



Isolation and Identification of *Vibrio* sp. from Marine Fishes of Mumbai, Maharashtra, India

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Vibrio is a common bacterium found in marine fishes. *Vibrio* species are pathogenic to humans and cause various gastrointestinal diseases. Fish markets, fish harvesting areas, vectors like flies, seawater and sometimes fresh water bodies are the source of spread of this bacterium. Improper handling or pathogen contamination during transit has an impact not only on human health but also on the population of marine fish. *Vibrio* is known to be a human pathogen, the onset and spread of this bacterium causes severe diarrhoea. In this study, the presence of *Vibrio* species in marine water fishes was determined from fishes collected from various fish markets in Mumbai, Maharashtra. Various biochemical tests were performed to isolate and identify the *Vibrio* species. In the family *Vibrionaceae* three species such as *Vibrio cholera*, *Vibrio parahaemolyticus* and *Vibrio*

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vulnificus were identified. Additionally, a survey was conducted using google forms to understand the consumption rate of fish by people and also to gauge the awareness among public about the bacterial disease caused by consumption of fishes. It was observed that a large number of individuals consumed various types of fishes including marine and freshwater fishes on a regular basis. People also consume raw fish delicacies. However, very few individuals were aware of the bacteria and its related diseases, most of the participants were unaware of the presence of bacteria like *Vibrio cholera* and its associated diseases.

Keywords: *Vibrio*; biochemical; isolation; identification; gastrointestinal; contamination.

1. INTRODUCTION

Mumbai, a metropolitan city situated along the seacoast, heavily relies on fish as a staple food. Fishing is not only an occupation but also a source of livelihood for many fishermen. However, fish is prone to bacterial contamination, which can have harmful effects on both the fish and those who consume it. Bacteria like *E. coli*, *Aeromonas hydrophilus* and *Vibrio* are found in fish, with *Vibrio* being the most dangerous as it can cause gastrointestinal diseases in humans. The consumption of various fish delicacies, such as dried fish and raw fish like sushi, especially if the fish is undercooked, increases the risk of bacterial infections. The main sources of bacterial contamination in seafood are the transit from the shore, landing centres, fish harvesting areas and fish markets. *Vibrio* species, which are halophilic and commonly found in marine waters, can contaminate seafood and lead to diseases like cholera and gastroenteritis. Contamination of seafood with *Vibrio* may lead to illnesses like cholera and gastroenteritis [1]. Cholera, a highly deadly bacterial disease that causes diarrhoea is a common phenomenon observed in various parts of the globe, especially India. The two major outbreaks were observed in 1997-2000 (68 outbreaks) and in 2009-2017 (559 outbreaks) in India [2,3,4].

In this study, fish like mackerels (*Rastrelliger kanagurta*), white mullets (*Mugil curema*), lady fishes (*Elops saurus*) and sawfish (*Pristis pectinata*) were selected, which are commonly consumed by the local people of Mumbai as it is cheap and easily available. These fishes were collected and examined for the presence of bacteria, Gram-negative bacteria isolated from them were characterised; and using biochemical assay, the genus of *Vibrio* was identified. *Vibrio* are found in seawater, brackish water and freshwater; they are gram-negative bacteria that are small, comma-shaped microorganisms that are facultative anaerobes (without oxygen requirements), do not produce spores and can

survive in a salty environment. *Vibrio* species that are majorly pathogenic to humans are *V. cholerae*, *V. parahemolyticus* and *V. vulnificans*. It was found responsible for gastroenteritis, wound infections and septicaemia [5]. Other species like *Vibrio alginolyticus*, *Vibrio fluvialis*, *Vibrio mimicus*, *Vibrio furnissii*, etc. are less severe but have pathogenic potential for humans [6]. People consume food that is contaminated with such bacteria, and the bacteria cross the gastric barrier and infect the intestine. They form colonies and multiply in the intestine, releasing toxins. This bacterium spreads fast to those who are immunocompromised and also to those individuals who use antacids and have GI tract-related disorders.

The purpose of this study is to isolate and identify *Vibrio* species and to explore the occurrence of *Vibrio cholera*, *Vibrio parahaemolyticus* and *Vibrio vulnificans* in fish and the potential risks they pose to human health. In addition, measures such as monitoring fish and seafood products for these pathogens, implementing appropriate sanitation measures in seafood processing plants and educating people about the risks of consuming raw or undercooked seafood can help to reduce the incidence of *Vibrio*- associated foodborne diseases.

2. MATERIALS AND METHODS

For the present study, the investigation was divided into two parts:

- 1) Isolation and identification of *Vibrio* species through biochemical test.
- 2) To understand the awareness among people about the bacterial diseases caused by fish consumption using Google Survey Form.

2.1 Isolation and Identification of *Vibrio* Through Biochemical Test

The isolation and identification of *Vibrio* was done as described in Bacteriological

Analytical Manual by FDA 2004 and Bergey's Manual [7,8].

Sampling Method: A total of 120 fish were collected from three different fish markets in Mumbai. Mackerel (N = 30), white mullet (N = 30), ladyfish (N = 30) and sawfish (N = 30) samples were collected from local markets in the study area. From one location, the collection of samples was done twice; five fish were collected each time. The samples were collected using polythene bags, labelled and transported to the laboratory for analysis.

The methodology for the isolation of *Vibrio* species from fish samples can be summarized as follows:

Sample preparation: Samples of fish muscles were obtained and homogenized with distilled water.

Enrichment: 1 ml of the sample was suspended in 9 ml of Alkaline Peptone Water (APW) with pH 8.2 and incubated at 37°C for exactly 24 hours.

Isolation: Loop full of the surface aliquot from the APW culture and streaked it onto the surface of Thiosulfate Citrate Bile Salts Sucrose (TCBS) agar. Incubated the plate at 37°C overnight.

Examination: TCBS plates were examined for yellow and green colonies that resemble *Vibrio*

species. A single colony of each colour was isolated and inoculated onto Nutrient Agar (NA). Incubated NA at 37°C for overnight.

Biochemical Testing: Biochemical Testing of *Vibrio* was done as described in the Bacteriological analytical manual by FDA 2004 and Bergey's Manual. Following biochemical, tests were performed on the isolated *Vibrio* culture: gram staining [9], growth in different salt concentrations (0%, 3%, 6%, 8%, and 10% NaCl), Voges Proskauer test, lysine decarboxylase, sucrose test, indole test, nitrate reduction test, triple sugar iron (TSI) test, oxidase test, string test [7,8].

3. RESULTS AND DISCUSSION

In the present study, 120 samples of fish were collected and grouped according to the location. After enrichment and isolation on selective media TCBS agar, biochemical tests were performed. As a result, *Vibrio cholera* was found in 60 samples; *Vibrio vulnificans* was found in 10 samples; and *Vibrio parahaemolyticus* was found in 10 samples. In 10 samples, *Vibrio* was absent.

Gram staining was performed and all samples were gram-negative. The observations of the biochemical test are summarized below in the Table 2.

Table 1. Fish sample collection from three location in batches

Name of Fish	Name of Location	Collection	No. of Fishes	Total Fishes Collected
Mackerel	Location 01: Malad	Collection 1	5	30 Mackerels were collected
		Collection 2	5	
	Location 02: Andheri	Collection 1	5	
		Collection 2	5	
	Location 03: Versova	Collection 1	5	
		Collection 2	5	
White Mullet	Location 01: Malad	Collection 1	5	30 White Mullets were collected
		Collection 2	5	
	Location 02: Andheri	Collection 1	5	
		Collection 2	5	
	Location 03: Versova	Collection 1	5	
		Collection 2	5	
Lady Fish	Location 01: Malad	Collection 1	5	30 Lady Fish were collected
		Collection 2	5	
	Location 02: Andheri	Collection 1	5	
		Collection 2	5	
	Location 03: Versova	Collection 1	5	
		Collection 2	5	
Saw Fish	Location 01: Malad	Collection 1	5	30 Saw Fish were collected
		Collection 2	5	
	Location 02: Andheri	Collection 1	5	
		Collection 2	5	
	Location 03: Versova	Collection 1	5	
		Collection 2	5	
				total = 120

Table 2. Observation and Interpretation table for biochemical test for Vibrio

Name of Fish	Name of Location	Colonies on TCBS plate	Gram staining	Growth In					VP	Lysine	Sucrose	Indole	NO ₃ reduction	TSI				String Test	Oxidase test	Interpretation
				0% salt	3% salt	6% salt	8% salt	10% salt						butt	Slant	H ₂ S	Gas			
Mackerel	Location 01: Malad	Small Yellow	Negative	+	-	-	-	-	-	+	+	-	+					Positive	Positive	<i>V. cholera</i>
	Location 02: Andheri	Small Green	Negative	+	+	+	-	-	-	+	-	-	+			Butt Positive		Positive	Positive	<i>NA</i>
	Location 03: Versova	Small Yellow	Negative	+	+	+	+	-	-	+	+	-	+					Positive	Positive	<i>V. cholera</i>
White Mullet	Location 01: Malad	Small Green	Negative	+	+	-	-	-	-	+	-	-	+					Positive	Positive	<i>V. vulnificus</i>
	Location 02: Andheri	Small Green	Negative	+	+	+	-	-	-	+	-	-	+			Butt Positive		Positive	Positive	<i>NA</i>
	Location 03: Versova	Small Green	Negative	+	+		-	-	-	+	-	-	+		Alkaline			Negative	Positive	<i>V. parahaemolyticus</i>
Lady Fish	Location 01: Malad	Small Green	Negative	+	+	-	-	-	-	+	-	-	+					Positive	Positive	<i>V. vulnificus</i>
	Location 02: Andheri	Small Yellow	Negative	+	+		-	-	-	+	+	-	+					Positive	Positive	<i>V. cholera</i>
	Location 03: Versova	Small Yellow	Negative	+	+	+	+	-	-	+	+	-	+					Positive	Positive	<i>V. cholera</i>
Saw Fish	Location 01: Malad	Small Yellow	Negative	+	-	-	-	-	-	+	+	-	+					Positive	Positive	<i>V. cholera</i>
	Location 02: Andheri	Small Yellow	Negative	+	+		-	-	-	+	+	-	+					Positive	Positive	<i>V. cholera</i>
	Location 03: Versova	Small Green	Negative	+	+		-	-	-	+	-	-	+		Alkaline			Negative	Positive	<i>V. parahaemolyticus</i>

The observation and results of the biochemical test can be summarized as: *Vibrio cholera* species were found in samples of mackerel and sawfish collected from Malad (Market 1) and Versova (Market 3). Ladyfish collected from Andheri (Market 2) and Versova (Market 3) also show the presence of *Vibrio cholera*. White mullets and ladyfish obtained from Malad (Market 1) show presence of *Vibrio vulnificans* and *Vibrio parahaemolyticus* was found in white mullets and sawfish collected from Versova (Market 3). *Vibrio* species are absent in mackerel and white mullets that were taken from Andheri (Market 2)

Survey on Consumption of Fish and Its Impact on Health: Survey was conducted to understand the consumption of fish food by the people and whether they are aware about the bacterial disease caused by consumption of fishes.

In a Google survey form, various questions were asked, such as which fish are commonly consumed by people, how often they consume them, how much they consume, the method of cooking fish, whether they experience any medical symptoms or illness after consuming fish and whether they are aware of the bacteria and contamination. 140 responses were received in the survey.

In the present study, *Vibrio cholera*, *Vibrio parahaemolyticus* and *Vibrio vulnificans* are the three different species identified from the fish samples that were collected from Malad, Andheri

and Versova which are different fish markets in Mumbai. *Vibrio cholera* was identified from samples of mackerels and saw fish, that were collected from Malad and Versova fish markets. Lady Fish collected from Andheri and Versova, also shows presence of *Vibrio cholera*. *Vibrio parahaemolyticus* was identified from the white mullets and saw fish collected from Versova. *Vibrio vulnificans* was identified from the white mullets and Lady Fish which were collected from Malad. No *Vibrio* species were identified from the Mackerels and White Mullet, which were collected from Andheri. A study from north-western Mumbai examined 140 samples of various fish and shellfish for the pathogenic strain of *V. parahaemolyticus* [10], the fact that species of *Vibrio parahaemolyticus* was identified from Versova (Mumbai) in the current study, it is likely that different coastal regions of Mumbai also regularly host these *Vibrio* species. Studies from south of India is comparable as they have identified the similar species of *V. parahaemolyticus* using Biochemical test and PCR [11,12,13]. According to a study in the south-west coast of India, 93.87% of samples were identified as *Vibrio parahaemolyticus* [14]. In Kolkata, 90 samples were collected and 60 samples were positive for *V. parahaemolyticus* [15]. Arunkumar and co-workers isolated 155 strains of *vibrio* species from south east region of Tamil Nadu and Puducherry [16]. These studies from over all India gives us a brief idea about the spread of *Vibrio parahaemolyticus* in various parts of India.

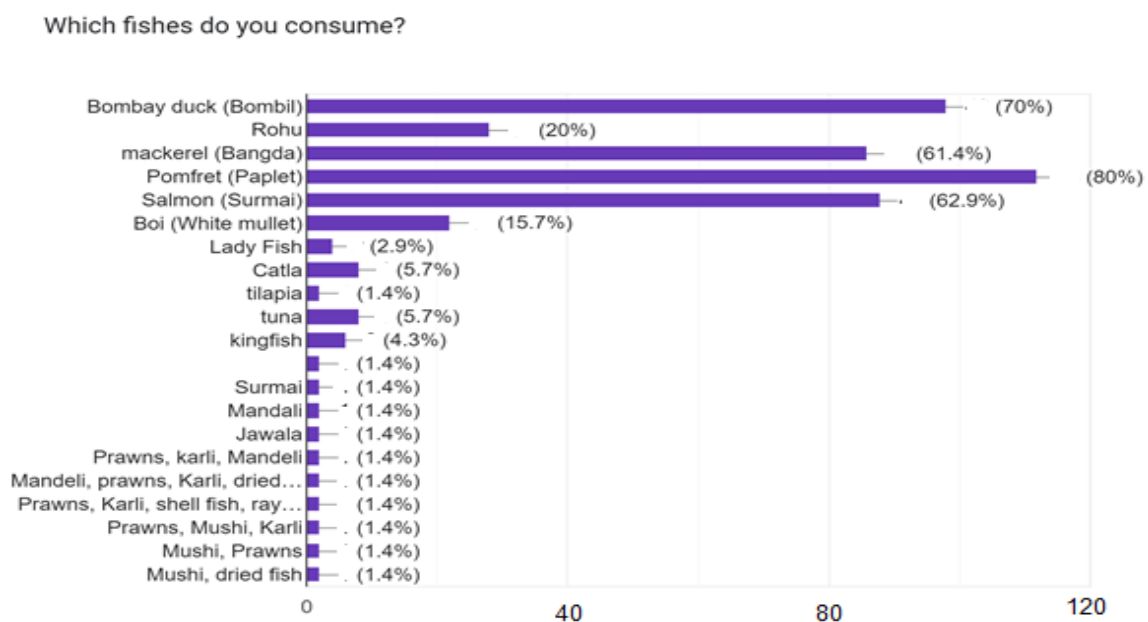


Fig. 1. Responses of Survey Question 1

Have you ever fallen sick after consume fish?

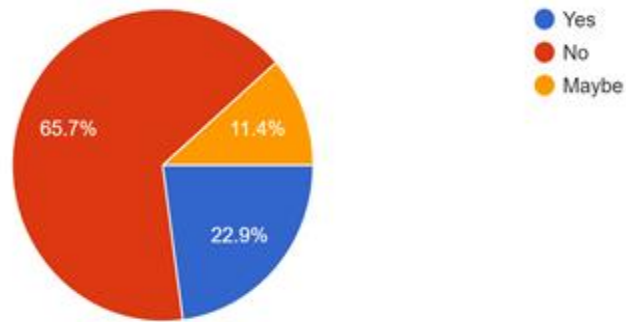


Fig. 2. Responses of Survey Question 2

Have you experienced any of the following symptoms after consumption of fish?

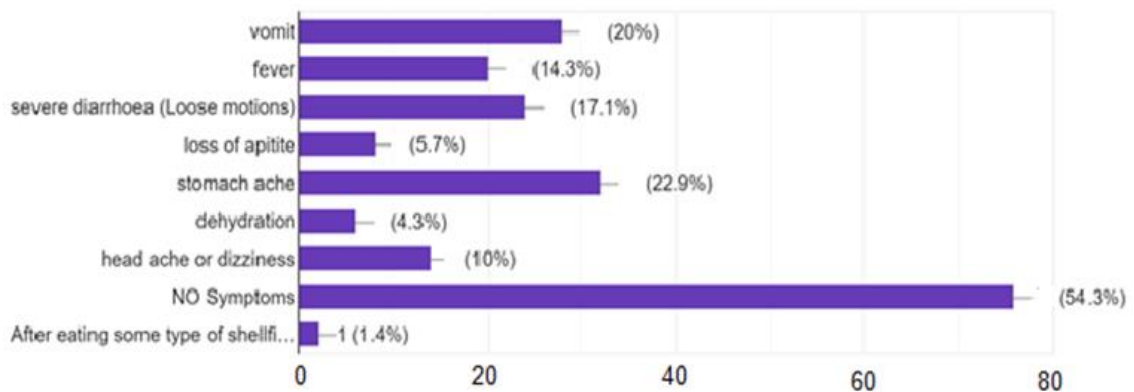


Fig. 3. Responses of Survey Question 3

Have you heard about the following bacteria and if Yes, which cause bacteria disease?

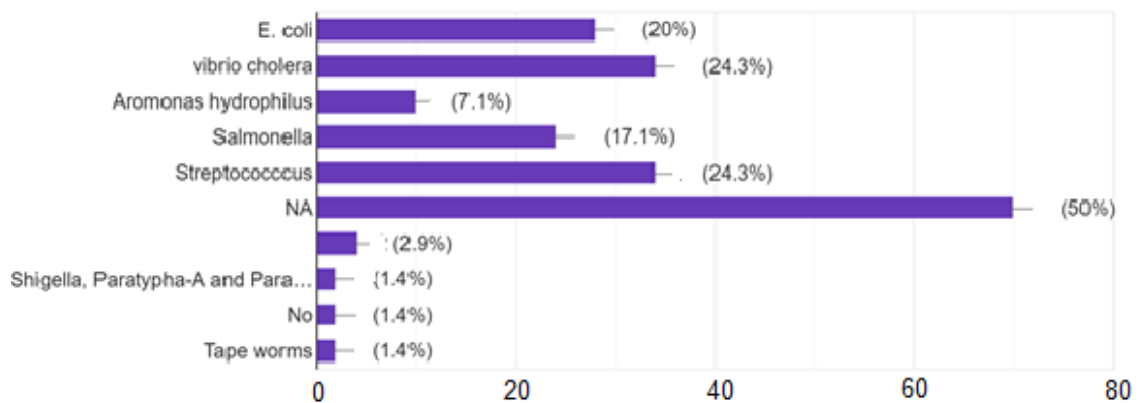


Fig. 4. Responses of Survey Question 4

K. Arunagiri and associates, who collected twenty fish and crab samples from fish stores in Kanchipuram and Walajapet, carried out similar study. They identified 21 species of *Vibrio* from fin fish and other aquatic materials [17], and the results of the current study showed that three of the 21 species of *Vibrio* were common in both the investigations.

In a similar investigation by Mookerjee and co-workers, 120 surface water samples were collected for testing from three separate locations along the Hooghly River in order to test the water for *Vibrio*. In the water samples five enteropathogenic *Vibrio* species, including *Vibrio cholerae* (35%), *Vibrio parahaemolyticus* (22.5%), *Vibrio mimicus* (19.1%), *Vibrio alginolyticus* (15.8%) and *Vibrio vulnificus* (11.6%), were present [18]. Among these five species of *Vibrio*, the three species identified in present study were common, however their sample is river water whereas we isolated *Vibrio* from marine fishes.

Other than India different Asian countries have also identified *Vibrio* in the fishes. In Sri-lanka, seven biochemical tests were performed on 159 samples collected from Mutwal and Chilwa and twelve species were thus isolated and identified within the family *Vibrionaceae*, including *A. hydrophila*, *V. cholerae*, *V. metschnikovii*, *V. parahaemolyticus*, *V. carchariae*, *P. shigelloides*, *V. vulnificus*, *V. damsela*, *V. mimicus*, *V. furnissii*, and *V. fluvialis* [19]. Among these species the three species identified in this study are same. TCBS is the selective media used for the culture of *Vibrio*. Chythanya and co-workers in their study of clinical samples eliminated majority of non-target microbes using a selective medium like TCBS agar. They identified *V. vulnificus*, *V. parahaemolyticus*, *V. damsela*, and *V. fluvialis* from moribund shrimps on TCBS agar [20], two of the species *V. parahaemolyticus* and *V. vulnificans* are common to present study. Nambabi and associates have isolated and identified various *vibrio* species and they concluded that various intrinsic and extrinsic factors are responsible for the deterioration of the fishes [21].

Survey was conducted and it was found that people consume fish food, some of them observe various symptoms and fell sick, contamination of fish can be a major reason. Most of the people are unaware about the various bacteria that are human pathogens and may cause diseases. It is necessary to educate people about sanitization

and how to prevent contamination of such food. As people are moderately aware about the ocean pollution and contamination, it is necessary to have holistic approach for making new policies [22]. There are multiple problems faced by the people who consume fish and also by aquaculture sector because *vibrio* have ability to adapt to marine environment. [23] Without public awareness and support, it is difficult to protect the marine protection acts [24].

4. CONCLUSION

In the fish markets of Mumbai, the fishes were biochemically tested using various parameters (Gram staining, growth in different salt concentrations, VP test, Lysine, sucrose, indole, TSI, string test, oxidase test) for the presence of gram-negative bacteria *Vibrio* and 10 out of 12 groups were identified with *Vibrio cholera*, *Vibrio parahaemolyticus*, *Vibrio vulnificus*. The presence of these species indicates that there is contamination of the seafood with bacteria which may cause diseases like Cholera and gastroenteritis. These species' existence suggests that the fishes have been contaminated with bacteria, which could result in illnesses like *cholera* and gastroenteritis. Novel methods like PCR or 16S-23S sequencing can be used to enhance the identification protocols. To determine the extent of contamination and the risk of illness, more samples, including fish and other crustaceans, need to be examined. The research might assist the officials in adopting appropriate measures to prevent the spread of illness. Additionally, a survey was conducted through google forms to understand the consumption of fish food by the people and whether they are aware of the bacterial disease caused by the consumption of fish. It was found that people consumed various types of fish including marine and freshwater fishes. People also consume raw fish delicacies and use various cooking techniques for fish. Very few people are aware of the bacteria and its related diseases.

CONFERENCE DISCLAIMER

Some part of this manuscript was previously presented and published in the conference: An International Conference on Coastal and Marine Conservation CMC-2024 dated from 1st and 2nd March, 2024 in Mumbai, India. Web Link of the proceeding: <https://mithibai.ac.in/wp-content/uploads/2024/02/CMC2024-CONFERENCE-brochure..pdf>

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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