Occurrence of antimicrobial resistant or pathogenic *Vibrio parahaemolyticus* in seafood. A mini review

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**Abstract**

*Vibrio parahaemolyticus* is a Gram-negative, non-sucrose fermenting marine halophilic bacterium. It is widely prevalent in the aquatic environment and is frequently isolated from seafood. Moreover, some *V. parahaemolyticus* strains isolated from seafood are pathogenic. *V. parahaemolyticus* is a human pathogen causing gastroenteritis after consumption of raw or undercooked seafood. Microbiological safety of seafood is of global concern in recent years due to outbreaks of seafood-borne pathogens such as *V. parahaemolyticus*. There has been recent increase of reports on antibiotic resistance among *V. parahaemolyticus* isolated from seafood. The emergence of antimicrobial resistant seafood-borne pathogens poses threat to human health. With regard to the increasing reports of *V. parahaemolyticus* food borne infections, we aimed to review occurrence of antibiotic resistant *V. parahaemolyticus* in selected seafood and its importance to consumers’ health.

**Keywords:** *V. parahaemolyticus*, occurrence, antimicrobial resistance, food safety

**Introduction**

Seafood has been described as one of the fastest growing sources of food in the world and serves as a major source of income to many developing and developed countries [55]. Various health benefits such as reduction of heart diseases risk [29, 41] and neural development during gestation and infancy [10, 16, 23] have been attributed to consumption of seafood. Despite the high benefits of seafood consumption, health risks related to seafood consumption cannot be overemphasized [23]. According to Wang et al. [59] and Iwamoto et al. [23], seafood (mollusks, finfish, marine mammals, fish eggs and crustaceans) constitute an important route of transmission of pathogenic microorganisms to human. Outbreaks of epidemic diarrhoea linked with consumption of contaminated raw seafood have been reported in different parts of the world. Feldhusen [14] investigated major bacterial pathogens that have been associated with seafood-borne diseases. Subsequent contamination may occur in various stages like processing, storage and distribution of seafood. Sources of contamination include water, facilities, equipment and handlers. The processing stage is particularly important due to the high microbial load on the surface of processing facilities. According to Hernandez-Macedo et al. [22], fecal materials containing spoilage microorganisms and pathogens can serve as source of microbial contamination of seafood.

Antimicrobial agents are commonly used in aquaculture either as preventive or curative treatments [12]. Antibiotic resistant *V. parahaemolyticus* has been reported recently [3, 5, 12, 47]. The emergence and re-emergence of antimicrobial resistant seafood-borne pathogens in recent years pose threat to human health [28]. This has been attributed to factors such as indiscriminate use of antibiotics in aquaculture.

With regard to the increasing reports of *V. parahaemolyticus* food-borne infections, we aimed to reviewing occurrence and prevalence of antibiotics resistant *V. parahaemolyticus* in seafood and its importance to consumers’ health.
Characteristics of *V. parahaemolyticus*

*V. parahaemolyticus* belongs to the family *Vibrionaceae*. It is a non-sucrose fermenting halophilic bacterium that can grow between 10 °C and 44 °C (optimum 35-37 °C), pH ranges from 5 to 11 and with 3-8% NaCl tolerance. *V. parahaemolyticus* possesses somatic (O) and capsular (K) antigens, and on this basis 12 O and 65 K groups have been determined [21, 58, 63]. It has been isolated from aquatic environment such as seawater, sediment and diverse vertebrate and invertebrate seafood [53]. *V. parahaemolyticus* is a human pathogen that causes gastroenteritis due to the presence of thermo-stable direct hemolysin (TDH) or TDH-related hemolysin (TRH) toxins, encoded by *tdh* and *trh* genes [2].

**V. parahaemolyticus** gastroenteritis in humans

The survival of *V. parahaemolyticus* in seafood subjected to chilling, freezing, heating, drying and smoking has been reported. This organism is being completely destroyed in cooked foods [43]. However, some seafood such as oysters is consumed raw. The consumption of raw or undercooked seafood contaminated with *V. parahaemolyticus* may cause acute gastroenteritis. This bacterium is recognized as the leading cause of human gastroenteritis associated with seafood consumption in the United States and an important seafood-borne pathogen throughout the world [49]. *V. parahaemolyticus* was firstly reported as seafood-borne pathogen in Japan in 1950 [21, 35]. Since then, various outbreaks due to consumption of either contaminated raw or undercooked seafood have been reported in countries such as the United States [13, 23, 39], China [36], Taiwan [6], Spain [37], Italy [46], Chile [17], Peru [18] and Brazil [31]. The number of outbreaks of *V. parahaemolyticus* infections in the aforementioned countries varies. For example, in the United States, 40 outbreaks of *V. parahaemolyticus* infection were registered during the period between 1973 and 1998 that included more than 1000 illnesses [11]. More than 300 gastroenteritis outbreaks due to *V. parahaemolyticus* were reported in China between 2003 to 2008, which resulted into over 9000 illnesses and 3940 hospitalizations [60]. According to Letchumanan et al. [33], *V. parahaemolyticus* causes 20-30% of food borne diseases in Japan and many cases in Asian countries. Martinez-Urtaza et al. [38] summarized data regarding several *V. parahaemolyticus* outbreaks in Spain. *V. parahaemolyticus* infection is characterized with acute abdominal pain, vomiting, watery or bloody diarrhea and gastroenteritis [2, 58] with an incubation period of 4 to 96 hours [35]. According to Zamora-Pantoja et al. [63], infective dose varies between 10³ and 10⁵ cfu, and the infection is self-limiting over a period of a week. Three serotypes, namely O3:K6, O4:K68, and O1:K untypeable (KUT), cause a pandemic of *V. parahaemolyticus* infecton [7]. Non-toxic *V. parahaemolyticus* strains do not cause any infection [25].

**Occurrence of *V. parahaemolyticus* in seafood**

*V. parahaemolyticus* is widely prevalent in the aquatic environment and is frequently isolated from seafood. The bacterium was found out to be prevalent among oysters (48.8-100%), mussels (34-68.1%), clams (63.9-100%), cockles (7.5-62%), scallops (55-60%), shrimps (7.1-57.8%), crabs (20%), fish (2.9-45.1%). Moreover, some *V. parahaemolyticus* strains isolated from seafood are pathogenic [1, 27, 30, 48, 50, 61, 64, 65]. The number of *V. parahaemolyticus* in seafood varies (Table I). Enumeration of this organism from seafood is important because Food and Drug Administration (FDA) stipulate less than 10⁶ cfu/g in seafood. However, despite this permissible limit, there are still outbreaks in the United States. Seafood has been described as vehicle of transmission of food borne bacteria that cause human illness worldwide [34]. The prevalence of *V. parahaemolyticus* depends on several factors including water temperature, salt and oxygen concentrations, interaction with plankton, presence of sediment, organic matter and marine organisms [34]. The presence of *V. parahaemolyticus* in seawater is influenced by season of the year with highest occurrence in the warmer months [43]. *V. parahaemolyticus* usually concentrates, multiplies and coheres in the gut of filter feeding shellfish such as clams, oysters and mussels [56]. The presence of *V. parahaemolyticus* in seafood can be hazardous to human health especially when postharvest temperatures are not properly controlled in the supply chain [15].

**Prevalence of antimicrobial resistant *V. parahaemolyticus* in seafood**

Microbial drug resistance has increased in recent years and therefore becomes public health issue [52]. Centre for Disease Control and Prevention (CDC) recommended antibiotics such as fluoroquinolones (levofloxacin), cephalosporin (ceftotaxime and ceftazidine), aminoglycosides (amikacin and gentamicin), and folate pathway inhibitors (trimethoprim-sulfamethoxazole) for treatment of *Vibrio* spp. infections [34]. However, variation in antibiotic resistance pattern among *V. parahaemolyticus* isolated from seafood in different countries has been observed. In a recent study regarding antibiotic resistance of *V. parahaemolyticus* isolated from seafood [45], it was observed that 20% of the isolates were resistant to all tested antibiotics. In another study, Shaw et al. [52] observed that 68% of isolates of *V. parahaemolyticus* were resistant to penicillin. The result of this study was similar to resistance pattern of *V. parahaemolyticus* isolated from Gulf Coast raw oysters in Louisiana [19]. Resistance to ampicillin and oxytetracycline was also reported recently among *V. parahaemolyticus* isolated from shrimps in Thailand [62]. The use of tetracycline which ranks among mostly used antibiotics in aquaculture is attributed to efficiency and reduced cost [42]. Lesley et al. [32] determined antibiotics resistance of *V. parahaemolyticus* isolated from cockles (*Anadara granosa*) in Malaysia. Results showed

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that all 62 tested strains were resistant to streptomycin, tobramycin, carbenicillin, teicoplanin, cefalothin, clindamycin, rifampicin, sulfamethoxazole and oflaxacin. A similar study in Malaysia revealed that out of 44 strains of V. parahaemolyticus isolated from cockle (Anadara granosa), 37 were confirmed to harbour toxR gene. Out of these toxR-positive strains, 34 were highly resistant to bacitracin (92%), 33 resistant to penicillin (89%), 25 resistant to ampicillin (68%), 14 resistant to cefuroxime (38%), 5 ceftazidime (14%) and 2 were resistant to amikacin (6%) [51]. In the study of Letchumanan et al. [34], 82% of 185 V. parahaemolyticus strains isolated from Malaysian banana prawn (Penaeus indicus) and red prawn (Solenocera subnuda) were resistant to ampicillin. The prevalence of multiple antibiotic resistance was attributed to abuse of antibiotics in treatment of bacterial infections in aquaculture. This was similar to a study in Korea. Jun et al. [26] observed high prevalence of antibiotic resistance to cefotaxime and ceftazidime (70-80%) among V. parahaemolyticus isolated from seafood obtained from several fish markets in Korea. Melo et al. [40] reported that 5 out of 10 V. parahaemolyticus strains isolated from shrimp (Litopenaeus vannamei) in Brazil showed multiple antibiotic resistance toward ampicillin (90%) and amikacin (60%). Ottaviani et al. [47] established resistance of 107 strains of V. parahaemolyticus isolated from wild shrimps in Italy to amoxicillin and ampicillin (100%), cefalexin (59%), colistin (47%), erythromycin (24%), cefalothin (18%) and streptomycin (6%). According to Costa et al. [8], V. parahaemolyticus strains isolated from shrimps (Litopenaeus vannamei) were resistant to penicillin (100%), tetracycline (90%), ampicillin (30%) and cefalothin (10%). Han et al. [20] reported that V. parahaemolyticus strains isolated from shrimps in Mexico were resistant to ampicillin, oxytetracycline and tetracycline.

Factors attributed to antimicrobial resistance in bacteria isolated from seafood include presence of plasmid, indiscriminate use of antibiotics in aquaculture and horizontal gene transfer. Indiscriminate use of antimicrobials such as tetracycline and quinolone either for therapeutic or prophylactic purposes has been described in intensive shrimp farming [62]. Although some V. parahaemolyticus strains were isolated from wild shrimps they showed high level of antibiotic resistance [47]. In the belief of Han et al. [19], this phenomenon due to environmental contamination by agricultural run-off or wastewater treatment plants which contain antimicrobial agents acting as selective pressure for the development of resistant aquatic bacteria. According to Shaw et al. [52], the patterns of antibiotic resistance among Vibrio species isolated from aquatic environments may have

<table>
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Table I: Occurrence of V. parahaemolyticus in selected seafood

impact on seafood, seafood consumers and human marine related activities such as recreation. Lesley et al. [32] stated that the specific role of antibiotics in management of human infections associated with Vibrio species is still unknown.

**Recommendation and future study on V. parahaemolyticus in seafood**

The occurrence and prevalence of antimicrobial resistant V. parahaemolyticus in seafood require urgent and formidable effort to prevent outbreaks of seafood-borne Vibrio infections. There is need for guided policy on use of antibiotics in aquaculture farming. Eating of raw seafood like oyster should be with caution. Continuous monitoring of seafood and aquaculture environment for presence of this pathogen is recommended. Additionally, there is need for meta-analysis and systematic study of global prevalence of antimicrobial resistant V. parahaemolyticus in seafood to provide knowledge regarding the most prevalence pattern of resistance to antibiotics in seafood globally.

**References**


VIBRIO PARAHAEMOLYTICUS IN SEAFOOD


