Egyptian Journal of Aquatic Biology & Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN 1110 – 6131
Vol. 29(2): 2289 – 2300 (2025)
www.ejabf.journals.ekb.eg

Evaluation of the Fresh Vannamei Shrimp (*Litopenaeus vannamei*) Quality in Modern Markets of Makassar City Based on Microbiological Parameters and Operational Performance

Sitti Hardiyanti Rachman[1*], Kasmiati[2], Fahrul[2], Rachmat Hidayat[2]

[1]Study Program of Fisheries Product Technology, Faculty of Fisheries and Marine, Lambung Mangkurat University, Jl. A. Yani KM. 36 South Banjarbaru, Banjarbaru, South Kalimantan, Indonesia
[2]Departemen of Fisheries, Faculty of Marine Science and Fisheries, Hasanuddin University, Jl. Perintis Kemerdekaan Km. 10. Tamalanrea District, South Sulawesi, Indonesia

[*]**Corresponding Author: sthardiyantirachman@ulm.ac.id**

ARTICLE INFO

Article History:
Received: Feb. 9, 2025
Accepted: April 5, 2025
Online: April 15, 2025

Keywords:
Microbiological quality,
Vannamei shrimp,
Modern market,
Operational performance

ABSTRACT

The vannamei shrimp (*Litopenaeus vannamei*) is a high-value fishery commodity widely consumed due to its economic and nutritional benefits. This study evaluated the microbiological quality of fresh vannamei shrimp sold in three modern markets in Makassar City based on total plate count (TPC) and addressing *Escherichia coli*, *Salmonella*, and *Vibrio cholerae*, while analyzing the relationship with operational aspects of distribution and handling. Samples were collected from three modern markets and were analyzed in the Central Laboratory for Fisheries Product Quality Control, South Sulawesi Province. The results indicated that TPC values ranged from 1.4×10^5 to 9.4×10^5 CFU/g, with several samples exceeding the maximum limit of 5.0×10^5 CFU/g, as defined by the Indonesian National Standard (SNI 01-2728.1-2018), indicating that some shrimp samples did not meet microbiological safety standards. *E. coli* contamination was found to exceed the safe limit in samples from Market B (23, 9.2, and 14 MPN/g), while samples from Markets A and C remained within acceptable limits (<3 MPN/g). *Salmonella* was detected only in Market B, whereas *Vibrio cholerae* was present in all samples. Operational factors such as transport distance (4.4–14km), supply frequency (1–7 times per week), and storage practices during sale contributed to the variation in microbial contamination levels. These findings highlight the need for improved monitoring of the shrimp distribution chain, better handling practices, and stricter hygiene protocols to ensure the safety and quality of the vannamei shrimp sold in modern markets in Makassar.

INTRODUCTION

Shrimp is one of the most economically valuable fishery commodities, playing a crucial role in the aquaculture industry and international trade. Indonesia is among the world's largest shrimp producers **(FAO, 2024),** with the vannamei shrimp (*Litopenaeus*

vannamei) as the dominant species in national production. In 2023, the vannamei shrimp accounted for approximately 75% of the total national shrimp production, reaching 642.988 tons **(KKP, 2023)**. This increase in production has been driven by advancements in aquaculture technology and modern farming practices, which have enhanced both the quantity and quality of shrimp production **(Sarjito *et al.*, 2022)**. Sulawesi is the fourth-largest shrimp farming region in Indonesia, following West Nusa Tenggara (NTB), West Java, and East Java, making it a key center for fisheries production **(KKP, 2023)**. As the central economic and trade hub in eastern Indonesia, Makassar holds a crucial position in the distribution and marketing of fishery products, particularly the vannamei shrimp. This shrimp species serves not only as a major export commodity but also as a highly consumed seafood item in both modern and traditional markets.

In the modern era, quality assurance and food safety, especially fishery products such as the vannamei shrimp, have become one of the priority demands of consumers **(Tucker *et al.*, 2006; Frewer *et al.*, 2008)**. According to the Indonesian National Standard 01-2729.1-2006 for fresh shrimp, microbiological parameters such as total plate count (TPC) and the absence of pathogenic bacteria, including *Escherichia coli*, *Salmonella* spp., and *Vibrio* spp., serve as primary indicators of shrimp quality **(SNI, 2006)**. Compliance with these microbiological standards is crucial to ensuring that shrimp remains safe for consumption and maintains its freshness throughout the supply chain. Numerous consumers assume that products sold in modern markets are inherently safer and have a higher quality than those available in traditional markets **(Katiyo *et al.*, 2020)**. This assumption is based on the belief that modern markets implement stricter hygiene protocols and maintain a more effective cold chain system to preserve product freshness.

Contrary to popular belief, research indicates that this perception does not always hold true in practice. Seafood products in modern markets can also be exposed to microbiological contamination, posing potential health risks to consumers. **Marpaung (2015)** found that dried salted fish sold in both modern and traditional markets in Jambi City contained bacterial contamination, although still within acceptable limits. Similarly, **Nakaguchi (2013**) reported that seafood products in Indonesian modern markets, including shrimp, were contaminated with *Vibrio parahaemolyticus*, with contamination levels reaching 66.7%. This bacterium carries virulence genes (*tdh* and *trh*), increasing its pathogenic potential and foodborne disease risks. Additionally, **Pramono *et al.* (2019)** detected antibiotic-resistant *Salmonella* in seafood sold in traditional markets in Surabaya, with similar contamination also observed in modern markets, indicating that microbiological risks are not limited to traditional market environments.

These findings suggest that the presence of modern market infrastructure does not automatically guarantee improved food safety **(Usmani *et al.*, 2021)**. Therefore, this study aimed to evaluate the microbiological quality and operational performance of fresh vannamei shrimp sold in modern markets in Makassar City. The objective of this research was to provide insights that can contribute to improving food safety management

practices, ensuring that shrimp quality complies with the standards set by the Indonesian National Standard.

MATERIALS AND METHODS

1. Study area

Sampling of fresh vannamei shrimp was conducted at three (3) modern markets in Makassar City (Fig. 1), namely Modern Markets A, B, and C. These markets were selected based on their strategic locations, representing the (A) eastern, (B) central, and (C) western regions of Makassar City, thereby providing a comprehensive representation of modern market distribution.

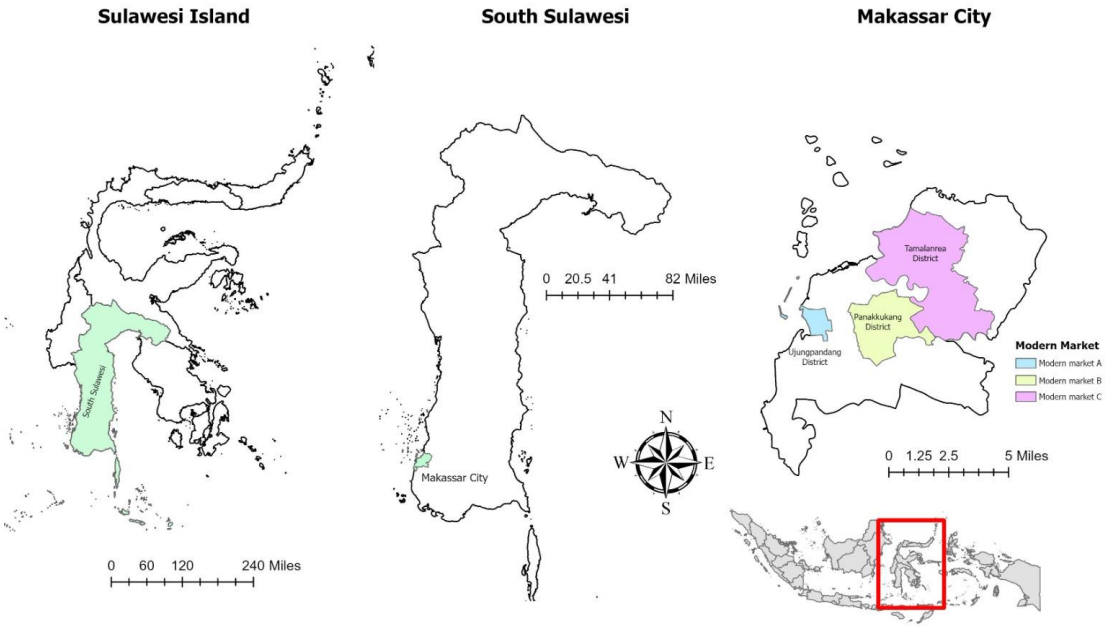

Fig. 1. Research location

2. Research methods

This study was conducted to evaluate the microbiological quality and operational performance of the fresh vannamei shrimp (*Litopenaeus vannamei*) sold in modern markets in Makassar City. This study included sampling procedures, microbiological analysis, and operational parameter assessment by interview.

2.1 Sampling method

Sampling was conducted three times a week at each of the three selected modern markets in Makassar: Market A (east), Market B (central), and Market C (west), between 10:00–11:00 AM. These markets were chosen based on purposive sampling due to their consistent operational hours (09:00–21:00) and regular sale of the fresh vannamei shrimp

(*Litopenaeus vannamei*). During each sampling session, 300–500 grams of the vannamei shrimp were collected, packed into zipper-sealed plastic bags, and stored in a cool box filled with ice to maintain freshness prior to analysis in the South Sulawesi Province Fishery Product Quality Implementation Laboratory. The research parameters were tested as follows:

2.2. Microbiological analyses

2.2.1 Total plate count (TPC)

The procedure for the TPC test, according to the Indonesian National Standard (SNI 01-2332.3-2015), consists of several stages. In the sample preparation stage, 25g of solid or 25ml of liquid sample—equivalent to 10% of the total volume—was combined with 225ml of Butterfield's Phosphate Buffered (BFP) solution, resulting in a 10^{-1} dilution. Further serial dilutions (e.g., 10^{-2}, 10^{-3}) were prepared depending on the sample characteristics. For the aerobic TPC test, 1ml from each dilution was pipetted into sterile Petri dishes in duplicate, mixed with 12–15ml of plate count agar (PCA), and incubated in an inverted position at 35°C ± 1°C for mesophilic bacteria or 45°C ± 1°C for thermophilic bacteria for 48 ± 2 hours. For the anaerobic TPC test, PCA was poured and solidified in Petri dishes, then 1ml of the diluted sample was added and overlaid with 15ml of Thioglycolate agar. Plates were incubated upright in an anaerobic jar under the same temperature conditions for 48 ± 2 hours.

2.2.2 *Escherichia coli*

The *Escherichia coli* testing procedure, according to the Indonesian National Standard (SNI 01-2332.1-2006), begins by homogenizing 25g of the sample with 225ml of Butterfield's Phosphate Buffered (BFP). Serial dilutions were prepared up to 10^{-3} and incubated for 48 hours at 36ºC using Lauryl Tryptose Broth (LTB) for presumptive *E. coli* detection. Positive results appeared as turbid media. These positive LTB results were then inoculated into *Escherichia Coli* (EC) broth and were incubated at 45ºC for 48 hours in a water bath. Positive EC broth results were further inoculated onto Levine's Eosin Methylene Blue (LEMB) agar and were incubated for 24 hours at 35ºC. Positive colonies on LEMB appear black or dark with or without a green metallic sheen. Suspected colonies were inoculated onto slanted PCA and were incubated for 24 hours at 35ºC. Confirmation of *E. coli* was done through biochemical tests including indole, Methyl Red (MR), Voges Proskauer (VP), citrate, and gram staining.

2.2.3 *Salmonella* spp.

The testing for *Salmonella* spp. according to the Indonesian National Standard (SNI 01-2332.1-2006) was conducted to detect the presence of *Salmonella* bacteria in shrimp samples. A 25g sample was mixed with 225ml of Lactose Broth (LB), homogenized for 2–3 minutes, and incubated for 24 hours. Enrichment was performed by transferring 0.1ml of the sample solution into 10ml of Rappaport-Vassiliadis (RV) medium and 1ml

into 10ml of Tetrathionate Broth (TTB), with the RV medium incubated at 42°C and the TTB medium at 43°C, both for 24 hours in a water bath. Isolation was carried out using bismuth sulfite agar (BSA), xylose lysine deoxycholate (XLD), and hektoen enteric agar, followed by incubation at 35°C for 24 hours. Colony morphology was observed on triple sugar iron (TSI) and lysine iron agar (LIA) media, and positive results from these observations underwent further biochemical tests, including assays for urease, indole, methyl red (MR), voges-proskauer (VP), simmons citrate, potassium cyanide (KCN), lactose, dulcitol, sucrose, and malonate.

2.2.4 *Vibrio cholerae*

The testing for *Vibrio cholerae* followed the Indonesian National Standard (SNI 01-2332.4-2006) to identify and confirm the presence of *V. cholerae* in shrimp samples. A 25g sample was mixed with 225ml of alkaline peptone water (APW), homogenized for 2–3 minutes to produce a 1:10 dilution, and further diluted by transferring 1ml of the homogenate into 9ml of APW. The mixture was incubated at 36°C for 24 hours. Enriched samples were streaked onto thiosulfate citrate bile salt sucrose (TCBS) agar and incubated at 36°C for 16–24 hours. Suspected colonies, identified by their large size, smooth surface, slightly flat appearance, opaque center, translucent edges, and yellow coloration (indicating sucrose fermentation), were purified by streaking three single colonies onto T1N1 agar or tryptic soy agar (TSA) supplemented with 1.5% sodium chloride (NaCl), followed by incubation at 36°C for 24 hours. Subsequent analysis included preliminary biochemical tests such as oxidase, sensitivity, triple sugar iron agar (TSIA), kligler iron agar (KIA), ortho-nitrophenyl-β-galactoside (ONPG), oxidative-fermentative, and gram staining. Advanced biochemical tests, including urea hydrolysis, arginine dihydrolase, salt tolerance, voges-proskauer, carbohydrate fermentation, and serological tests, were performed to confirm the presence of *V. cholerae.*

2.3 Operational performance

In addition to microbiological testing, this study assessed operational performance factors that could influence the quality of the fresh vannamei shrimp. Data were collected through interviews with market employees, focusing on six key parameters: the condition of shrimp during transportation from suppliers to modern markets; the distance from suppliers to modern markets; the frequency of vannamei shrimp stocking per week in each market; the turnover rate of the vannamei shrimp per day; shrimp display conditions during sales, and shrimp handling upon arrival at the market. These factors were analyzed to determine their potential impact on the freshness and microbiological quality of the shrimp.

3. Data analysis

The data were analyzed descriptively and visualized in the form of tables and spider charts.

RESULTS AND DISCUSSION

1. The microbiological quality

The microbiological quality of the fresh vannamei shrimp sold in three modern markets in Makassar City was evaluated based on total plate count (TPC) and *Escherichia coli*, both analyzed quantitatively, as shown in Table (1). Additionally, *Salmonella* and *Vibrio cholerae* were assessed qualitatively, as presented in Table (2).

Table 1. The number of total plate count (TPC) and *Escherichia coli* detected on vannamei shrimp *(Litopenaeus vannamei*) sold in modern markets in Makassar City

Microbial evaluated	Modern markets			Quality standards (SNI 01-2728.1-2018)
	A	B	C	
Total plate count (CFU/g)	1.6×10^5	2.1×10^5	9.4×10^5	**Maximum 5.0×10^5**
	1.4×10^5	3.6×10^5	8.3×10^5	
	1.6×10^5	2.0×10^5	9.3×10^5	
Escherichia coli **(MPN/ 25 g)**	<3	23	<3	**<3**
	<3	9,2	<3	
	<3	14	<3	

Table 2. Detection of *Salmonella* and *Vibrio cholerae* on vannamei shrimp *(Litopenaeus vannamei)* sold in modern markets in Makassar City

Microbial Evaluated	Modern markets			Quality Standards (SNI 01-2728.1-2018)
	A	B	C	
Salmonella **(MPN/ 25 g)**	Negative	Positive	Negative	**Negative**
	Negative	Negative	Negative	
	Negative	Negative	Negative	
Vibrio chelerae **(MPN/ 25 g)**	Positive	Positive	Positive	
	Positive	Positive	Positive	
	Positive	Positive	Positive	

The supply chain of vannamei shrimp (*Litopenaeus vannamei*) in modern markets in Makassar City involves suppliers, modern markets, and end consumers. The shrimp come from aquaculture farms supplied by two main suppliers, with different distribution patterns for each market, as shown in Fig. (2).

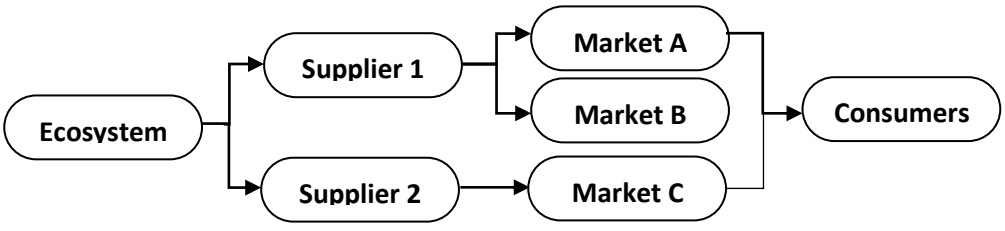

Fig. 2. Supply chain of on vannamei shrimp (*Litopenaeus vannamei*) marketed in modern markets in Makassar City

2. Operational performance of modern markets in maintaining the quality of marketed vannamei shrimp

The operational performance of each modern market plays a crucial role in determining the microbiological quality of the vannamei shrimp being sold. The evaluation is based on several parameters, including supplier distance, stocking frequency, stock turnover frequency, storage and display methods, and transportation conditions, as shown in Table (3) and illustrated in Fig. (3).

Table 3. Operational parameter on vannamei shrimp (*Litopenaeus vannamei*) marketed in modern markets in Makassar City

Parameter	Market A	Market B	Market C
Condition of Shrimp During Transportation from Supplier to Modern Market	Shrimp stored in boxes with ice	Shrimp stored in boxes with ice	Shrimp stored in boxes with ice
Distance from Supplier to Modern Market	14 km	6.8 km	4.4 km
Frequency of Vannamei Shrimp Stocking per Week in Each Market	3 times (Monday, Wednesday, Friday)	Once a week	7 times (daily)
Frequency of Vannamei Shrimp Turnover per Day	3–5 times/day	3–5 times/day	2 times/day
Shrimp Display During Sales	Shrimp placed under and on top of ice piles (not all shrimp surfaces are in direct contact with ice)	Shrimp placed under ice piles	Shrimp placed under and on top of ice piles (not all shrimp surfaces are in direct contact with ice)
Shrimp Handling Upon Arrival at the Market	Shrimp washed with clean water and sorted	Shrimp washed with clean water and sorted	Shrimp washed with clean water and sorted

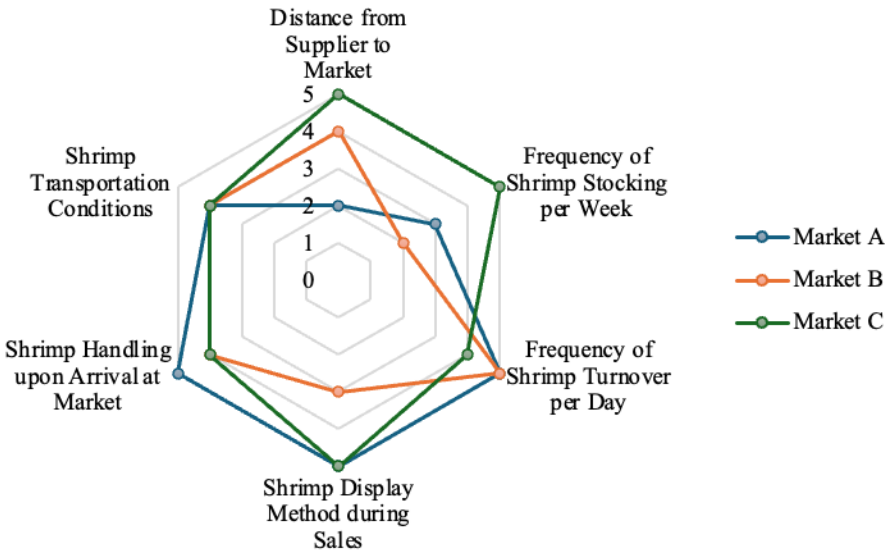

Fig. 3. The spider diagram above illustrates the operational parameter index values (1-5) for three markets (Market A, Market B, and Market C)

DISCUSSION

The microbiological quality of the vannamei shrimp (*Litopenaeus vannamei*) sold in three modern markets in Makassar is significantly influenced by the supply chain and the operational performance of each market. Key factors affecting shrimp quality include stocking frequency, storage methods, sanitation conditions, post-harvest handling, and transportation **(Haddad, 2019)**. Differences in these operational practices contribute to variations in the microbiological contamination levels of the shrimp being sold.

Total plate count (TPC) is a key indicator of microbiological quality in food products. The study revealed that the highest TPC values were found in Modern Market C, ranging from 8.3×10^5 to 9.4×10^5 CFU/g, exceeding the maximum limit of 5.0×10^5 CFU/g set by the Indonesian National Standard (SNI 2728:2018). This indicates that shrimp sold in Market C is not safe for direct consumption. This result is strongly correlated with the operational performance of Market C. Although it has a high stocking frequency (daily), its stock turnover rate is low (only twice per day) and the shrimp are displayed in large quantities at once. Additionally, shrimp in this market is often submerged in melted ice water, creating a high water activity (aw) environment that accelerates microbial growth **(Tapia *et al.*, 2008; Rebezov *et al.*, 2022)**. Improper storage practices are the primary cause of the high TPC values in Market C. On the other hand, Modern Market A demonstrated lower TPC values (1.4×10^5 – 1.6×10^5 CFU/g), remaining within the SNI safety limits. This market maintained a higher stocking frequency (three times per week) and a faster stock turnover (3–5 times per day), which helped maintain shrimp freshness and reduce microbial growth.

The study found that *E. coli* contamination was the highest in Modern Market B, with values ranging from 9.2 to 23 MPN/25 g, far exceeding the safety threshold of <3 MPN/25g set by SNI. In contrast, Modern Markets A and C showed safer results, with values <3 MPN/25g. The presence of *E. coli* in food products is typically an indicator of fecal contamination due to poor sanitation practices. The operational evaluation results showed that Market B had a very low stocking frequency (only once per week), leading to longer shrimp storage periods, which increase bacterial contamination risks. According to **Costa (2013)** and **Barbosa *et al.* (2016)**, high levels of *E. coli* contamination are often associated with the use of contaminated water and poor hygiene control in the seafood supply chain. Furthermore, research by **Rohmah *et al*. (2018)** found that cross-contamination during post-harvest processing, such as from washing water or unhygienic equipment, also contributes to high *E. coli* contamination levels. Thus, the high *E. coli* levels in Market B are directly linked to its low stocking frequency and inadequate post-harvest handling before shrimp reaches the market.

Salmonella is a major foodborne pathogen that can cause severe gastrointestinal infections. In this study, *Salmonella* was detected only in Modern Market B, while in Markets A and C, it was tested negative. According to **Rubini *et al*. (2018)**, the high levels of *E. coli* are often associated with the presence of *Salmonella*, as both bacteria are commonly found together in fecal contamination. This aligns with the findings of this study, where Market B showed high *E. coli* levels and was the only market with *Salmonella* contamination. The key operational factor contributing to *Salmonella* contamination in Market B is the low stocking frequency and extended storage duration, which increases the likelihood of pathogen proliferation.

One of the most significant findings of this study is that *Vibrio cholerae* was detected in all shrimp samples from the three modern markets (A, B, and C). *Vibrio cholerae* is a pathogenic bacterium that can cause cholera infections in humans. Unlike other bacteria primarily associated with market storage conditions, *V. cholerae* contamination is likely introduced at the shrimp farming stage before distribution to markets. According to **Letchumanan *et al.* (2015)**, *Vibrio* spp. is commonly found in marine environments and can contaminate seafood from aquaculture ponds to market distribution. Additionally, the study of **Brauge *et al.* (2024)** indicates that contaminated aquaculture water from domestic waste can increase the risk of *V. cholerae* in seafood products. Operational evaluations showed that despite differences in storage methods and stocking frequencies, *V. cholerae* was present in all samples, suggesting that the primary contamination source is the shrimp farms rather than market handling practices.

CONCLUSION

This study confirms that the vannamei shrimp sold in three modern markets in Makassar City are contaminated with *Vibrio cholerae*, with *Salmonella* detected in

Market B, and *E. coli* exceeding the safety limit in Market B (23, 9.2, and 14 MPN/25g), while shrimp in Markets A and C remain within acceptable limits (<3 MPN/g). The highest total plate count (TPC) was recorded in Market C ($8.3 \times 10^5 – 9.4 \times 10^5$ CFU/g), exceeding the safety threshold set by SNI 01-2728.1-2018, making the shrimp unsafe for direct consumption without proper cooking. Operational performance affects microbiological contamination. Market A, with frequent stocking and fast turnover, had the best shrimp quality. Market B, with low stocking frequency and prolonged storage, showed the highest *E. coli* and *Salmonella* contamination. Market C, despite daily restocking, had low turnover and poor display conditions, leading to excessive TPC levels. Improving storage time, hygiene protocols, temperature control, and drainage systems is essential to reducing microbial contamination.

REFERENCES

Barbosa, L. J.; Ribeiro, L. F.; Lavezzo, L. F.; Barbosa, M. M. C.; Rossi, G. A. M. and do Amaral, L. A. (2016). Detection of pathogenic *Escherichia coli* and microbiological quality of chilled shrimp sold in street markets. *Letters in Applied Microbiology*, 62(5), 372–378. https://doi.org/10.1111/lam.12562.

Brauge, T.; Mougin, J.; Ells, T. and Midelet, G. (2024). Sources and contamination routes of seafood with human pathogenic Vibrio spp.: A Farm-to-Fork approach. In Comprehensive Reviews in Food Science and Food Safety (Vol. 23, Issue 1, pp. 1–25). *John Wiley and Sons Inc*. https://doi.org/10.1111/1541-4337.13283

Costa, R. A. (2013). *Escherichia coli* in seafood: A brief overview. *Advances in Bioscience and Biotechnology*, *04*(03), 450–454. https://doi.org/10.4236/abb.2013.43a060.

FAO. (2024). The State of World Fisheries and Aquaculture 2024 – Blue Transformation in action. Rome. https://doi.org/10.4060/cd0683en.

Frewer, L. J.; Frewer, L.; De Jonge, J. and Van Kleef, E. (2008). Consumer perceptions of food safety. *Medical Sciences*, *II*.

Haddad, A.N. (2019). Evaluation of Post-Harvest Procedures for Quality Enhancement in the Louisiana Commercial Shrimp Industry. https://digitalcommons.lsu.edu/gradschool_theses

Katiyo, W.; Coorey, R;, Buys, E. M. and de Kock, H. L. (2020). Consumers' perceptions of intrinsic and extrinsic attributes as indicators of safety and quality of chicken meat: Actionable information for public health authorities and the chicken industry. *Journal of Food Science*, *85*(6), 1845–1855. https://doi.org/10.1111/1750-3841.15125.

Letchumanan, V.; Pusparajah, P.; Tan, L. T. H.; Yin, W. F.; Lee, L. H. and Chan, K. G. (2015). Occurrence and antibiotic resistance of Vibrio parahaemolyticus from Shellfish in Selangor, Malaysia. *Frontiers in Microbiology*, 6(DEC). https://doi.org/10.3389/fmicb.2015.01417

Marpaung, R. (2015). Kajian Mikrobiologi pada Produk Ikan Asin Kering yang Dipasarkan di Pasar Tradisonal dan Pasar Swalayan dalam Upaya Peningkatan Keamanan Pangan di Kota Jambi. *Jurnal Ilmiah Universitas Batanghari Jambi* .Vol.15 No.3 2015

Nakaguchi, Y. (2013). Contamination by *vibrio parahaemolyticus* and its virulent strains in seafood marketed in Thailand, Vietnam, Malaysia, and Indonesia. *Tropical Medicine and Health*, *41*(3), 95–102. https://doi.org/10.2149/tmh.2011-06.

Pramono, H.; Kurniawan, A.; Andika, N.; Putra, T. F.; Hazwin, M. A. R. Utari, S.; Masithah, E. D. and Sahidu, A. M. (2019). Detection of antibiotic-resistant Salmonella sp. in the seafood products of Surabaya local market. *IOP Conference Series: Earth and Environmental Science*, *236*(1), 3–8. https://doi.org/10.1088/1755-1315/236/1/012115.

Rebezov, M.; Chughtai, M. F. J.; Mehmood, T.; Khaliq, A.; Tanweer, S.; Semenova, A.; Khayrullin, M.; Dydykin, A.; Burlankov, S.; Thiruvengadam, M.; Shariati, M. A. and Lorenzo, J. M. (2022). Novel techniques for microbiological safety in meat and fish industries. In *Applied Sciences (Switzerland)* (Vol. 12, Issue 1). MDPI. https://doi.org/10.3390/app12010319.

Rohmah, J.; Rini, C. S. and Cholifah, S. (2018). The relationship between hygiene and sanitation to Escherichia coli contamination on foods in a campus cafeteria. *IOP Conference Series: Materials Science and Engineering*, *420*(1). https://doi.org/10.1088/1757-899X/420/1/012143.

Rubini, S.; Galletti, G.; D'Incau, M.; Govoni, G.; Boschetti, L.; Berardelli, C.; Barbieri, S.; Merialdi, G.; Formaglio, A.; Guidi, E.; Bergamini, M.; Piva, S.; Serraino, A. and Giacometti, F. (2018). Occurrence of *Salmonella* enterica subsp. enterica in bivalve molluscs and associations with *Escherichia coli* in molluscs and faecal coliforms in seawater. *Food Control*, *84*, 429–435. https://doi.org/10.1016/j.foodcont.2017.08.035.

Sarjito, S.; Rosa, A. and Aninditia, S. (2022). Screening of sponge-associated bacteria to control vibriosis in vannamei shrimp (*Litopenaeus vannamei*). *Biodiversitas*, *23*(10), 5333–5341. https://doi.org/10.13057/biodiv/d231043.

SNI. (2006). Standar Nasional Indonesia 01-2332.2-2006. Cara uji mikrobiologi - Bagian 2: Penentuan *Salmonella* pada produk perikanan: Spesifikasi. Badan Standardisasi Nasional.

(2006b) Standar Nasional Indonesia 01-2332.4-2006. Cara uji mikrobiologi - Bagian 4: Penentuan *Vibrio cholerae* pada produk perikanan. Badan Standardisasi Nasional.

SNI. (2015). Standar Nasional Indonesia 01-2345-2015, 3–5. Cara Uji Mikrobiologi - Bagian 3: Penentuan Angka Lempeng Total (ALT) pada Produk Perikanan.

(2015b). Standar Nasional Indonesia 2332.3:2015. Penentuan *Coliform* dan *E. coli* pada Produk Perikanan. Badan Standardisasi Nasional.

SNI. (2018). Standar Nasional Indonesia 01-2728.1-2018. Udang segar – Bagian 1. Spesifikasi. Badan Standardisasi Nasional.

Tapia, M. S.; Alzamora, S. M. and Chirife, J. (2008). Effects of Water Activity (aw) on Microbial Stability: As a Hurdle in Food Preservation. In *Water Activity in Foods: Fundamentals and Applications* (pp. 239–271). Blackwell Publishing Ltd. https://doi.org/10.1002/9780470376454.ch10.

Tucker, M.; Whaley, S. R. and Sharp, J. S. (2006). Consumer perceptions of food-related risks. In *International Journal of Food Science and Technology* (Vol. 41, Issue 2, pp. 135–146). https://doi.org/10.1111/j.1365-2621.2005.01010.x.

Usmani, M.; Brumfield, K. D.; Jamal, Y.; Huq, A.; Colwell, R. R. and Jutla, A. (2021). A review of the environmental trigger and transmission components for prediction of cholera. In *Tropical Medicine and Infectious Disease* (Vol. 6, Issue 3). MDPI AG. https://doi.org/10.3390/tropicalmed6030147.