenal) serta dua usulan baru, yaitu kijing frozen siap masak dan kijing utuh krispi. Keempat produk ini dinilai sesuai tren pasar, sederhana secara teknologi, dan berpotensi mendukung pengembangan UMKM dalam kerangka *zero waste*.

Kata kunci: Hasil Samping, Hilirisasi, Kijing Krispi, Kijing Taiwan, Pengembangan Produk

INTRODUCTION

The Chinese pond mussel (*Sinanodonta woodiana*), also known by its synonyms *Anodonta woodiana* and *Sinanodonta pacifica,* is an invasive freshwater bivalve that grows faster than native species such as *Pilsbryoconcha exilis* (Arief *et al.*, 2023; Douda *et al.*, 2025). This species is considered a promising candidate for freshwater pearl production due to its high-quality nacre (Kalesaran & Lumenta, 2021; Arief *et al.*, 2023; Sahidin *et al.*, 2023). If its development continues, pearl production in the future may generate large quantities of by-products in the form of mussel meat. Without proper management, these by-products may be overlooked, even though they could be processed into value-added products. Early utilization aligns with the zero-waste concept and supports the circular economy.

Mussels are generally used as animal feed (Konieczny *et al.*, 2022), larval feed (Hasan *et al.*, 2019), or natural biofilters (Surono *et al.*, 2023), while their use as human food remains limited. In fact, their availability in freshwater ecosystems is abundant, particularly in Java, Kalimantan, and Sumatra (Sahidin *et al.*, 2021; 2022). The limited utilization of mussels as food may be due to their chewy meat texture, low yield, negative consumer perceptions, and the lack of popular mussel-based products in the market.

Nevertheless, several studies have attempted to process mussel meat into food products such as meatballs, nuggets, shredded meat (abon), fresh noodles, crackers, and tortillas (Ghazali *et al.*, 2015; Mustaring *et al.*, 2020; Temba *et al.*, 2023; Nur'aini *et al.*, 2019; Hasan *et al.*, 2019). Trial results have demonstrated acceptable sensory quality and nutritional value (Radikal & Janika, 2015; Ghazali *et al.*, 2015; Mustaring *et al.*, 2020). However, mussel-based products are still rarely found in mainstream retail markets compared to chicken nuggets or beef meatballs. Most studies remain at the trial stage, without sustainable downstream development. This is evident from the absence of mussel-based processed products in large-scale distribution, including e-commerce platforms.

Unlike previous studies that predominantly used local mussels (*Pilsbryoconcha exilis*), this article specifically focuses on the invasive species *Sinanodonta woodiana*, which has a larger body mass, greater availability, and relatively faster growth rate. These characteristics make *S. woodiana* more promising as a raw material for food products, but also require proper post-harvest handling to prevent environmental and ecological issues. It is important to note that some recent taxonomic discussions suggest that tropical populations of *S. woodiana*, especially those found in Indonesia, may represent a separate lineage often referred to as *Sinanodonta pacifica*. However, due to their close morphological and ecological similarities, this distinction does not significantly affect the focus of this study, which emphasizes processing approaches and market feasibility rather than taxonomic resolution.

This distinction opens new perspectives in food product development, as invasive mussels have not been widely explored as sustainable, value-added raw materials. The novelty of this article lies in connecting the unique characteristics of *S. woodiana* meat with processing

strategies and market feasibility, while also providing a foundation for further experimental studies and potential downstream applications through small and medium enterprises (SMEs). This study aims to examine the processing potential of *S. woodiana* and propose processing strategies suitable for its meat characteristics and market acceptance.

METHODS

This study was carried out through a literature review and preliminary observation.

1. Literature Review
   The literature search was conducted using several online databases such as Google Scholar, Scopus, and DOAJ, with keywords including *Sinanodonta woodiana*, *Pilsbryoconcha exilis*, Chinese pond mussel, mussel processing, freshwater mussel, and market challenge. Publications were limited to the period of 2015–2025 to capture the most recent decade of research while ensuring relevance to current developments. The inclusion criteria covered studies related to the utilization of mussels as food, ecology, and fishery product processing technology. Articles that were not directly relevant or not available in full text were excluded from the review.
2. Preliminary Observation
   Observations were conducted on *S. woodiana* specimens obtained from local freshwater catches in West Java, Indonesia. The parameters observed included the general appearance of the meat, texture after heating, shrinkage level, and responses to several preliminary treatments (soaking in pineapple extract, pressure cooking). These treatments were selected because pineapple extract contains bromelain enzymes that may tenderize mussel meat, while pressure cooking is a common household practice to soften tough textures. In addition, indications of changes in nutritional quality and potential costs associated with each treatment were also recorded. The results of the observations were analyzed descriptively to provide an initial overview of the limitations and opportunities for utilizing mussel meat as a food raw material.
3. Data Analysis
   Data obtained from the literature and observations were analyzed qualitatively and descriptively to identify opportunities and constraints in processing *S. woodiana*. The results of the analysis were then used to formulate processing strategies considered suitable for mussel meat characteristics and potentially acceptable to the market. As this study is exploratory in nature, the findings are intended to provide an initial framework for further experimental validation and product development.

RESULTS

Biological and Ecological Context of Mussels

Mussels are a group of freshwater bivalves with a wide distribution in Indonesia, particularly in Java, Sumatra, and Kalimantan (Sahidin *et al.*, 2021). This species is known for its adaptability across a range of elevations (Sahidin *et al.*, 2022) and its high reproductive capacity, which contributes to relatively abundant populations (Arief *et al.*, 2023).

Two common species are *Sinanodonta woodiana* (Taiwan mussel) and *Pilsbryoconcha exilis* (local mussel). Compared to the local mussel, *S. woodiana* exhibits a faster growth rate, larger shell size, and greater tolerance to environmental stress. Biometric analyses in West Java showed that *S. woodiana* has a higher shell height-to-length ratio (0.66 ± 0.04) compared to *P. exilis* (0.50 ± 0.03), as well as a larger shell width-to-length ratio (0.44 ± 0.05 vs. 0.23 ± 0.02), confirming its relatively larger body size (Arief *et al.*, 2023). These invasive traits allow the species to dominate aquatic habitats if left unmanaged, posing ecological challenges such as competition for space and food, and potential exclusion of native mussels (Arief *et al.*, 2023; Mehler *et al.*, 2024; Bielen *et al.*, 2016).

On the other hand, *S. woodiana* also holds significant economic potential, particularly as a raw material for freshwater pearl production. Previous studies have shown that this species possesses high-quality nacre, making it a promising candidate for development as a high-value commodity (Sahidin *et al.*, 2022; Arief *et al.*, 2023). If pearl aquaculture expands on a large scale in the future, it will likely generate substantial by-products in the form of mussel meat.

Therefore, understanding the biology and ecology of mussels is not only essential for conservation but also serves as a foundation for prospective utilization strategies of their by-products through innovative, competitive food product development.

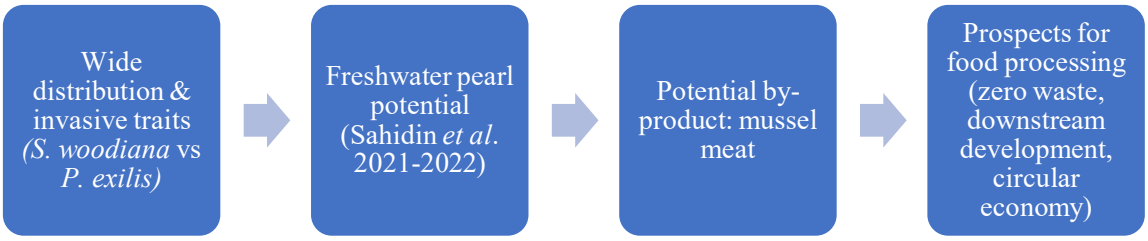

Figure 1. Biological and ecological context of freshwater mussels.
Sinanodonta woodiana has invasive traits and a wider distribution compared to *Pilsbryoconcha exilis*, while also holding economic potential through freshwater pearl aquaculture. If pearl aquaculture is developed on a large scale in the future, it will generate substantial by-products in the form of mussel meat. The utilization of these by-products through food processing innovation has the potential to support the zero-waste concept and promote downstream fishery product development.

Review of Previous Studies on Mussel Processing

The nutritional aspect of mussels serves as an important foundation in assessing their feasibility as an alternative food source. In terms of nutritional composition, fresh Taiwan mussels have relatively higher protein levels compared to local mussels (Konieczny *et al.*, 2022; Nurjanah *et al.*, 2020), while their carbohydrate, fat, and ash contents also support their potential as a nutritious food source.

Efforts to utilize mussels as food ingredients have been carried out through various product innovations. Over the past decade, several studies have reported the processing of mussel meat into surimi (Stangierski *et al.*, 2018), meatballs, nuggets, shredded meat (abon), fresh noodles, crackers, tortillas, and steamed buns (bakpao) (Ghazali *et al.*, 2015; Mustaring *et al.*, 2020; Temba *et al.*, 2023; Nur'aini *et al.*, 2019; Hasan *et al.*, 2019; Adam *et al.*, 2022). This diversification demonstrates that mussels can be developed into a variety of food forms already familiar to Indonesian consumers.

Nevertheless, most mussel-based products remain limited to laboratory-scale or small-scale MSMEs, and only a few have reached modern markets such as retail outlets. Several sensory evaluations and nutritional analyses have shown fairly good acceptance (Ghazali *et al.*, 2015; Mustaring *et al.*, 2020; Adam *et al.*, 2022), yet their sustainable development appears to be less than optimal.

A summary of mussel-based processed products that have been studied, their quality test results, and the main constraints is presented in Table 1.

Table 1. Prospects and Challenges of Mussel-Based Processed Products Based on Previous Studies

Product	Advantages	Classic Technical Constraints	By-product Absorption Capacity	Technology	Nutritional Loss	Market Opportunities & Sustainability	Downstream Status	Development Recommendation (*)	References
Meatball	Familiar, widely preferred, simple technology	Chewy texture, low yield	Medium	Low	Medium	Medium	Lab/SME-scale trials	Recommended (high)	Ghazali *et al.*, 2015
Nugget	Practical, popular for families/children, frozen food retail friendly	Negative image, weak branding	Medium	Medium	Medium	Medium–High	Lab-scale trials	Recommended (very promising)	Radikal & Janika (2015)
Fresh Noodles	Familiar, easy to process	Low yield, negative perception	Low	Low	Low	Low	Lab-scale trials	Not recommended	Hasan *et al.*, 2019
Steamed Bun (*Bakpao*)	Innovative, attractive visual appeal	Chewy texture, negative perception	Low	Low	Low	Low	Campus-scale trials	Not recommended	Adam *et al.*, 2022
Crackers	Crispy snacks, popular in Indonesia	Low yield, low nutritional value	Low	Low	High	Medium	Lab-scale trials	Not recommended	Mustaring *et al.*, 2020; Hasan *et al.*, 2019
Shredded Meat (*Abon*)	Long shelf life, savory	Low yield, negative perception	Medium	Medium	High	Low	Small-scale trials	Not recommended	Nur'aini *et al.*, 2020
Surimi	Multifunctional, high absorption capacity	Expensive technology, limited B2B market	High	High	Medium	Low	Lab-scale trials	Not recommended (for Indonesia)	Stangierski *et al.*, 2018

(*)**Note:** The development recommendations in this table are based on the authors' analysis of the potential for downstream application in the context of the modern Indonesian market. These categories are not intended to evaluate the quality of previous studies, but rather to provide strategic guidance for future development.

Based on Table 1, several consistent constraints can be identified, including the chewy texture of mussel meat, relatively low meat yield, limited consumer acceptance, and the absence of products that have reached downstream commercialization. These issues collectively explain why mussel-based processed products have yet to penetrate modern markets and remain relatively unfamiliar to consumers.

The literature also reports variations in mussel meat yield. Biometric estimates indicate that the yield of both local mussels (*P. exilis*) and Taiwan mussels (*S. woodiana*) ranges between 30–34% of total body weight (Arief *et al.*, 2023). However, compositional analysis by Nurjanah *et al.,* (2020) found a lower fresh meat yield of around 20%, while actual processing into mussel *abon* by Nur'aini *et al.,* (2020) resulted in a final yield as low as 8%.

Preliminary observations on Taiwan mussels support these findings. Experimental results showed that the meat tends to become chewy even after brief heating, although cooking loss remains within a normal range. Tenderization treatment using pineapple extract soaking softened the texture but was accompanied by considerable mass loss, consistent with findings by Falahuddin *et al.,* (2022) in duck meat and Tasirin *et al.,* (2025) in muscovy duck meat. Pressure cooking also resulted in softer meat but carried a high risk of nutrient loss and produced a less familiar product form for consumers.

These observations collectively provide a factual basis for understanding the physical characteristics, limitations, and preliminary processing responses of *S. woodiana* meat. Importantly, they also suggest that intensive tenderization treatments are less suitable for downstream development. Therefore, future product strategies should emphasize **minimal processing approaches** that preserve the natural chewy texture of mussels while maintaining

nutritional value. In this regard, the findings serve as a foundation for interpreting the downstream development challenges discussed in the following section.

DISCUSSION

Challenges in the Downstream Development of Mussel-Based Products

The development of mussel-based products faces multiple complex challenges encompassing technical, social, economic, and market dimensions, all of which influence the success of transitioning from raw material to market-ready products.

From a technical perspective, the development of mussel-based products encounters several major obstacles. Mussel meat tends to become tough after cooking and has a relatively low yield, which complicates processing. At the same time, overly long processing may reduce nutritional quality, particularly protein and mineral content, thereby diminishing the added value of the product. This aligns with findings that excessive heating can cause structural changes in muscle proteins, leading to reduced nutritional quality, especially in terms of protein and mineral levels (Tamilmani & Pandey, 2015).

From a socio-economic perspective, mussels are still often perceived as dirty organisms or merely as animal feed rather than as human food. Although specific studies on mussels are limited, research on freshwater clams has shown that consumer purchase intention is influenced by social factors such as product cleanliness, family acceptance, and perceived risk, which in turn affect economic decisions to purchase or not (Acebrón & Dopico, 1999). Furthermore, public awareness of the potential of mussels as food remains low, with people generally valuing fish more highly than mussels (Expósito-Granados *et al.*, 2024). Other studies on bivalves have also found that consumer perception is heavily influenced by handling practices and food safety concerns, such as contamination risks during storage or processing (Crovato *et al.*, 2019). In addition, consumer concerns about mussel food safety are likely influenced by environmental issues, including heavy metal pollution and habitat degradation (Zieritz *et al.*, 2016).

Studies on bivalve consumption highlight significant barriers to market acceptance, including price, convenience, and sensory perceptions of taste, aroma, and texture, while nutritional and product quality remain the main drivers (Gawel *et al.*, 2023). Consumers tend to be more receptive to bivalves when they are processed into modern, “highly transformed” products and are willing to pay more for food that is attractive, healthy, and practical. Nevertheless, mussel-based products still face market challenges due to weaker branding, limited distribution, and low consumer familiarity compared to other processed meat products.

Currently, there are no business models or MSME units that have successfully developed mussel-based products sustainably. Limitations in technology, lack of promotion, and low market interest have caused most products to remain at the trial stage. Operational barriers are similar to those faced by freshwater shellfish fisheries in developing markets, including limited transportation, inadequate market facilities, and uneven profit distribution between producers and traders (Lako *et al.*, 2019). Downstream challenges also include hygienic processing and packaging, limited knowledge of food safety, and the lack of product certification and promotion. Potential solutions include hygienic training for MSME actors, financial support, the development of value-added products, improvement of market facilities, promotional efforts to stimulate demand, and the implementation of certification or food safety standards (Lako *et al.*, 2019).

Overall, downstream challenges highlight the gap between the potential and the actual utilization of mussels as food. Technical constraints, consumer perceptions, limited absorption capacity of by-products (mussel meat), and technological requirements that do not align with MSME contexts all restrict the sustainability of mussel product development in the market. These challenges emphasize the need for processing approaches that are technically feasible, socially acceptable, and market-oriented. In this context, the following subsection explores

alternative processing methods that may better align with the characteristics of mussel meat and the Indonesian market.

Prospects of Potential Processing Methods (Proposed)

The selection of processing methods for mussels needs to consider two main aspects: the characteristics of the raw material and modern consumer preferences. The meat of *Sinanodonta woodiana* tends to become tough after heating, is prone to shrinkage, and has a relatively low yield, which presents challenges in product formulation. On the other hand, contemporary consumers prefer processed products that are practical, nutritious, and familiar in the market. Therefore, processing approaches should remain simple, ensure nutrient retention, and improve sensory acceptance so that mussels can gain added value and downstream opportunities.

Based on literature review and preliminary observations, two product ideas are considered prospective for further development:

1. Crispy Whole Mussels

This product offers the advantage of contrasting textures, with a crispy outer layer and juicy interior. The processing method may involve a preliminary treatment such as marination to tenderize the meat, followed by seasoned flour coating and quick frying. This concept aligns with the trend of seafood-based snacks, targeting households as well as café and street food markets. In addition, the raw material absorption capacity is relatively high because the whole mussel is used, supporting the circular economy concept.

2. Frozen Ready-to-Cook Mussels

This product consists of whole mussel meat that has been cleaned and undergone preliminary treatment (brief blanching and light marination), then frozen and packaged. Consumers can directly prepare it according to their preference (stir-fried, fried, or cooked in soup). This product fits the trend of ready-to-cook seafood in modern markets, with strong potential for retail penetration due to its practicality, hygiene, and flexibility.

A summary of the prospects of the two proposed products is presented in Table 2.

Table 2. Prospective Products Based on Taiwanese Mussel (*Sinanodonta woodiana*)

Proposed Product	Processing Form	Target Market	By-Product Utilization Level	Technology	Market Potential	Status
1. Crispy Whole Mussels	Whole mussel meat coated with seasoned flour, ready-to-fry/frozen	Households & café/street food	Medium–high	Low	Medium–high	Proposed
2. Frozen Ready-to-Cook Mussels	Whole mussel meat (pre-cooked/cleaned, frozen)	Households & restaurants	High	Low	High	Proposed

Both of these concepts are still at the idea stage and require validation through further research. However, the rationale based on raw material characteristics and consumption trends provides a strong foundation that these methods are promising for further development. With the right approach, mussel-based products can be directed toward competitive downstream applications while also supporting the sustainable utilization of by-products from freshwater pearl aquaculture under the zero-waste concept.

Overall, four mussel-based products are considered the most prospective for further development: mussel meatballs and mussel nuggets (existing products that have been extensively studied), as well as the two new ideas proposed in this article, namely frozen ready-to-cook mussels and crispy mussels. The selection of these four products is based on technical feasibility, by-product absorption potential, technological simplicity, and market opportunities.

Meatballs and nuggets remain relevant because they are already familiar to consumers and hold potential for modern retail markets with proper branding strategies. Meanwhile, frozen ready-to-cook mussels and crispy mussels are proposed as new alternatives emphasizing convenience, nutrient retention, and sensory experiences more aligned with modern consumer preferences. To provide a clearer overview, the main processing flows of these four prospective products are illustrated schematically in Figure 2.

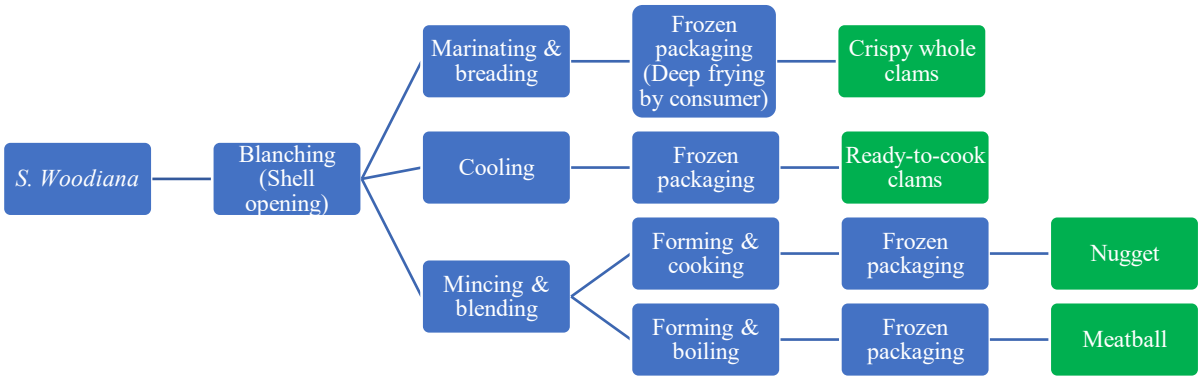

Figure 2. Flowchart of prospective processing concepts for *S. woodiana*.
Blanching is applied for shell opening, followed by three main processing pathways leading to four potential products: crispy clams, ready-to-cook clams, nuggets, and meatballs. Blue boxes indicate processing steps, while green boxes represent final products.

CONCLUSION

The Chinese pond mussel (*Sinanodonta woodiana*) demonstrates strong potential as a value-added food resource, particularly through the utilization of by-products from freshwater pearl aquaculture. Although various mussel-based products, such as meatballs, nuggets, noodles, shredded meat, crackers, and steamed buns have been tested, none have successfully penetrated modern retail markets. This emphasizes the need for more targeted and downstream-oriented processing strategies. Four products are considered most promising for further development: mussel meatballs, mussel nuggets, frozen ready-to-cook mussels, and crispy mussels, selected based on raw material characteristics, absorption potential, technological simplicity, and market opportunities. Overall, these findings highlight the importance of developing simple yet effective processing methods that preserve the distinctive texture of mussels and enhance sensory acceptance, enabling greater market readiness and supporting the sustainable utilization of freshwater pearl aquaculture by-products within a zero-waste framework.

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REFERENCES

Acebrón, L. B., & Dopico, D. C. (1999). Attitudes Towards Buying Fresh Mussels. *Journal of Food Products Marketing, 5*(3), 49–63. https://doi.org/10.1300/J038v05n03_06

Adam, A., Mas'ud, H., & Kamila, A. (2022). Daya Terima Serta Analisis Zat Besi dan Protein Bakpao Substitusi Tepung Kerang Lokal (*Pilsbryoconcha exilis*) dengan Isian Pasta Kacang Merah (*Phaseolus vulgaris* L.). *Media Gizi Pangan, 29*(2), 1–10. https://doi.org/10.32382/mgp.v29i2.3107

Arief, M. C. W., Sahidin, A., Apriliani, I. M., Nurruhwati, I., Zahidah, Z., Muhammad, G., & Komaru, A. (2023). Native Indonesian Pond Mussel (*Pilsbryoconcha exilis*) and Alien *Sinanodonta woodiana*: The Potential Effect on the Future Conservation and Economic Benefit. *AACL Bioflux, 16*(2), 1192–1204. Retrieved from http://www.bioflux.com.ro/aacl

Bielen, A., Bošnjak, I., Sepčić, K., Jaklič, M., Cvitanić, M., Lušić, J., Lajtner, J., Simčič, T., & Hudina, S. (2016). Differences in Tolerance to Anthropogenic Stress Between Invasive and Native Bivalves. *Science of the Total Environment, 543*(Part A), 449–459. https://doi.org/10.1016/j.scitotenv.2015.11.049

Crovato, S., Pinto, A., Mascarello, G., Marcolin, S., & Ravarotto, L. (2019). From Purchase to Consumption of Bivalve Molluscs: A Qualitative Study in the Veneto Region, Italy. *Food Control, 106*, 106700. https://doi.org/10.1016/j.foodcont.2019.06.007

Douda, K., Zieritz, A., Vodáková, B., Urbańska, M., Bolotov, I. N., Marková, J., Froufe, E., Bogan, A. E., & Lopes-Lima, M. (2025). Review of the Globally Invasive Freshwater Mussels in the Genus *Sinanodonta* Modell, 1945. *Hydrobiologia, 852*, 1243–1273. https://doi.org/10.1007/s10750-023-05457-3

Expósito-Granados, M., Vaughn, C. C., Quintas-Soriano, C., & Castro, A. J. (2024). Valuing Ecosystem Services of Freshwater Mussels and Fish. *Human Dimensions of Wildlife*. Advance online publication. https://doi.org/10.1080/10871209.2024.2429427

Falahudin, A. A., Somanjaya, R., & Suardi, F. S. (2022). Pengaruh Marinasi Ekstrak Buah Nanas (*Ananas comosus*) terhadap Sifat Fisik dan Organoleptik Daging Itik Rambon Afkir. *Agrivet: Jurnal Ilmu Pertanian dan Peternakan, 10*(1), 1–9. https://doi.org/10.31949/agrivet/v10i1.2614

Gawel, J. P. F., Aldridge, D. C., & Willer, D. F. (2023). Barriers and Drivers to Increasing Sustainable Bivalve Seafood Consumption in a Mass Market Economy. *Food Frontiers, 4*, 1257–1269. https://doi.org/10.1002/fft2.282

Ghazali, T. M., Desmelati, & Karnila, R. (2015). Pemanfaatan Daging Kijing Air Tawar (*Pilsbryoconcha exilis*) pada Pembuatan Bakso terhadap Penerimaan Konsumen. *Student Online Journal Riau, 2*(2), 1–10.

Hasan, B., Iriani, D., Sari, N. I., Warningsih, T., Suzanti, F., & Septyanti, E. (2019). Pembinaan Usaha Pengolahan dan Pemasaran Produksi Kijing di Desa Sungai Paku Kecamatan Kampar Kiri, Kampar. *UNRI Conference Series: Community Engagement, 1*, 477–485. https://doi.org/10.31258/unricsce.1.477-485

Kalesaran, O. J., & Lumenta, C. (2021). Analysis of Scanning Electron Microscopy on *Sinanodonta (Anodonta) woodiana* Nacre (Lea, 1834). *Journal of Aquaculture and Fish Health, 10*(1), 1–10. https://doi.org/10.20473/jafh.v10i1.19567

Konieczny, P., Andrzejewski, W., Yang, T., Urbańska, M., Stangierski, J., Tomczyk, Ł., & Mikołajczak, B. (2022). Selected Quality Attributes of Freshwater Mussel Powder as a Promising Ingredient for Pet Food. *Animals, 12*(1), 90. https://doi.org/10.3390/ani12010090

Konieczny, P., Tomaszewska-Gras, J., Andrzejewski, W., Mikołajczak, B., Urbańska, M., Mazurkiewicz, J., & Stangierski, J. (2016). DSC and Electrophoretic Studies on Protein

Denaturation of *Anodonta woodiana* (Lea, 1834). *Journal of Thermal Analysis and Calorimetry, 126*(1), 69–75. https://doi.org/10.1007/s10973-016-5707-0

Lako, J., Kuridrani, N., & Sobey, M. (2019). Freshwater Mussel (*Batissa violacea*) Fishery and Its Value in Fiji. *The Journal of Pacific Studies, 39*(1), 192–215. https://doi.org/10.33318/jpacs.2019.39(1)-08

Mehler, K., Labecka, A. M., Sîrbu, I., Flores, N. Y., Leuven, R. S. E. W., & Collas, F. P. L. (2024). Recent and Future Distribution of the Alien Chinese Pond Mussel *Sinanodonta woodiana* (Lea, 1834) on the European Continent. *Aquatic Invasions, 19*(1), 51–72. https://doi.org/10.3391/ai.2024.19.1.114856

Mustaring, H., Patang, & Mustarin, A. (2020). Pemanfaatan Kerang Kijing (*Pilsbryoconcha exilis*) sebagai Bahan Baku dalam Pembuatan Kerupuk. *Jurnal Pendidikan Teknologi Pertanian, 6*(2), 151–162.

Nur'aini, H., Ishar, I., & Darius, I. (2019). Innovation of Abon Lokan (*Pilsbryoconcha exilis*) Processing Using Tebu Telu (*Saccharum edule*) Substitution. *Agritepa, 6*(1), 13–15.

Nurjanah, N., Jacoeb, A. M., & Hidayat, T. (2020). Perubahan Komposisi Kimia Kijing Lokal (*Pilsbryoconcha exilis*) Segar dan Kukus. *Marinade, 3*(2), 148–159. Retrieved from http://ojs.umrah.ac.id/index.php/marinade

Radikal, & Janika, R. (2015). Processing of Gravestone Nugget (*Pseudodon vandenbushianus*) with Gravestone Meat Concentration and Yellow Pumpkin (*Cucurbita moschara*). *Agritepa, 1*(2), 1–10.

Sahidin, A., Muhammad, G., Hasan, Z., Arief, M. C. W., & Komaru, A. (2022). Color Profile and Microstructure of the Nacre Shell of an Invasive Freshwater Mussel, *Sinanodonta woodiana*, at Different Elevations in West Java, Indonesia. *Aquaculture, 553*, 738068. https://doi.org/10.1016/j.aquaculture.2022.738068

Sahidin, A., Muhammad, G., Hasan, Z., Arief, M. C. W., Marwoto, R. M., & Komaru, A. (2021). Indonesian Freshwater Bivalves: A Meta-Analysis of Endemicity, Ecoregion Distributions, and Conservation Status. *AACL Bioflux, 14*(6), 3750–3775. Retrieved from http://www.bioflux.com.ro/aacl

Stangierski, J., Andrzejewski, W., Tomaszewska-Gras, J., Grześ, B., Konieczny, P., & Urbańska, M. (2018). Effect of Washing on the Quality of Surimi-Like Preparation Obtained from Soft Tissue of Freshwater Mussel *Sinanodonta woodiana* (Lea, 1834). *Journal of Aquatic Food Product Technology, 27*(10), 1091–1102. https://doi.org/10.1080/10498850.2018.1518360

Surono, S., Nisvera, M., & Rahayu, S. Y. S. (2023). Potensi Kijing Lokal (*Pilsbryoconcha exilis*) sebagai Biofilter terhadap Penurunan Kadar Sianida (CN). *Ekologia: Jurnal Ilmiah Ilmu Dasar dan Lingkungan Hidup, 23*(1), 34–40.

Tamilmani, P., & Pandey, M. C. (2015). Thermal Analysis of Meat and Meat Products: A Review. *Journal of Thermal Analysis and Calorimetry, 123*(6), 1899–1917. https://doi.org/10.1007/s10973-015-4696-8

Tasirin, T., Utami, E. T. W., & Adyatama, A. (2025). Pengaruh Lama Marinasi Kombinasi Sari Pati Buah Nanas dan Pepaya terhadap Sifat Fisik dan Organoleptik Daging Entok (*Cairina moschata*). *Jurnal Teknologi Hasil Peternakan, 6*(1), 27–42. https://doi.org/10.24198/jthp.v6i1.60707

Temba, O. R., Tega, Y. R., & Ndahawali, S. (2023, January 27–28). Pemanfaatan Kerang Kijing (*Pilsbryoconcha exilis*) dalam Pembuatan Nugget. In *1st National Seminar on Sustainable Agricultural Technology Innovation (SATI)* (pp. 161–167). Universitas Kristen Wira Wacana Sumba, Fakultas Sains dan Teknologi. Retrieved from https://ojs.unkriswina.ac.id/index.php/semnas-FST

Zieritz, A., Lopes-Lima, M., Bogan, A. E., Sousa, R., Walton, S., Rahim, K. A. A., Wilson, J.-J., Ng, P.-Y., Froufe, E., & McGowan, S. (2016). Factors Driving Changes in

Freshwater Mussel (Bivalvia, Unionida) Diversity and Distribution in Peninsular Malaysia. *Science of the Total Environment, 572*, 1371–1382. https://doi.org/10.1016/j.scitotenv.2016.07.098