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Nutritional Potential and Food Safety Aspects of Gonggong Snails (family *Strombidae*) as Sustainable Local Marine Protein Sources: A Narrative Literature Review

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Abstract

Gonggong snails belonging to the family Strombidae have potential as sustainable local marine protein sources and functional foods. This study aimed to synthesize scientific evidence regarding the nutritional potential and food safety aspects of gonggong snails through a narrative literature review approach. A narrative review was selected due to the limited and fragmented nature of available studies across ecology, fisheries, nutrition, and food safety disciplines. Literature searches were conducted using Google Scholar, ScienceDirect, and PubMed databases for publications published between 2015 and 2025. The search strategy used combinations of keywords related to species identification, nutritional composition, bioactive compounds, and food safety. A total of 1,271 articles were initially identified, and eight studies fulfilled the inclusion criteria after screening and qualitative evaluation. Existing evidence indicates that gonggong snails contain relatively high protein levels, reaching approximately 54% based on proximate analysis, and possess bioactive compounds with antimicrobial activity against Staphylococcus aureus and Escherichia coli. Several studies also reported the presence of contaminants such as lead (Pb), cadmium (Cd), and microplastics, indicating potential food safety concerns associated with environmental exposure. However, comprehensive nutritional profiling, including amino acid composition, micronutrients, and nutrient bioavailability, remains limited. Overall, gonggong snails possess strong potential as sustainable marine protein sources and functional foods; however, integrated nutritional evaluation, contaminant monitoring, and food safety assessment are urgently needed to support their safe and sustainable utilization.

Keywords: *family Strombidae, bioactive compounds, food safety, gonggong snail, local protein source*

1. BACKGROUND

Indonesia possesses extensive coastal and marine biodiversity, including various economically important marine organisms such as mollusks, crustaceans, fish, algae, and coral reef-associated species. These marine resources play an important role in supporting food security and the livelihoods of coastal communities (Anugrah & Alfarizi, 2021). Among them, mollusks are considered ecologically abundant and economically valuable marine resources (Uneputty et al., 2022) that are widely utilized as seafood in many coastal regions (Khan & Liu, 2019).

Marine gastropods have long been recognized as potential food resources due to their relatively high nutritional value, containing considerable amounts of protein, essential fatty acids, minerals, and bioactive compounds that may provide health benefits (Tan et al., 2021; Venugopal & Gopakumar, 2017). One of the marine gastropods commonly consumed in Indonesia is the gonggong snail, reported in the literature under different taxonomic names including *Strombus canarium* and *Laevistrombus turturella*, reflecting ongoing taxonomic revisions within the Strombidae family (Maxwell et al., 2019). This review therefore refers to gonggong snails within the family Strombidae, encompassing studies identifying the species under either name. These gastropods are commonly found in the waters of the Riau Archipelago, particularly around Bintan Island and Tanjungpinang (Muzahar et al., 2022a), and hold considerable cultural and economic significance as a local fishery commodity.

From a nutritional perspective, the increasing global demand for protein — driven by population growth and changing dietary patterns — underscores the importance of identifying sustainable and locally accessible protein resources (Henchion et al., 2017; Colgrave et al., 2021). Studies on hemolymph characteristics and semi-artificial spawning techniques suggest that Laevistrombus

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turturella also has potential for aquaculture development (Muzahar et al., 2022a; Viruly et al., 2019c), which may support sustainable production and reduce pressure on wild populations.

From a food safety perspective, however, gonggong snails inhabit benthic coastal ecosystems and exhibit detritivorous feeding behavior, characteristics that increase their susceptibility to contaminant accumulation including heavy metals and microplastics (El-Sharkawy et al., 2025). Despite their ecological and nutritional relevance, food safety evaluation of gonggong snails has not been comprehensively addressed in existing literature.

Several studies have investigated specific aspects of gonggong snails, including habitat characteristics (Supratman et al., 2019), ecological distribution (Nezaputri et al., 2021), nutritional composition (Darmawanto et al., 2022; Rasyid & Dody, 2018), bioactive compounds (Viruly et al., 2019b; Viruly et al., 2023), and processed food development (Tumpuan, 2020; Mulyadi & Sari, 2022). However, these studies remain fragmented and discipline-specific. No existing study has integrated ecological characteristics, detailed nutritional profiling — including amino acid composition, mineral content, and bioavailability — with systematic food safety assessment. This represents a critical gap, particularly given the growing interest in promoting gonggong snails as sustainable local marine protein sources.

Therefore, this narrative review aims to synthesize and critically analyze existing evidence on the ecological characteristics, nutritional potential, and food safety aspects of gonggong snails (family Strombidae), with the goal of providing a more integrated understanding of their potential as sustainable local marine protein sources and identifying priority areas for future research.

2. METHOD

2.1. Study Design

This study was conducted using a narrative literature review approach to synthesize scientific evidence regarding the nutritional potential and food safety aspects of gonggong snails (family Strombidae) as local marine protein sources. A narrative review approach was selected due to the limited and fragmented nature of available studies, which are dispersed across multiple disciplines, including ecology, food science, fisheries, and aquaculture. This approach enables a flexible and integrative synthesis to provide a broader understanding of both nutritional value and food safety concerns associated with gonggong snails. A narrative review approach was considered more appropriate than a systematic review because the currently available evidence remains limited, heterogeneous, and dispersed across multiple disciplines, making quantitative synthesis difficult.

2.2 Literature Search Strategy

Literature searches were conducted using three scientific databases: Google Scholar, ScienceDirect, and PubMed, covering publications from 2015 to 2025 to capture both foundational and recent studies relevant to the topic.

The search strategy employed a thematic approach organized around four main topics: (1) species identification, (2) nutritional composition, (3) bioactive compounds, and (4) food safety. Keywords and Boolean combinations applied across all three databases are summarized in Table 1.

Initial searches were performed using these keyword combinations. Relevant articles were subsequently screened based on titles and abstracts. A snowballing technique was also applied by examining reference lists and citation trails of selected articles to identify additional relevant studies not captured in the initial database search.

Duplicate articles identified across databases were removed manually prior to screening. Although formal quality assessment tools were not applied, methodological clarity, relevance to the review objectives, and availability of primary data were considered during article selection.

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Table 1. Keywords and Search String Examples Used Across Databases

Theme	Keywords	Example Search String
Species identification	*Strombus canarium*, *Laevistrombus turturella*, gonggong, dog conch	(*'Strombus canarium'* OR *'Laevistrombus turturella'* OR 'gonggong' OR 'dog conch')
Nutritional composition	Nutritional composition, protein, proximate composition, functional food	('gonggong' OR 'dog conch') AND ('protein' OR 'nutritional composition' OR 'proximate composition' OR 'functional food')
Bioactive compounds	Bioactive, antimicrobial peptide, antimicrobial activity	('Strombus canarium' OR 'Laevistrombus turturella') AND ('bioactive' OR 'antimicrobial peptide')
Food safety	Heavy metal, food safety, contamination, microplastic	('gonggong' OR 'dog conch') AND ('heavy metal' OR 'food safety' OR 'microplastic' OR 'contamination')

2.3 Inclusion and Exclusion Criteria

Articles were included if they met all of the following criteria: (1) published in peer-reviewed journals or reputable academic sources; (2) focused on gonggong snails belonging to the family Strombidae, particularly studies referring to Strombus canarium, Laevistrombus turturella, or related strombid gastropods; and (3) discussed at least one of the following aspects: nutritional composition, bioactive compounds, food safety, or relevance as sustainable marine protein sources. Only full-text articles were included to ensure comprehensive evaluation.

Articles were excluded if they were not directly related to marine gastropods as food sources, lacked sufficient methodological details, consisted solely of review papers without primary data, or were duplicate publications.

2.4 Article Selection Process

The overall selection process is presented in Figure 1, structured following a PRISMA-informed flow diagram. The initial search identified 1,271 articles across the three databases. After removal of duplicates, 910 articles remained and proceeded to title and abstract screening. Following this stage, 145 articles were identified as potentially relevant and evaluated through full-text review. Articles that did not meet the study objectives or lacked adequate methodological detail were excluded at this stage. Ultimately, eight studies fulfilled all inclusion criteria and were qualitatively analyzed.

2.5 Data Extraction and Analysis

Data from the selected articles were extracted and grouped into the following thematic categories: (1) ecological distribution and habitat characteristics, (2) nutritional composition, (3) bioactive compounds, (4) food safety concerns, and (5) potential utilization as food sources.

Extracted data were analyzed qualitatively using a thematic synthesis approach. Findings from individual studies were categorized based on recurring themes to identify similarities, differences, and inconsistencies across studies. Particular attention was given to identifying research gaps, especially regarding the integration of nutritional evaluation and food safety assessment. The selected studies and their key findings are summarized in Table 2.

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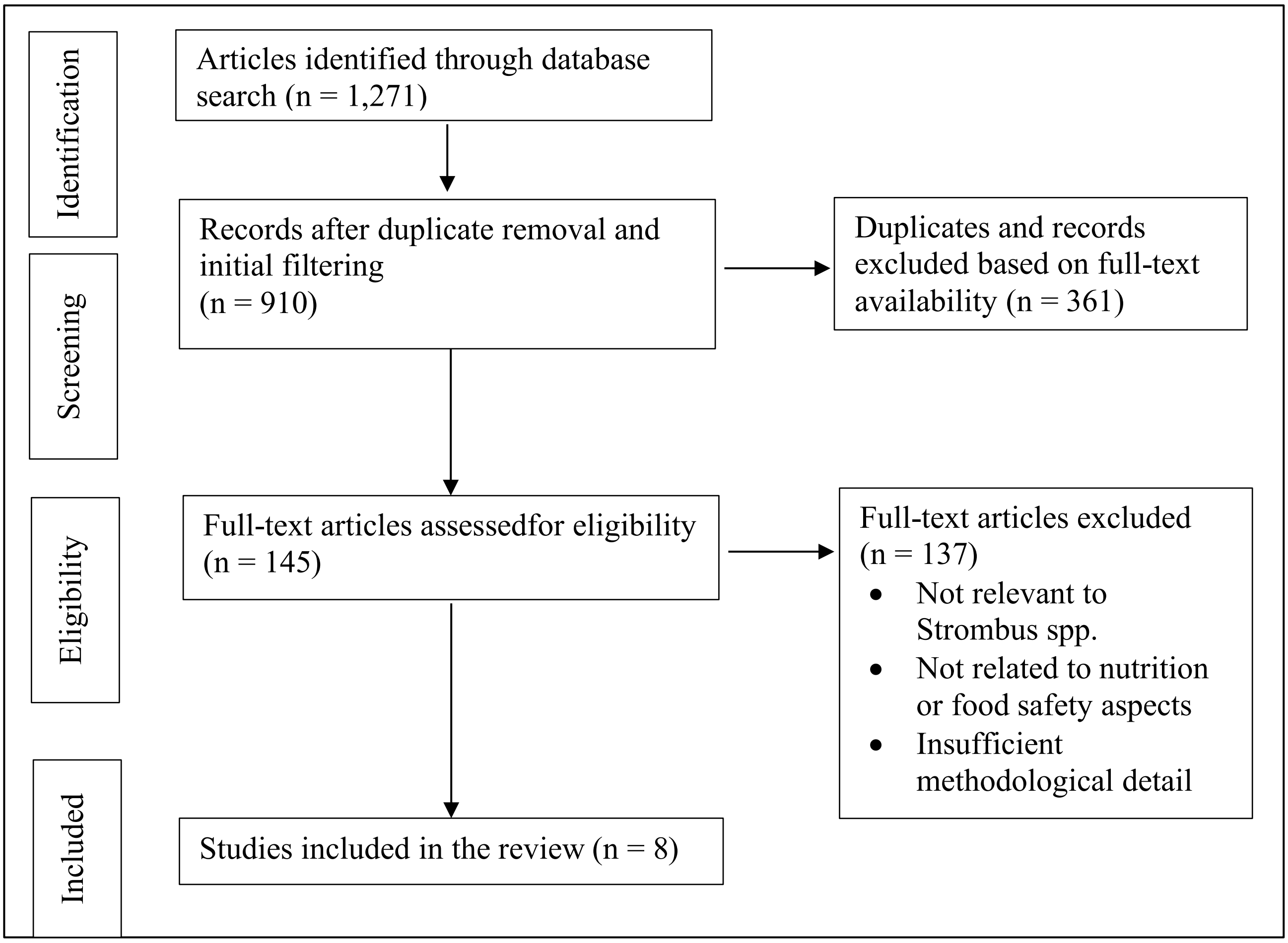

Figure 1. PRISMA-informed flow diagram of literature search and selection process

Table 2. Selected Studies on the Nutritional Composition, Food Safety, and Utilization of Gonggong Snails (family Strombidae)

Title	Author (Year)	Study Design	Result	Limitation
Protein Histon Pada Siput Gonggong Bintan *Strombus* sp. Sebagai Kandidat Pangan Fungsional	Viruly et al. (2019b)	Experimental laboratory study (protein characterization and antimicrobial assay)	Histone proteins (H2A and H2B) were identified in gonggong snail with molecular weights of 11–37 kDa. The extracts exhibited antimicrobial activity against *Staphylococcus aureus* (25.65±0.02 mm) and *Escherichia coli* (14.45±0.13 mm), indicating potential as a functional food source	Limited to protein characterization and antimicrobial assay; no nutritional analysis, bioavailability, or food safety evaluation
Edible Portion dan Komposisi Proksimat Siput Gonggong (*Strombus* Sp.)	Darmawanto, et al. (2022)	Laboratory experimental study (proximate composition analysis)	Protein 54%, fat 5.41%, moisture 14.11%, ash 3.79%, carbohydrates 22.68% (dry weight basis); edible portion 5.02–6.79%.	Proximate analysis only; no amino acid profiles, mineral content, bioactive compounds, or

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Title	Author (Year)	Study Design	Result	Limitation
Dari Perairan Wawonii				food safety evaluation
Evaluation of the nutritional value and heavy metal content of the dried marine gastropod *Laevistrombus turturella*	Rasyid & Dody (2018)	Laboratory experimental study (nutritional and heavy metal analysis)	Appreciable protein content; detectable Pb and Cd levels indicating nutritional potential and contamination risk	Limited sampling area and lack of risk assessment regarding safe consumption thresholds
Identification and characterization of antimicrobial peptide (AMP) candidate from Gonggong Sea Snail (*Laevistrombus turturella*) extract	Viruly et al. (2023)	Experimental laboratory study (molecular characterization and antimicrobial assay)	Antimicrobial peptide candidates identified with inhibitory activity against pathogenic bacteria	Focused on peptide identification only; no nutritional or food safety evaluation
Bioaccumulation of Lead (Pb) on The Dog Conch (*Strombus canarium*) in Madong Waters, Tanjung Pinang	Tirtama et al. (2024)	Field-based observational study with laboratory analysis (heavy metal bioaccumulation assessment)	Pb accumulation detected in *S. canarium* tissues; potential bioindicator of coastal contamination	Limited spatial coverage; no temporal analysis or human health risk assessment
Kandungan Logam (Pb) pada *Strombus canarium* Linnaeus,1758 (Mollusca :*Gastropoda*) di Perairan Malang Rapat dan Tanjung Siambang Provinsi Kepulauan Riau	Askara et al. (2020)	Field sampling and laboratory analysis (heavy metal quantification)	Lead (Pb) was detected in gonggong snail samples from different coastal locations, indicating environmental exposure and potential accumulation in edible tissues.	No comparison against regulatory thresholds or safe consumption assessment.
The Effect of the Use of Organic Acids to Reduce the Levels of Metal Lead (Pb)	Amelia et al. (2024)	Experimental laboratory study (treatment intervention	Organic acids effectively reduced Pb levels in gonggong meat; potential post-harvest mitigation strategy	Limited to Pb reduction only; no assessment of other contaminants,

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Title	Author (Year)	Study Design	Result	Limitation
on The Meat of Gonggong Snails		using organic acids)		nutritional quality, or sensory properties
Microplastic contamination extent on *Strombus* sp. in North Bintan Waters	Idris et al. (2022)	Field-based observational study with laboratory analysis (microplastic identification)	*Strombus* sp. contained microplastic particles indicating exposure to emerging contaminants in coastal environments.	No human health risk assessment or food safety implications evaluated

Taxonomic names are presented as reported in the original studies due to inconsistencies and revisions in the classification of gonggong snails within the family Strombidae.

3. DISCUSSION

3.1. Gonggong Snails as Local Marine Food Resources

Synthesis of findings

Gonggong snails inhabit seagrass-associated coastal ecosystems, which serve as feeding grounds and substrates supporting their growth and availability as marine food resources (Supratman et al., 2019). Ecological studies report that gonggong snails tend to exhibit a clustered distribution pattern with relatively low abundance in seagrass habitats (Supratman et al., 2019).

Discussion

The dependence of gonggong snails on seagrass ecosystems implies that their availability as food resources is highly sensitive to coastal environmental conditions. Environmental degradation, including pollution, sedimentation, and coastal development, may reduce population stability and long-term availability (Cob & Das, 2021). This condition indicates that the sustainability of gonggong snails as local protein sources cannot be separated from efforts to conserve coastal habitats. Consequently, responsible harvesting practices and seagrass ecosystem protection are essential prerequisites for their sustainable utilization.

3.2. Nutritional Potential of Gonggong Snails

Synthesis of findings

Proximate composition analysis demonstrated that gonggong snails contain relatively high protein levels, reaching approximately 54% on a dry weight basis, accompanied by moderate fat content (±5.41%), moisture levels of around 14.11%, ash 3.79%, and carbohydrates 22.68% (Darmawanto et al., 2022). Considerable protein levels in dried preparations were also reported by Rasyid & Dody (2018). In addition to macronutrients, bioactive compounds including antimicrobial histone proteins (Viruly et al., 2019b) and antimicrobial peptide candidates (Viruly et al., 2023) have been identified, exhibiting inhibitory activity against *Staphylococcus aureus* and *Escherichia coli*.

Discussion

These protein values are comparable to, or even higher than, several commonly consumed marine commodities, as presented in Table 3, highlighting the nutritional potential of gonggong snails as local protein sources (Tan et al., 2021). The presence of antimicrobial bioactive compounds further suggests that gonggong snails may be developed not only as conventional protein sources but also as functional foods (Ngandjui et al., 2024).

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Nevertheless, the currently available evidence remains limited to proximate analysis and identification of specific bioactive compounds. Comprehensive nutritional characterization — including amino acid profiles, fatty acid composition, micronutrient content, and nutrient bioavailability — is still lacking, in contrast to more detailed nutritional characterizations available for other commercially important gastropods (Tan et al., 2021; Warsidah et al., 2024). Furthermore, the influence of environmental and seasonal factors on nutritional variability has not been investigated, representing a significant gap in understanding the actual nutritional value of gonggong snails across different harvesting conditions.

Table 3. Comparison of Protein Content Among Selected Marine Protein Sources

Marine Food Source	Protein Content (%) dry basis	Reference
Gonggong snail (*Strombus* sp.)	54%	Darmawanto et al. (2022)
Oyster (*Crassostrea hongkongensis*)	>52%	Li et al. (2022)
Blue mussel (*Mytilus edulis*)	43–62%	Fernandez et al. (2015)
Gastropods from mangrove ecosystem	36–52%	Warsidah et al. (2024)

These comparisons indicate that gonggong snails possess protein levels comparable to other commercially important marine mollusks, supporting their potential as nutrient-dense local protein sources.

3.3. Feeding Behavior as a Key Mechanism Influencing Nutritional Quality and Contamination.

Synthesis of findings

Laevistrombus turturella exhibits omnivorous feeding patterns, primarily consuming detritus and microalgae including members of Bacillariophyceae and Chlorophyceae, with detritus contributing approximately 65–70% of total dietary intake (Nezaputri et al., 2021; Supratman & Syamsudin, 2016). Lead (Pb) has been detected in gonggong tissues collected from coastal waters of Kepulauan Riau (Askara et al., 2020; Tirtama et al., 2024), consistent with bioaccumulation processes observed in other benthic marine invertebrates (Cayabo et al., 2024).

Discussion

This detritivorous feeding strategy contributes to nutrient accumulation, as detritus contains organic matter rich in microbial biomass and microalgal components, which may partly explain the relatively high protein content reported in gonggong snails (Nezaputri et al., 2021). However, this same ecological mechanism simultaneously increases the risk of contaminant accumulation, since detritus and sediments frequently serve as sinks for environmental contaminants including heavy metals and pathogenic microorganisms (El-Sharkawy et al., 2025). This dual characteristic underscores the importance of evaluating gonggong snails through an integrated approach that considers both nutritional value and food safety aspects simultaneously.

3.4. Food Safety Risks

Synthesis of findings

Several studies have reported the presence of heavy metals in gonggong snail tissues. Lead (Pb) was detected in *Strombus canarium* collected from Madong Waters, Tanjungpinang (Tirtama et al., 2024) and from Malang Rapat and Tanjung Siambang coastal areas (Askara et al., 2020). Cadmium (Cd) levels were also reported in dried preparations of Laevistrombus turturella (Rasyid & Dody, 2018). Experimental evidence further demonstrated that the application of organic acids effectively reduced Pb levels in gonggong snail meat, indicating a feasible post-harvest mitigation strategy (Amelia et al., 2024). In addition, microplastic particles were detected in Strombus sp. collected from North Bintan waters (Idris et al., 2022).

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Discussion

Heavy metals such as mercury (Hg), cadmium (Cd), and lead (Pb) are commonly found in marine ecosystems and may accumulate within gastropod tissues at levels influenced by water quality, sediment characteristics, and anthropogenic activities in coastal areas (El-Sharkawy et al., 2025; Garofalo et al., 2025; Tamele & Vázquez Loureiro, 2020). Notably, none of the included studies compared detected Pb concentrations against applicable regulatory thresholds. In Indonesia, the maximum permissible limit for Pb in fishery products including mollusks is regulated under BPOM Regulation No. 5 of 2018 at 0.5 mg/kg (Badan Pengawas Obat dan Makanan RI, 2018), while SNI 7387:2009 sets a limit of 1.50 mg/kg for bivalve shellfish (Badan Standardisasi Nasional, 2009). Internationally, the Codex Alimentarius CXS 193-1995 establishes a maximum level of 0.3 mg/kg for lead in fish (Codex Alimentarius Commission, 2024). The absence of such comparisons in existing studies represents a critical gap, as it prevents definitive conclusions regarding the actual health risk posed to consumers from specific harvesting locations.

Although no included study specifically evaluated microbiological contamination in gonggong snails, marine gastropods are generally susceptible to contamination by pathogenic microorganisms such as *Vibrio* spp., *Salmonella*, and *Escherichia coli*, particularly in polluted coastal environments (Venugopal & Gopakumar, 2017; Roy et al., 2024). Post-harvest handling, storage, and processing practices also play significant roles in determining microbiological safety.

Regarding emerging contaminants, the detection of microplastics in *Strombus* sp. indicates exposure to anthropogenic pollution through sediment and feeding interactions (Idris et al., 2022). Beyond physical contamination, microplastics may act as carriers of toxic chemicals and microorganisms, potentially compounding food safety concerns (Alberghini et al., 2022). However, the health implications of microplastic exposure through gonggong snail consumption remain poorly characterized and warrant dedicated investigation.

3.5. Implications as Sustainable Protein Sources

Synthesis of findings

Gonggong snails are locally available and culturally accepted in the Kepulauan Riau region (Samsi & Rusmidin, 2024; Mulyadi & Sari, 2022). Their meat has been successfully developed into value-added processed products including sausages (Mulyadi & Sari, 2022) and siomay (Tumpuan, 2020), demonstrating acceptable sensory properties and consumer acceptance.

Discussion

The combination of high protein content, bioactive properties, local availability, and cultural acceptance supports the potential of gonggong snails for food diversification and regional food security enhancement (Middleton et al., 2025). However, their dependence on seagrass habitats makes them vulnerable to environmental degradation (Pruckner et al., 2022), and their benthic feeding behavior increases susceptibility to contaminant accumulation. These characteristics indicate that the development of gonggong snails as sustainable protein sources requires integrated approaches encompassing ecosystem conservation, nutritional quality assurance, processing technology development, and systematic food safety evaluation (Cob & Das, 2021; Elvevoll et al., 2022).

3.6 Research Gaps and Future Directions

Future research should prioritize the following areas. First, comprehensive nutritional characterization including amino acid profiles, fatty acid composition, micronutrient content, and nutrient bioavailability is urgently needed to move beyond proximate analysis, as demonstrated for other commercially important gastropods (Tan et al., 2021; Warsidah et al., 2024). Second, systematic food safety evaluations addressing heavy metal concentrations relative to regulatory thresholds, microbiological hazards, and microplastic contamination are essential for evidence-based consumer safety assessment (Garofalo et al., 2025; Roy et al., 2024). Third, spatial and temporal analyses are necessary to understand how environmental variability influences both nutritional quality and contaminant accumulation across different harvesting locations and seasons (Tan et al., 2021). Finally,

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integrated and multidisciplinary research combining ecology, nutrition, food safety, and processing technology is essential to optimize the potential of gonggong snails as safe and sustainable marine protein sources (Henchion et al., 2017).

3.7. Synthesis of the Potential of Gonggong Snails as Local Protein Sources

Based on the reviewed studies, gonggong snails demonstrate considerable potential as alternative protein sources derived from local marine resources. Their presence in coastal ecosystems, particularly seagrass habitats, reflects not only their ecological importance but also their availability for sustainable utilization.

Their high protein content and bioactive compounds indicate that gonggong snails may serve not only as conventional protein sources but also as functional food ingredients. This potential aligns with global trends toward nutrient-dense and sustainable food resources.

Several studies have also explored the utilization of gonggong snails in processed food products. Gonggong meat has been developed into various value-added products such as sausages (Mulyadi & Sari, 2022) and siomay (Tumpuan, 2020), demonstrating acceptable sensory properties and consumer acceptance (Samsi & Rusmidin, 2024). These findings indicate that gonggong snails possess not only nutritional potential but also promising applicability for local food diversification and small-scale food industries.

However, this potential cannot be separated from food safety concerns associated with contaminant accumulation. The limited integration among studies addressing ecology, nutrition, processing, and food safety remains a major barrier to the development and commercialization of gonggong-based products. Therefore, the development of gonggong snails as local protein sources should be approached within an integrated framework that links ecosystem sustainability, nutritional quality, processing technology, and food safety assurance.

3.8. Limitations of This Review

This review has several limitations. First, the number of available studies specifically addressing nutritional and food safety aspects of gonggong snails remains limited. Second, most included studies were conducted in restricted geographic areas, particularly around Kepulauan Riau, limiting broader generalization. Third, heterogeneity in species nomenclature and study methodologies may affect comparability among studies. In addition, this review used a narrative approach and did not perform quantitative synthesis or formal quality assessment of included studies. Furthermore, the search was conducted in three databases only (Google Scholar, ScienceDirect, and PubMed), and grey literature or non-English publications were not included, which may have resulted in the exclusion of relevant studies.

4. CONCLUSION

Gonggong snails (family Strombidae) demonstrate strong potential as sustainable local marine protein sources, supported by their relatively high protein content — reaching approximately 54% on a dry weight basis — and the presence of bioactive compounds with antimicrobial activity. These characteristics position gonggong snails as promising candidates for both conventional protein utilization and functional food development.

However, current evidence remains limited and fragmented. Comprehensive nutritional profiling, including amino acid composition, fatty acid profiles, micronutrient content, and nutrient bioavailability, has not yet been established. Concurrently, food safety concerns associated with heavy metal accumulation — particularly lead (Pb) and cadmium (Cd) — and the detection of microplastics highlight the need for systematic contaminant monitoring. Critically, no existing study has compared detected contaminant levels against applicable regulatory thresholds, preventing definitive conclusions regarding consumer safety.

Future research should prioritize three interconnected areas: (1) comprehensive nutritional characterization beyond proximate analysis, particularly amino acid profiles and nutrient bioavailability;

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(2) systematic food safety assessment including heavy metal quantification relative to national and international regulatory standards, microbiological hazard evaluation, and microplastic risk characterization; and (3) integrated spatial and temporal monitoring of harvesting areas to account for environmental variability. Multidisciplinary approaches combining nutritional science, food safety assessment, processing technology, and coastal ecosystem conservation are essential to support the safe and sustainable development of gonggong snails as value-added local marine food resources.

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