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Identification of Potentially Pathogenic Bacteria in Fresh Marine Fish Sold at Kebon Roek Market, Mataram

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Abstract: This study aimed to enumerate, detect, and identify potentially pathogenic bacteria contaminating fresh marine fish sold at Kebon Roek Market, Mataram City. This preliminary laboratory-based descriptive survey focused on the fish species most frequently purchased by consumers: eastern little tuna (*Euthynnus* sp.), sardinella (*Sardinella* sp.), and Indian mackerel (*Rastrelliger* sp.). Fish samples were collected from nine purposively selected vendors located in different sections of the market, comprising three vendors each from the front, middle, and rear areas. Laboratory analyses included determination of the Total Plate Count (TPC), bacterial isolation using selective media, and bacterial identification based on cellular morphology, Gram-staining reactions, and biochemical characteristics. The bacterial loads were 3.36×10^6 CFU/g in eastern little tuna, 1.76×10^6 CFU/g in Indian mackerel, and 4.85×10^5 CFU/g in sardinella. The bacterial counts detected in eastern little tuna and Indian mackerel exceeded the maximum limits specified in the Indonesian National Standard SNI 7388:2009. Bacterial identification revealed the presence of potentially pathogenic bacteria, including *Enterobacter* spp., *Citrobacter* spp., *Escherichia coli*, *Edwardsiella* spp., *Vibrio* spp., and *Aeromonas* spp. These findings indicate that fresh marine fish sold at Kebon Roek Market may serve as a vehicle for transmitting pathogenic bacteria to consumers. Therefore, improved hygiene and sanitation practices are required throughout the fish distribution and retail chain to ensure food safety.
Keywords: Fresh marine fish; potentially pathogenic bacteria; Kebon Roek Market; Total Plate Count (TPC)

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INTRODUCTION

Kebon Roek Market is a traditional market located in Ampenan District, Mataram City. It serves as an important trading center for coastal communities and supplies marine fishery products obtained from fishing grounds around Lombok Island. Its proximity to Mataram's urban area and the fishing settlements of Ampenan makes the market an important distribution point for fresh marine fish consumed by communities in Mataram and the surrounding areas (Fabita, 2023; Mataram City Government, 2025; Wanderlog, 2026; Wilandari et al., 2020). Ampenan has considerable potential in capture fisheries, aquaculture, and fish processing, further emphasizing the importance of maintaining the quality and safety of fishery products distributed through its traditional markets (Wilandari et al., 2020). Although Kebon Roek Market plays an important role in providing consumers with fresh fish, the microbiological quality of fish sold at the retail level remains a relevant food-safety concern.

Fish is a highly perishable food commodity because its high water activity and nutrient content provide favorable conditions for enzymatic reactions and microbial growth. The deterioration of fish quality results from the combined effects of endogenous enzymatic activity, microbial metabolism, and chemical reactions that begin soon after capture (Gram & Dalgaard, 2002; Nie et al., 2022; Odeyemi et al., 2018; Wang & Zheng, 2025). After death, fish undergo several biological and biochemical changes, including rigor mortis and autolysis, during which endogenous

enzymes progressively degrade muscle tissues. These processes alter the texture, color, odor, and flavor of fish, ultimately reducing its freshness, sensory acceptability, and market value.

In addition to these intrinsic changes, fish deterioration is strongly influenced by external factors, particularly inadequate postharvest handling. Delayed chilling, insufficient use of ice, poor sanitation, contaminated water or equipment, and prolonged transportation from fish landing sites to retail markets can accelerate bacterial proliferation. Only certain members of the microbial community, commonly referred to as specific spoilage organisms, contribute substantially to the production of the undesirable odors and flavors associated with fish spoilage (Gram & Dalgaard, 2002). Their metabolic activity may generate ammonia, trimethylamine (TMA), sulfur-containing compounds, and other volatile metabolites that indicate progressive quality deterioration (Odeyemi et al., 2018; Wang & Zheng, 2025). Consequently, continuous temperature control, adequate icing, hygienic handling, and prevention of cross-contamination throughout storage, transportation, and retail display are essential for slowing microbial growth and preserving fish quality (Food and Agriculture Organization, 2022; Food and Agriculture Organization of the United Nations & World Health Organization, 2020).

Microbiological spoilage and the presence of foodborne pathogens are related but distinct concerns. Spoilage-associated bacteria, including certain species of *Pseudomonas*, primarily reduce product quality, whereas pathogenic bacteria directly threaten consumer health. Bacterial hazards associated with fish and fishery products include pathogenic *Vibrio* spp., *Aeromonas* spp., *Salmonella* spp., and *Staphylococcus aureus* (Hegde et al., 2023; Novoslavskij et al., 2016; Shikongo-Nambabi et al., 2011). These microorganisms may originate from aquatic environments or be introduced through contaminated water, ice, utensils, market surfaces, food handlers, and other sources of postharvest cross-contamination. Consumption of contaminated fish may cause gastrointestinal infections, food poisoning, and other foodborne illnesses, particularly when fish is inadequately handled, stored, or cooked.

Despite the importance of Kebon Roek Market in the local distribution of fresh marine fish, published information on the occurrence and diversity of potentially pathogenic bacteria in fish sold at this market remains limited. Previous local studies have primarily examined the socioeconomic development of the market and the fisheries potential of Ampenan rather than the microbiological safety of fish offered to consumers (Fabita, 2023; Wilandari et al., 2020). This lack of site-specific evidence limits the assessment of potential microbial hazards and the development of appropriate hygiene and food-safety interventions. Therefore, this study aimed to determine the occurrence and identify potentially pathogenic bacteria in fresh marine fish sold at Kebon Roek Market. The findings are expected to provide baseline information for improving hygienic handling practices, cold-chain management, and microbiological surveillance of fresh fish in traditional markets.

METHOD

Fish Sampling

This study employed a descriptive-exploratory, cross-sectional design supported by laboratory testing and analysis. Fish samples were purposively collected from nine vendors selling three different fish species: eastern little tuna (*Euthynnus* sp.), sardinella (*Sardinella* sp.), and Indian mackerel (*Rastrelliger* sp.). The selected vendors were located in the front, middle, and rear sections of Kebun Roek Market. These fish species were selected because they were among the species most

frequently purchased by consumers at the market. The selection was confirmed through brief interviews conducted before sample collection.

Three individual fish of each predetermined species were collected from each vendor. Samples were collected aseptically and placed in sterile, individually coded zip-lock bags to prevent sample misidentification. The samples were subsequently transported to the Microbiology Laboratory of the Research and Development Unit, West Nusa Tenggara Central General Hospital, for bacterial culture and testing.

Preparation of Fish Flesh

Fish flesh was excised from the dorsal region of each sample, and a 25-g portion was weighed. The flesh was then homogenized using a previously sterilized blender. The dorsal region was selected because it has relatively limited contact with the external environment and represents one of the most commonly consumed portions of the fish (Badan Standarisasi Nasional, 2008; ISO 6887-3, 2017).

The total plate count procedure was initiated by mixing 10 g of homogenized fish flesh with Buffered Peptone Water (BPW) to obtain a final volume of 100 mL, referred to as the composite pool. BPW was used as the diluent because it maintains microorganism viability, stabilizes pH, and facilitates the recovery of stressed bacterial cells (Badan Standarisasi Nasional, 2008; ISO 6887-3, 2017).

The fish homogenate was serially diluted from 10^{-1} to 10^{-6}. One milliliter of the homogenate from the initial suspension was transferred into a test tube containing 9 mL of BPW and mixed until homogeneous. Subsequently, 1 mL of the suspension from the first dilution tube was transferred into the second tube containing 9 mL of BPW, and the procedure was repeated until the sixth dilution was obtained.

Following serial dilution, 1 mL of each dilution was inoculated onto Plate Count Agar (PCA). All plates were incubated at 37°C for 24 h. Colony counts were performed using plates containing 25–250 colonies (Harley & Prescott, 2002). The bacterial concentration was calculated using the following equation:

$$\mathrm{CFU/mL} = \frac{\text{Number of colonies} \times \text{Dilution factor}}{\text{Volume of sample plated (mL)}}$$

(Sukmawati & Hardianti, 2018)

Isolation of *Salmonella*

One gram of fish sample from the composite pool was transferred into a test tube containing 9 mL of BPW and mixed until homogeneous. The sample was incubated at 37°C for 24 h. After incubation, the inoculum was collected using a sterile inoculating loop and streaked onto Xylose Lysine Deoxycholate (XLD) agar. The plates were then incubated at 37°C for 24–48 h.

XLD agar contains deoxycholate, a bile salt that inhibits the growth of most Gram-positive bacteria and several non-enteric bacteria, thereby facilitating the selective isolation of enteric bacteria such as *Salmonella* and *Shigella*. Presumptive *Salmonella* colonies on XLD agar were identified as pink-to-red, circular colonies with black centers, entire margins, and convex elevations (ISO 6579-1, 2020; Burhana et al., 2024).

Isolation of *Escherichia coli*

One gram of fish sample from the composite pool was transferred into a test tube containing 9 mL of BPW and mixed until homogeneous. The sample was incubated at 37°C for 24 h. The resulting inoculum was collected using a sterile inoculating loop and streaked onto the surface of MacConkey Agar (MCA). The plates were subsequently incubated at 37°C for 24–48 h.

MCA contains lactose and the pH indicator neutral red. Lactose is fermented by *E. coli*, resulting in acid production. The acidic conditions change the color of the neutral-red indicator from straw-colored to pink. Presumptive *Escherichia* colonies on MCA were identified as pink, circular colonies with entire margins, smooth surfaces, and convex elevations (ISO 16649-1, 2018; Christanti & Azhar, 2019).

Isolation of *Staphylococcus*

One gram of fish sample from the composite pool was transferred into a test tube containing 9 mL of BPW and mixed until homogeneous. The sample was incubated at 37°C for 24 h. The inoculum was then collected using a sterile inoculating loop and streaked onto the surface of Mannitol Salt Agar (MSA).

MSA was used because it contains mannitol as a fermentable carbon source and a high concentration of NaCl, which selectively inhibits the growth of many bacteria other than *Staphylococcus* (ISO 6888-1, 2021). The plates were subsequently incubated at 37°C for 24–48 h. Presumptive *Staphylococcus* colonies on MSA were identified as yellow, circular colonies with smooth surfaces, entire margins, and convex elevations (Karimela et al., 2017).

Isolation of *Vibrio*

One gram of fish sample from the composite pool was transferred into a test tube containing 9 mL of BPW and mixed until homogeneous. The sample was incubated at 37°C for 24 h. Following incubation, the inoculum was collected using a sterile inoculating loop and streaked onto the surface of thiosulfate–citrate–bile salts–sucrose (TCBS) agar using the streak-plate method.

TCBS agar was used because it contains several components that inhibit the growth of non-*Vibrio* bacteria. Sodium citrate and bile salts inhibit many Gram-positive bacteria and several enteric Gram-negative bacteria. In addition, the alkaline pH of approximately 8.5–8.6 supports the growth of *Vibrio*, which is relatively tolerant of alkaline conditions, while suppressing the growth of many other bacterial groups.

The plates were incubated at 37°C for 24–48 h. Presumptive *Vibrio* colonies on TCBS agar were identified as green or yellow, circular colonies with entire margins and convex elevations (ISO 21872-1, 2017; Ihsan, 2021).

Biochemical Characterization

Biochemical tests were performed to characterize and identify bacterial isolates based on their biochemical properties. Pathogenic bacteria were identified using the procedures described by Barrow and Feltham (2009).

The biochemical characterization of *Salmonella* spp. and *Escherichia coli* included sugar-fermentation tests, Triple Sugar Iron (TSI) agar, Simmons citrate, urease, motility, indole, ornithine, Methyl Red (MR), Voges–Proskauer (VP), and oxidase tests.

The biochemical characterization of *Staphylococcus* included catalase, oxidase, and Voges–Proskauer tests. The biochemical characterization of *Vibrio* included sugar-fermentation tests, TSI agar, Simmons citrate, motility, indole, ornithine, MR, VP, oxidase, and catalase tests. Bacterial isolates were identified at the genus level using a profile-matching method (Holt et al., 1994; Krieg et al., 2010).

RESULTS AND DISCUSSION

Figure 1 presents the fish species examined in this study. These species are among the most frequently caught fish in the waters of West Lombok and the most commonly sold at Kebon Roek Market.

Figure 1. Fish species examined in this study (A. Mackerel tuna (*Euthynnus* sp.); B. sardinella (*Sardinella* sp.); and C. mackerel (*Rastrelliger* sp.).

Total Plate Count

The mean bacterial total plate count (TPC) values obtained from fresh marine fish samples sold at Kebon Roek Market are presented in Table 1.

Table 1. Mean bacterial total plate count values in fish samples collected from Kebon Roek Market

No.	Sample	Mean TPC (CFU/g)
1	Mackerel tuna (*Euthynnus* sp.)	3.36×10^6
2	Sardinella (*Sardinella* sp.)	4.85×10^5
3	Mackerel (*Rastrelliger* sp.)	1.76×10^6

The TPC values for mackerel tuna and mackerel exceeded the maximum limit established by the Indonesian National Standard SNI 7388:2009, which is $\leq 5 \times 10^5$ CFU/g (Badan Standardisasi Nasional, 2009). TPC values above this limit indicate that the samples did not meet the microbiological quality requirements for fresh fish. Several factors may have contributed to the elevated TPC values, even though the fish were classified as fresh or recently caught:

1. Inadequate post-harvest handling. If fish are not chilled immediately after capture, bacterial populations can increase rapidly.
2. Disruption of the cold chain. Marine fish are highly perishable food products. During transportation from the landing site to the market, unstable storage temperatures can accelerate bacterial growth.
3. Contamination from the aquatic environment. Waters contaminated by domestic or industrial waste may contain high bacterial loads. Fish inhabiting such environments may therefore carry substantial numbers of microorganisms even before capture.
4. Poor sanitation and hygiene. Contamination may originate from unclean display tables, inadequately washed cutting equipment, unhygienic handling by vendors, or contaminated washing water.
5. High ambient temperatures at the market. Traditional markets commonly have

ambient temperatures of approximately 28–35°C, a range that supports the growth of many mesophilic bacteria (Huss, 1995; Department of Trade and Industry, 2001; Wang & Zheng, 2025).

In addition to these factors, Huss (1995) identified several biological characteristics that may explain the high TPC values observed in mackerel tuna and mackerel:

1. Mackerel tuna and mackerel are pelagic fish that live within the water column, swim rapidly, and commonly form schools. Their high metabolic rates may accelerate post-mortem deterioration and reduce product quality.
2. Their muscle tissue contains approximately 70–80% water, resulting in high water activity that supports microbial growth.
3. Mackerel tuna and mackerel have relatively high protein contents of approximately 25.0% and 21.3%, respectively.
4. These fish also contain high concentrations of non-protein nitrogen compounds, which bacteria can use more readily than intact proteins.

Isolation of Bacteria on Selective Media

Bacterial isolation from fish samples obtained from nine selected fresh marine fish vendors yielded 32 isolates with varying growth characteristics on selective media, including Xylose Lysine Deoxycholate agar (XLD), MacConkey agar (MCA), Mannitol Salt Agar (MSA), and Thiosulfate-Citrate-Bile Salts-Sucrose agar (TCBS).

Of the 32 isolates, 10 exhibited colony and cellular morphological characteristics resembling those of the target, potentially pathogenic bacteria. These isolates were TKA and TBA on MCA; TBA on TCBS; KBA, TKB, and TBB on MCA; KBB and KBC on XLD; and TKC and TBC on TCBS. These 10 isolates were selected for further characterization. Isolates whose characteristics did not resemble those of the target bacteria were excluded from subsequent analyses. Identification was conducted sequentially through colony-morphology characterization, cellular-morphology assessment using Gram staining, and biochemical testing.

Colony and Cellular Morphological Characteristics of the Isolates

Ten bacterial isolates were obtained from nine fresh marine fish samples sold at Kebon Roek Market. Their colony and cellular morphological characteristics are presented in Table 2.

Table 2. Colony and cellular morphological characteristics of the bacterial isolates

No.	Isolate code	Selective medium	Colony color	Colony form	Elevation	Margin	Gram reaction	Cell shape
1	TKA	MCA	Shiny pink	Circular	Convex	Entire	Negative	Rod-shaped
2	TBA	MCA	Pink	Circular	Convex	Entire	Negative	Rod-shaped
3	TBA	TCBS	Yellow	Circular	Convex	Entire	Negative	Comma-shaped or curved rod
4	KBA	MCA	Pink	Circular	Convex	Entire	Negative	Rod-shaped
5	TKB	MCA	Shiny pink	Circular	Convex	Entire	Negative	Rod-shaped
6	TBB	MCA	Translucent pink	Circular	Convex	Entire	Negative	Rod-shaped
7	KBB	XLD	Cream with black centers	Irregular	Convex	Entire	Negative	Rod-shaped
8	TKC	TCBS	Green	Circular	Convex	Entire	Negative	Rod-shaped
9	TBC	TCBS	Green	Circular	Convex	Entire	Negative	Rod-shaped
10	KBC	XLD	Cream with black centers	Irregular	Convex	Entire	Negative	Rod-shaped

Table Note: TKA, mackerel tuna sample I; TBA, sardinella sample I; KBA, mackerel sample I; TKB, mackerel tuna sample II; TBB, sardinella sample II; KBB, mackerel sample II; TKC, mackerel tuna sample III; TBC, sardinella sample III; and KBC, mackerel sample III.

Figure 2 presents the colony and cellular morphologies of bacteria isolated from the three fish species collected at Kebon Roek Market.

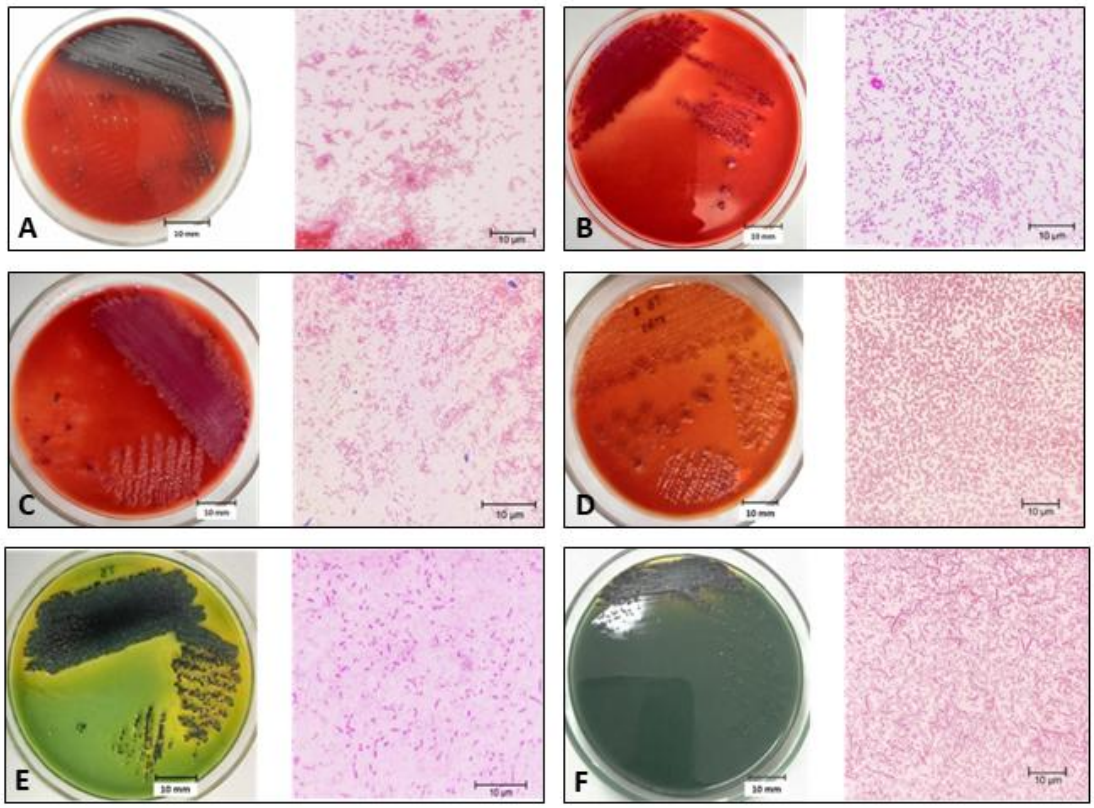

Figure 2. Colony and cellular morphologies of fish-contaminating bacteria isolated from three fish species sold at Kebon Roek Market (A. *Salmonella* spp. in the mackerel sample; B. *Escherichia* spp. in the mackerel tuna sample; C. *Escherichia* spp. in the sardinella and mackerel samples; D. *Escherichia* sp. in the sardinella sample; E. *Vibrio* spp. in the sardinella sample; and F. *Vibrio* spp. in the mackerel tuna and sardinella samples)

Observations of bacterial colony morphology revealed distinct characteristics among isolates grown on the different selective media. On XLD, the colonies were cream-colored with black centers, irregular in form, convex in elevation, and irregular at the margins. The presence of black centers suggested hydrogen sulfide production.

On MCA, most isolates produced pink to shiny-pink, circular colonies with convex elevations and entire margins. These characteristics were consistent with those of lactose-fermenting Gram-negative bacteria. The TBB isolate grown on MCA formed translucent-pink, circular colonies with convex elevations and entire margins, indicating its ability to ferment lactose. Gram staining showed that the isolate consisted of Gram-negative, rod-shaped cells. These characteristics are consistent with those of *E. coli*, which is a Gram-negative, rod-shaped bacterium that typically forms smooth colonies with convex surfaces (Rahmawati et al., 2021).

On TCBS, the isolates produced yellow or green, circular colonies with convex elevations and entire margins, indicating differences in their ability to ferment sucrose. The TBA isolate on TCBS exhibited circular colonies with entire margins and convex

elevations. Its green colony color indicated an inability to ferment sucrose. Cellular-morphology observations showed Gram-negative, comma-shaped or curved rods. This finding is consistent with Ihsan (2021), who described *Vibrio* as a Gram-negative bacterium with short, curved rod-shaped cells.

Overall, Gram-staining results showed that all isolates belonged to the Gram-negative bacterial group, although their cellular shapes varied. Most isolates were rod-shaped, whereas the TBA isolate exhibited comma-shaped or curved rod-shaped cells.

Biochemical Characteristics of the Isolates

The biochemical characteristics of the isolates obtained from nine fresh marine fish samples sold at Kebon Roek Market are presented in Table 3.

Table 3. Biochemical characteristics of the bacterial isolates

Biochemical test	XLD–KBB	XLD–KBC	MCA–TKA	MCA–TBA	MCA–KBA	MCA–TKB	MCA–TBB	TCBS–TBA	TCBS–TKC	TCBS–TBC
TSI	K/A (+/−)	K/A (+/−)	K/A (−/+)	K/K (+/+)	K/K (+/+)	K/A (−/+)	A/A (−/+)	K/A (−/+)	K/A (−/−)	K/A (−/−)
Simmons' citrate	+	+	+	+	+	+	−	+	+	+
Urease	−	−	+	+	+	+	−	—	—	—
Motility	+	+	+	+	+	+	+	+	−	−
Indole	+	+	−	−	−	−	−	+	−	−
Ornithine	+	+	+	+	+	+	−	+	−	−
Acid from glucose	+	+	+	+	+	+	+	−	+	+
Acid from sucrose	−	−	+	−	−	+	−	+	+	+
Acid from lactose	−	−	+	+	+	+	+	+	+	+
Acid from maltose	+	+	+	+	+	+	+	+	+	+
Acid from mannitol	−	−	+	+	+	+	+	+	+	+
Methyl red	+	+	−	+	+	−	+	−	−	−
Voges–Proskauer	−	−	+	−	−	+	−	−	+	+
Oxidase	−	−	−	−	−	−	−	+	+	+
Presumptive identification	*Edwardsiella*	*Edwardsiella*	*Enterobacter*	*Citrobacter*	*Citrobacter*	*Enterobacter*	*Escherichia*	*Vibrio*	*Aeromonas*	*Aeromonas*

Table note: TKA, mackerel tuna sample I; TBA, sardinella sample I; KBA, mackerel sample I; TKB, mackerel tuna sample II; TBB, sardinella sample II; KBB, mackerel sample II; TKC, mackerel tuna sample III; TBC, sardinella sample III; and KBC, mackerel sample III. A, acid reaction; K, alkaline reaction; and —, result not reported.

Biochemical testing was conducted to determine the genera of the potentially pathogenic bacteria obtained during isolation. Among the isolates subjected to further testing, two exhibited biochemical characteristics consistent with the target bacteria. *Vibrio* spp. were presumptively identified in the TBA isolate grown on TCBS, whereas *Escherichia* sp. was identified in the TBB isolate grown on MCA.

Several non-target bacteria were also presumptively identified. *Enterobacter* spp. were detected in the TKA and TKB isolates, *Citrobacter* spp. in the TBA and KBA isolates, *Edwardsiella* spp. in the KBB and KBC isolates, and *Aeromonas* spp. in the TKC and TBC isolates. These bacteria were recovered on MCA, XLD, and TCBS. The biochemical tests were used to strengthen the presumptive identification of the bacterial isolates.

The Triple Sugar Iron agar test produced different reaction patterns among the

isolates, reflecting variations in their ability to ferment glucose, lactose, and sucrose. The TBB isolate, presumptively identified as *Escherichia* sp., produced an A/A reaction, indicating an acidic reaction in both the slant and the butt of the tube. This result indicated that the isolate was able to ferment glucose and lactose (Holt et al., 1994; Ihsan, 2021).

The Simmons' citrate test was positive for the *Enterobacter* spp. and *Citrobacter* spp. isolates, indicating their ability to use citrate as a carbon source. In contrast, the *Escherichia* sp. isolate produced a negative result. The indole test was positive for the *Edwardsiella* spp. isolates, indicating their ability to produce indole from the amino acid tryptophan (Holt et al., 1994; Burhana et al., 2024).

The oxidase test was positive for the *Vibrio* and *Aeromonas* isolates, indicating that these genera belong to a group of non-enteric Gram-negative bacteria that possess cytochrome oxidase enzymes. In addition, the isolates grown on TCBS produced positive catalase-test results, demonstrating their ability to synthesize catalase, which decomposes hydrogen peroxide into water and oxygen. This characteristic is commonly observed among facultatively anaerobic bacteria (Holt et al., 1994; Lestari et al., 2020).

Pathogenic *Vibrio*, particularly *V. cholerae*, may be transmitted through water contaminated with fecal material from infected individuals. Mechanical transmission by insects, such as green flies, may also occur (Faudiyah, 2020). Inadequate market sanitation may further increase the risk of contamination because these bacteria can proliferate rapidly at ambient temperature when fish are not promptly chilled (Ihsan, 2021).

The presence of *Escherichia* in fresh marine fish generally does not originate from the fish themselves but results from secondary contamination during post-harvest handling. Contamination may arise from unhygienic fish-handling equipment, including storage containers. Contaminated ice may also facilitate bacterial transfer to fish. Furthermore, inadequate market sanitation, including humid and contaminated environmental conditions, increases the likelihood of contamination during display and sale (Napitupulu, 2017).

The detection of *Enterobacter* and *Citrobacter* in the fish samples indicates possible fecal or environmental contamination. Potential sources include seawater contaminated by domestic waste, inadequately cleaned fish-handling equipment, and direct contact with the hands of fish handlers during market transactions (Lestari et al., 2020).

Edwardsiella spp. are opportunistic pathogens frequently found in both freshwater and marine fish, particularly when fish experience stress associated with post-harvest handling. The presence of *Edwardsiella* spp. may therefore have been associated with declining fish quality caused by suboptimal storage conditions. Plumb (2018) reported that these bacteria can proliferate readily in fish exposed to environmental stress.

Salmonella spp., *Escherichia coli*, and *Vibrio* spp. are among the bacterial groups most frequently associated with foodborne diseases in humans. Meanwhile, *Edwardsiella* spp., *Citrobacter* spp., and several *Vibrio* species may also act as fish pathogens, thereby reducing fish quality and adversely affecting fish health (Austin & Austin, 2007; Hegde et al., 2023).

CONCLUSION

This study demonstrated that the bacterial loads detected in Indian mackerel tuna (*Euthynnus* sp.) and mackerel (*Rastrelliger* sp.) exceeded the maximum limits

specified in SNI 7388:2009. Potentially pathogenic bacterial genera identified among the three fish species examined included *Salmonella* spp., *Escherichia* sp., *Vibrio* spp., *Enterobacter* spp., *Citrobacter* spp., and *Edwardsiella* spp. These findings indicate that the microbiological quality of the fresh marine fish examined did not consistently meet the applicable food safety standard. The elevated bacterial loads and the detection of potentially pathogenic bacteria suggest inadequate hygienic control during handling, storage, or marketing and may represent a potential food safety concern for consumers.

RECOMMENDATION

The bacterial counts exceeding the established standards and the detection of several potentially pathogenic bacterial genera in fresh marine fish sold at Kebon Roek Market highlight the need to improve post-harvest handling practices, maintain an effective cold chain, strengthen sanitation and hygiene measures, and conduct regular quality monitoring. These measures are essential to ensure food safety and protect consumer health.

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