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FOOD BORNE OUTBREAKS ASSOCIATED WITH SOME PATHOGENS FOUND IN SEAFOOD: A GENERAL OVERVIEW

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Abstract

This article conducts a general overview on FOOD BORNE OUTBREAKS ASSOCIATED WITH SOME PATHOGENS FOUND IN SEAFOOD in Nigeria. The immediate aim is to create awareness of the existence of such PATHOGENS as a source of microbiological and public health hazzard and to call the attention of public health policy makers to conduct overreaching research to proffer relevant and far reaching solutions. FOOD BORNE OUTBREAKS ASSOCIATED WITH SOME PATHOGENS FOUND IN SEAFOOD in Nigeria could be outlined as Vibrio cholerae, Vibrio parahaemolyticus, Psychrobacter, Photobacterium etc. The article therefore recommends routine surveillance, stringent hygiene practices, and public health education to stem the tide. It also advocates for preventative strategies—such as monitoring harvest waters, enforcing seafood safety regulations, proper cooking of seafood, continued Research and a One Health approach to safeguard public health

Introduction

Seafood was initially recognized as a healthy food choice because it is a low-fat source of high quality protein. Because high-fat diets were associated with increased risk for coronary heart disease (CHD) and some cancers, the National Research Council (NRC) recommended substituting fish for fatty meats and whole-milk dairy products as a way of reducing fat and cholesterol intake (Manson, *et al.,* 2019). Seafood is indeed a high-protein food that is lower in calories, total fat and saturated fat when compared to other protein-rich animal foods. Seafood also contains a number of vitamins (A, B-complex, and D) and minerals (selenium, iodine, iron and zinc) that have been linked to various health benefits. Studies have shown that eating seafood can decrease the risk of heart attack, stroke and hypertension (Abera, *et al.,* 2024).

U.S. Health organizations recommend consuming 250 mg of EPA+DHA per day, and suggest a diet containing 8 ounces of fish per week, especially species high in omega-3s, will provide a beneficial average daily intake (Durazzo, *et al.*,2022) (Barboza, 2022). The American Heart Association recommends 1000 mg of Eicosapentaenoic Acid (EPA) /Docosahexaenoic Acid (DHA per day for patients with coronary heart disease. Pregnant woman and their children also benefit from omega-3s and 2010 Dietary Guidelines for Americans recommend at least 8 ounces and up to 12 ounces of seafood per week to get the healthy benefits of EPA and DHA. Fish with medium to high levels of omega-3 fatty acids include oily ocean fish, such as salmon,
herring, mackerel and sardines (Mahaffey*, et al.*,2009).

Potential Risk of seafood consumption

Seafood is rich in omega-3 fatty acids, which can reduce heart disease risk, triglyceride levels, plaque growth, blood pressure, and benefit developing babies. However, seafoods contamination by heavy metals like methylmercury, pollutants like PCBs, and dioxins (Calder, 2015), harmful bacteria like vibrio species (Karami, *et al.,* 2017) and plastic wastes can negatively impact human health. Different groups of seafood consumers are affected by consuming contaminated seafood. Pregnant women, elderly people and people with compromised immune system are most vulnerable groups of consumers that can be highly likely affected by consuming contaminated seafood. This article therefore conducts a general overview on FOOD BORNE OUTBREAKS ASSOCIATED WITH SOME PATHOGENS FOUND IN SEAFOOD in Nigeria. The immediate aim is to create awareness of the existence of such PATHOGENS as a source of microbiological and public health hazzard and to call the attention of public health policy makers to conduct overreaching research to proffer relevant and far reaching solutions.

FOOD BORNE OUTBREAKS ASSOCIATED WITH SOME PATHOGENS FOUND IN SEAFOOD: A GENERAL OVERVIEW

Health risks of seafood consumption for pregnant woman

Pregnant women are often advised to consume seafood due to its nutritional benefits, including omega-3 fatty acids that are important for fetal brain development (Mahaffey, *et al.,* 2009). However, seafood also contains a variety of contaminants that can pose a risk to both the mother and developing fetus(Jeffries, *et al.,* 2011).

Seafood contains harmful levels of environmental contaminants such as methylmercury, PCBs, dioxins (Mahaffey, *et al.,* 2009) and brominated flame retardants (BFRs) Oliver, 2015), which can pose significant risks to human health, especially for pregnant women and developing fetuses (Sani, *et al.,* 2017).. Exposure to these chemicals has been associated with adverse neurological, developmental, endocrine, reproductive, and immune effects in offspring, as well as increased risk of preterm birth, low birth weight, and cognitive deficits (Oliver, 2015). According to Misser, *et al.*,(2022), prenatal exposure to methylmercury has been linked to adverse developmental outcomes such as impaired cognitive function and behavioral problems. High levels of methylmercury in seafoods can also lead to fetal growth restriction and preterm birth (Choi, *et al.*, 2009).

In addition to methylmercury, PCBs, dioxins, and other persistent organic pollutants have been linked to negative effects on reproductive health and immune function, as well as increased cancer risk (Grandjean, *et al.,* 2014). Pregnant women are therefore advised to avoid consuming predatory seafoods such as shark, swordfish, tilefish, and king mackerel, which tend to havehigher levels of these contaminants (Meeker, *et al.,* 2009). Infections induced by seafoods consumption during pregnancy can harm a developing fetus. These infections can be fatal to the mother, fetus, or newborn when it is untreated. Furthermore, it can lead to viral infections, potentially causing spontaneous abortions or organ disease(Van Oostdam, *et al.,* 2005). However, pregnancy exposure to methylmercury is unlikely to be a significant risk factor for low neurodevelopmental functioning, especially in terms of cognitive performance (Huss, *et al.,* 2000) in early childhood.

Therefore, it is recommended that pregnant women consume a variety of low-mercury seafoods that provide essential nutrients without exposing them to excessive levels of contaminants. The US FDA and EPA advise a maximum intake of 8–12 ounces (2–3 servings) per week of cooked seafoods low in mercury, such as shrimp, salmon, canned light tuna, tilapia, and catfish (Clarkson, *et al.*, 2003). According to FDA recommendation, pregnant women, women of childbearing age, and young children should also avoid high-mercury seafoods such as shark, swordfish, king mackerel, and tilefish (Lüth, *et al.,* 2020) which can accumulate more toxins in their tissues due to their longer lifespan and higher trophic level in the food chain.

In addition to contaminants, some species of microbes such as *E. coli, Aeromonashydrophila, Yersinia spp., Brucella spp., Shigella spp., Salmonella spp., Streptococcus iniae, Clostridium botulinum, Klebsiella spp.,* and Edwardsiellatarda are already isolated from fish (Gochfeld and Burger, (2005). Therefore, some fish species may harbor infectious agents such as *Listeria monocytogenes,Vibrio parahaemolyticus,* and *Salmonella spp.,* which can cause foodborne illnesses in pregnant women (Mahaffey, 2004).. These pathogens can cross the placenta and infect the fetus, leading to miscarriage, stillbirth, or severe neonatal infection. To minimize the risk of foodborne illness, pregnant women should avoid eating raw or undercooked seafood, refrigerated smoked seafood, and sushi made with seafood (Silk, *et al.*, 2012).

Health risks of fish consumption for adults

The consumption of contaminated seafood can expose adults to various health risks, such as heavy metal toxicity (e.g., mercury, lead, cadmium) and accumulation of POPs Burger and Gochfeld 2005). High levels of methylmercury exposure can damage the nervous system, leading to tremors, depression, memory problems Tchounwou, *et al.,* 2012), neurological damage, kidney damage, and reproductive problems in adults Sutton,D. *et al.,* 2012).. However, (Downer, *et al.*, 2017) stated that there is rare information that frequent seafood consumption raises the risk of cardiovascular disease in a community. But a recent study by (Clarkson, *et al.,* 2006) showed that even low-level mercury exposure from seafood consumption may increase the risk of cardiovascular disease for adults. Therefore, like other vulnerable groups, it is important for adults to choose seafood with lower levels of contaminants and limit their intake of high- mercury fish for optimal health.

In addition, other heavy metals such as lead and cadmium are also found in seafood and cause harmful effects on the kidneys, bones, and nervous system to adults (Wirth, *et al.,* 2010).Persistent Organic Pollutants (POPs) may accumulate in the fatty tissues of seafood and affect the immune system, reproductive organs, and hormonal balance of adults (Yoshizawa, *et al.,* 2002). PCBs can be linked to cancer and other health problems in adults (Satarug, *et al.,* 2010). Higher levels of PCBs in blood were associated with an increased risk of prostate cancer in men (Lind, *et al.*, 2012) and breast cancer in women.

To reduce the risks associated with fish consumption, it is recommended to follow safe consumption guidelines. For instance, the WHO advises limiting the intake of predatory seafood and consuming smaller seafood that are low in contaminants (Prince,*et al.*, 2006). Individuals with health conditions such as liver or kidney diseases should also consult a healthcare provider before consuming seafood. It is also recommended to vary the types of seafood consumed to avoid overexposure to one particular contaminant. By doing so, adults can benefit from the nutritional advantages of seafood while minimizing the potential risks associated with its Consumption.

Seafood Consumption in Nigeria

Seafood consumption in Nigeria plays a significant role in nutrition, the economy, and food security. It provides a vital source of animal protein, essential fatty acids, and micronutrients for millions of Nigerians, especially in coastal and riverine communities (FAO, 2022). However, the rising demand for seafood, driven by population growth and urbanization, has led to overfishing and pressure on local fish stocks (Adewumi&Olaleye, 2011). Nigeria supplements local production with large volumes of fish imports, particularly frozen mackerel and stockfish, which affects foreign exchange reserves and local fisheries development (FDF, 2020). To sustain seafood consumption, there is a growing emphasis on aquaculture, which has expanded rapidly in recent years and now contributes significantly to the national fish supply (Alfred-Ockiya, 2018).

Microbial flora found in seafood

It is generally agreed that the microbial flora of seafood found in temperate waters consist of Gram-negative psychrotolerant bacteria, whose growth is possible at 0°C but optimal around 25°C. Among these, the majority belong to the subclass γ of *proteobacteria: Pseudomonas, Shewanella, Acinetobacter, Aeromonas, Vibrio, Moraxella, Psychrobacter, Photobacterium,* etc. and to a lesser extent the CFB (CytophagaFlavobacter-Bacteroides) group (Huber, *et al.,* 2004; Wilson, *et al.,* 2008). Nevertheless, Gram-positive bacteria like *Micrococcus, Bacillus, Lactobacillus, Clostridium or Coryneforms,* may also be present in variableproportions (Shewan, 1971; 1977; Hobbs, 1983; Mudarris and Austin, 1988; Gram and Huss, 1996; Gennari,*et al.*, 1999; Wilson, *et al.*, 2008). Some genera, like *Vibrio, Photobacterium* and

Shewanella,require the presence of salt to multiply and are thus typically found in seawater while Aeromonasis more common in fresh water even though it is often isolated from marine products (Hanninen,*et al.*, 1997). In tropical fish, the flora has the same composition overall (Al Harbi and Uddin,2005; Emborg, *et al.*, 2005), but often with a greater proportion of Gram-positive bacteria(Micrococcus, *Bacillus, Coryneforms*) and *enterobacteria* (Devaraju and Setty, 1985; Liston,1992; Huss, 1999).

The indigenous microflora of the gastro-intestinal tract of fish have been much more studied than those of the skin or the mucus due to their importance in digestion, nutrition and growth and in disease control in aquaculture (Ringo, *et al*., 1995; Spanggaard, *et al.*, 2000). Gram-negative bacteria dominate the intestinal flora. In general, Aeromonas, Pseudomonas and members of the Flavobacterium/Cytophaga group are most often found in the intestine of freshwater seafood while Vibrio, Acinetobacter, and Enterobacteriaceae are more common in marine seafood (Ringo, *et al.,* 1995; Ringo and Birkbeck, 1999). These are fermentative bacteria that develop rapidly in the gastrointestinal tract due to the low pH, the lack of oxygen and the abundance of nutrients. Staphylococci have also been found to be the dominant flora in the intestine of the Arctic char (Ringo and Olsen, 1999). Although not predominant, lactic acid bacteria (*Lactobacillus, Carnobacterium, Streptococcus, Leuconostoc, Lactococcus, Vagococcus)* have often been isolated from the gastro-intestinal tract of seafood (Ringo and Gatesoupe, 1998). (Pond, *et al.,* 2006) have identified a strict anaerobe *(Clostridium gasigenes*) in the intestinal flora of rainbow trout. Similarly, Kim, *et al*. (2007) have shown the presence of Clostridium in the intestinal mucus. Moreover, molecular methods have enabled a new species belonging to the genus Mycoplasma to be detected for the first time in fish. It was found in abundance in the intestine of wild and farmed salmon (Holben, *et al.,* 2002).

The worldwide shrimp market is mainly composed of the Nordic shrimp (*Pandalus borealis*), which is only fished, and the tropical shrimp (*Penaeus sp*.), which can be fished or farmed and whose production has expanded rapidly in recent years. The deep-water tropical shrimp (*Parapenaeuslongirostris*) is also found in Europe, particularly on the Spanish and Portuguese Markets (Sobriono, *et al*., 2005) As in fish, the bacterial flora of shrimps depends on several factors including the species considered, the geographic location and environment, the temperature and salinity of thewater, etc. However, overall, the same species of microorganisms are found in shrimps and infish from a given geographical zone. In fresh tropical shrimps, the initial bacterial flora consistsmainly of *Pseudomonas, Vibrio, Acinetobacter, Moraxella, Flavobacterium* and a high proportion of *Aeromonas* (Vanderzant, *et al.,* 1973; Jayaweera and Subasinghe, 1988;Jeyasekaran, *et al.,* 2006).

In India, Gopal, *et al.* (2005) have detected significant amounts ofdifferent species of *Vibrio*, including *V. parahaemolyticus*. Benner*, et al*. (2004), working on Nicaraguan shrimps, reported a predominance of Coryneforms and Moraxella followed by lower levels of *Bacillus, Lactobacillus, Micrococcus, Proteus, Shewanella, Acinetobacter* and Pseudomonas. These results confirm those previously obtained by Matches, (1982).Chinivasagam, *et al.,* (1996) have shown the influence of the fishing zone on the nature of theinitial flora:

mostly Gram-positive bacteria on shrimps fished at low depths and Pseudomonas on those caught in deep water. The nature of this initial flora has an effect on sample.

Acinetobacter

Acinetobacteriwoffii, a serious human pathogen, has been identified as a cause of nosocomial infections such as bacteremia, pneumonia and meningitis (Bergogne-Bérézin, *et al.,*1996). There are only a few studies reporting A. iwoffii as a pathogen of fish. In 2016 and 2017, six bacterial strains, isolated from diseased fish of the Schizothorax genus, were identified as A. iwoffii by morphology, biochemical tests, 16S rDNA and gyrB gene sequencing analysis (Cao, *et al.,* 2018).

Aeromonas

As part of Singapore's National Strategic Action Plan towards AMR while incorporating a Health approach, the Antimicrobial Resistance Congress (AMR) surveillance program looked at the prevalence of *Aeromonasspp* from 1343 seafood samples since August 2021 (Koh, *et al.,* 2024). According to the research,1 69% (n=136/197) were *Aeromonashydrophila/caviae* and 23% (n=46/197) were Aeromonassobria . The highest prevalence of *Aeromonasspp*was found in fish (53% n=104/197) and oysters (26% n=52/197). A lower prevalence was found in prawn and mussel (6% n=12/197), feed (4%=7/197) with scallop, clam, squid, and cockle as (5% n=10/197). It was noted that oysters are often eaten raw and have a possibly higher risk of foodborne illness. Thus, antimicrobial profiles and genome analysis were performed on 30 Aeromonas spp. Isolates from oyster samples to delve more into AMR implications in aquatic environments and public health (Ramachandran and Teo, (2024).

Vibrio Species

Vibrio spp. are Gram-negative, facultatively anaerobic motile curved rods with a single polar flagellum. Among the members of the genus, 12 species have so far been reported to be pathogenic to humans, where eight of these may be associated with foodborne infections of the gastrointestinal tract. Most of these foodborne infections are caused by *V. parahaemolyticus* and *V. cholerae,* and to a lesser extent by *V. vulnificus*. (Roshini, *et al.,* 2023).

Vibrio cholerae

Among the *vibrios, V. cholerae* is of most concern because of its ability to cause cholera*. V. cholerae* can be divided into serogroups on the basis of the O antigen. Of the more than 200 *V.cholerae* serogroups that exist, only O1 and O139 are associated with the epidemiological features and clinical syndrome of cholera (Chowdhury, *et al*., 2023). However, organisms of *V. cholerae* serogroups other than O1 and O139 (non-O1 non-O139 serogroups) have been associated with sporadic cases of foodborne outbreaks of gastroenteritis, but have not spread in epidemic form. The most important virulence factor associated with *V. cholerae* O1 and O139 5 serogroups is the cholera toxin. Non-O1 non-O139 serogroups are generally nontoxigenic.

Vibrio parahaemolyticus

V. parahaemolyticus was first identified as a foodborne pathogen in Japan in the 1950s. By the late 1960s and early 1970s, *V. parahaemolyticus* was recognised as a cause of diarrhoeal disease worldwide, although most common in Asia and the United States (Wang, *et al*.,2023). In Hong

Kong, *V. parahaemolyticus* continued to be the top causative agent among all the reported food poisoning outbreaks in recent years, Food and Environmental Hygiene Department. (2005).

Vibrio vulnificus

V. vulnificus is an opportunistic pathogen that can cause wound infections and primary septicaemia. This bacterium has less often been described as a cause of gastroenteritis, and its role as a primary cause of gastrointestinal disease remains to be determined.. Wound infections occur in connection with puncture wounds after handling of raw seafood or trauma and exposure to saline environments that harbour the organism (Daskalov, *et al.,* 2023).

Psychrobacter

The *genus Psychrobacter*belongs to the family of Moraxellaceae within the class of Gammaproteobacteria. The members of this genus are psychrophilic to psychrotolerant, halotolerant, aerobic, nonmotile, Gram-negative *coccobacilli. Psychrobacter* species have been mainly isolated from cold environments including Antarctic sea ice, seawater, deep sea, permafrost soil but also from other environments, such as pigeon feces, fish, poultry, dairy products, fermented seafood (Bowman, 2006).

Photobacterium

Photobacterium is a marine motile,*psychotrophic,* facultative Gram negative bacteria, and member of the Vibrionaceae family (Jérôme, *et al*., 2016). This genus comprises of P. phosphorus, *P. iliopiscarium, P. aquimaris, P. piscicola and P. kishitanii (*Figge, *et al.*, 2014). However, P. phosphoreum is more associated with seafood spoilage than others (Macé, et al., 2013). P. phosphoreum has been detected in several studies as spoilage bacterium in seafood such as fish, salmon, It is the main spoilage organism in lobster (Gornik, *et al.,* 2011), and shrimp (Hansen, et al., 2009; Macé, *et al.,* 2012b). It can survive high CO 2 (Gornik, *et al.,* 2013a), hence it plays significant role in packaged seafood (Pennacchia, *et al.*, 2011).

Foodborne outbreaks associated with some pathogens found in seafood

Salmonella

Reports of the CDC outbreaks associated with fish and seafood have shown that Salmonella was the leading cause of these outbreaks. Of these Salmonella outbreaks, 10, with 224 cases, were caused by crustaceans; 14 outbreaks, with 852 cases, were caused by fish; and 2 outbreaks, with 13 cases, were caused by molluscan shellfish (Heinitz, *et al.,* 2000). Salmonella has a prevalence rate of 7.4% along the U.S. coastlines, with Salmonella enterica serovar Newport occurring at a higher percentage (75%) than other serovars. Acute gastroenteritis caused by Salmonella spp. continues to be a worldwide public health concern (Brands, *et al.,* 2005). In humans, salmonellosis is usually due to the consumption of contaminated food or water. The fecal wastes from infected animals and humans are important sources of bacterial contamination of the environment and the food chain (Elhadi, *et al.,* 2004).

The FDA has conducted studies which showed that aquacultured seafood was more likely than wild-caught seafood to contain Salmonella (Martinez-Urtaza, *et al*., 2010). Many researchers also have evaluated the presence of Salmonella, fecal coliforms, and Escherichia coli in shrimp aquaculture ponds (Koonse, *et al*., 2005). The relationship between the occurrence of Salmonella in shrimp from aquaculture operations, and the concentration of fecal bacteria in the source and grow-out pond water has been described by (Koonse, *et al*., 2013). These could be the possible routes of contamination of shrimp and other seafood with this pathogen. Salmonella infection presents as either enteric syndrome, also called typhoid, or as gastroenteritis, which is more common (García, *et al.,* 2007).

Listera Monocytogenes

Listeria monocytogenes is prevalent in nature and can be found in soil, foliage, and the feces of animals and humans (Brands, *et al.,* 2005). This specie is indigenous to the marine and estuarine environments, so its association with fish and seafood should be expected (Norton,*et al.,* 2001). *L. monocytogenes* has also been known to establish itself as an in-house bacterium in a processing facility. It can create a biofilm on stainless steel surfaces and can be isolated from equipment, cold stores, and floors, enabling it to recontaminate products in the production environment (Iwamoto, *et al.,*2010),. In-house reservoirs of *Listeria. monocytogenes* have been reported from fish-processing establishments (Iwamoto, *et al.,* 2010),, and the bacterium has been isolated from domestic and imported fresh, frozen, and processed seafood products, including crustaceans, molluscan shellfish, and fish (Jami, *et al.,* (2014).

L. monocytogenes has many serotypes, but it is serotype ½b that is associated with seafood contamination . *L. monocytogenes* has unique survival properties: it is psychrotrophic (able to grow at refrigeration temperatures) (Tocmo, *et al.,*2014), can survive irradiation, can grow in high salt concentration, and can survive a wide range of pH (Nakamura, *et al.,* 2006). The greatest threat from *L. monocytogenes* is through ready-to-eat products such as processed crabmeat. A study by (FarberHoffman, *et al.,* 2003) demonstrated that *L. monocytogenes* grows better on crabmeat than on other seafood. Since it can grow to high concentrations in refrigerated, vacuum-packed, ready-to-eat foods that will not be subjected to further processing such as heating, there is a serious health risk associated with this organism. This has caused some safety and regulation issues, since there is no established infectious dose (Wieczorek, *et al.,*2020).

Raw fish and shrimp have been linked to an outbreak of L. monocytogenes which caused nine deaths in New Zealand (Pagadala, *et al.,* 2012). Since this outbreak, the seafood industry has been concerned with the ability of *L. monocytogenes* to grow to high levels in shrimp when stored at refrigerated temperatures (Nakamura, *et al.,* 2006). Consumers buy raw fish and seafood from their local grocery store and cook it at home, which greatly reduces the risk of outbreaks, but the extent of cooking depends on various factors such as the size of the seafood product and the type of cuisine or dish. The shelf life of seafood is greatly influenced by microbial load, added to the fact that these are highly perishable commodities (Jami, et al.2014). The National Advisory Committee on Microbiological Criteria for Foods report concluded that *L. monocytogenes* is a pathogen of concern in ready-to-eat seafood products but not for raw fish and seafood products that will be cooked by consumers.

Vibrio cholerae

V. cholerae is a bacterium that many believe is no longer a threat, especially to U.S. citizens. Cholera is thought to be an issue for countries with questionable sanitation practices. Unfortunately, there are approximately one to two cases of cholera reported per week in the United States (Rakesh *et al.,* 2013). While many of these cases of cholera are associated with travel to places with endemic cholera outbreaks, it should be remembered that the Gulf Coast has a long history of cholera. The first confirmed case was in Louisiana in 1832, and the last case was in 1873.

V. cholerae has been repeatedly isolated in blue crabs from the Gulf Coast. The Gulf Coast has been a reservoir of naturally occurring environmental toxigenic *V. cholerae,* and the crabs harvested from that area remain a risk to consumers, especially during the warmer months (Nitchev, *et al.,* 2002). In 2005 there were two confirmed cases of toxigenic *V. cholerae* O1, serotype Inaba, biotype El Tor, isolated from a couple from Louisiana after they ate locally caught crabs and shrimp (Halpern, *et al.,* 2017). *V. cholerae O1*, due to its higher resistance compared to other Vibrio bacteria, could lead to safety hazards in seafood products (Escobar, *et al.,* 2015). Marine foods have been identified as vehicles for the transmission of cholera (Halpern, *et al.,* 2017).

The factors and mechanisms that affect the bacterium's survival in the aquatic environment are not completely understood (Escobar, *et al.,* 2015). However, some research groups have stated that this pathogen can attach to abiotic surfaces, to zooplankton and phytoplankton, and to the carapaces of crustaceans such as shrimp and crab (Faruque, *et al.,* 2010). Vibrio bacteria are generally considered to be heat-sensitive, but some reports show that *V. cholerae* O1 has some resistance in hot foods (Escobar, *et al.,* 2015).

Vibrio parahaemolyticus

In the Unites States, *V. parahaemolyticus* was first noted in the Chesapeake Bay in association with dead and dying blue crabs in 1969, whereas the first fully documented case occurred in Maryland in 1971, which was also associated with steamed crab (DePaola, *et al.,* 2003). The ecology of Chesapeake Bay was examined, and it was found that the incidence of V. *parahaemolyticus* was correlated with water temperatures. The organism was not found in sea waters during the winter months, but it could be isolated from sediments in small numbers. It was later established that *V. parahaemolyticus* could survive the winter months by attaching to planktons and then proliferate inside the planktons (Cook, *et al*., 2002). With the increase in water temperatures, *V. parahaemolyticus* is released from the planktons and can be easily detected in the waters.

V. parahaemolyticus illness is mainly associated with consumption of contaminated raw or undercooked shellfish. Oysters, clams, and mussels and cooked crustaceans such as shrimp and crab have also been implicated in *V. parahaemolyticus* infections (Parveen, *et al.,* 2008). V. *parahaemolyticus* can increase to high levels in oysters because of its ability to enhance its concentration and survival in oysters. Oysters are filter feeders, and *V. parahaemolyticus* is associated with zooplanktons, which results in enhancing the bioconcentration of the bacteria in
oysters (Johnson, *et al.*, 2010).

V. parahaemolyticus was recognized as an emerging foodborne illness in 1950 (Zimmerman, *et al.,* 2010).*V. parahaemolyticus* is the *Vibrio spp.* most associated with blue crabs. Due to the halophilic nature of the *Vibrio spp., V. parahaemolyticus* grows very well in the same high-salinity habitat necessary for blue crabs to complete their life cycle (Parveen, *et al.,* 2008). Both *V. cholerae* and *V. parahaemolyticus* have been found to bio-accumulate in the gut and gills of blue crabs, most likely due to the crabs' omnivorous diet (Leary, *et al.,* 2002).

In 1971, the United States experienced its first major *V. parahaemolyticus* foodborne outbreak, which was associated with crabs in Maryland. The outbreak caused approximately 425 people to become ill and was traced to improperly steamed crabs (Hettiarachi, *et al.,* 2008). In 1998, the CDC received a report that 13 people in Florida became ill with *V. parahaemolyticu*s from eating crabs. In New York in 2006, 80 people were diagnosed with *V. parahaemolyticus* after eating crab in a restaurant (Bowers, *et al.*, 2010). Approximately 25 serotypes of *V. Parahaemolyticus* are being monitored by the CDC (White, et al., 2008). In addition, emerging research has determined that a specific gene, the tdh gene, was responsible for a virulence factor capable of causing the hemolytic syndrome when *V. parahaemolyticus* colony counts were well below the FDA-accepted *V. parahaemolyticus* limits (DePaola, *et al*., 2007). Less than 5% of environmental isolates produce tdh.

Vibrio vulnificus

V. vulnificus is considered the most serious of all the pathogenic *Vibrio spp.* because it has been identified as being the leading cause of seafood-related fatalities (Daniels, 2011). The infectious dose of *V. vulnificus* is 10 3 bacteria/g of food, but it is one of the more heat-sensitive bacteria and is easily destroyed with proper cooking (Jones and Oliver, (2009). . The danger with foodborne illness associated with *V. vulnificus* is its propensity to progress into severe necrotizing wound infections or fatal septicemia in patients with pre-existing conditions such as hemochromatosis or cirrhosis (Oliver, 2005). Liver disease plays a particular factor in the virulence of *V. vulnificus* due to the availability of free iron in the patient's serum (Chase and Harwood, 2011). Of the *Vibrio* cases that occur, *V. vulnificus* has the highest mortality rate: approximately 50% of the cases result in death approximately 48 hours post consumption (Jiang, *et al*.,2010). *V. vulnificus* and *V. parahaemolyticus* are regularly isolated together in crabs sampled for bacterial titers (Krug, *et al.,* 2004).

Clostridium botulinum

C. botulinum is found in marine sediments mainly as spores and can contaminate fish and seafood. If the conditions are right, the spores can germinate into the vegetative state and start producing neurotoxins that cause botulism (Lindström and Korkeala, 2006). The optimal conditions for *C. botulinum* to produce toxins are anaerobic conditions and at pH above 4.6.(Peck, 2006). Each year about 150 confirmed cases of botulism occur in the United States for all food categories (Karen, 2018). Controlling the growth of C. botulinum in fish and seafood can be achieved by reducing the pH below 4.6, using salt or sodium nitrite, by lowering the moisture content, and by lowering the temperature (Karen, 2018). The aim of the study is to reveal the pathogenic microbial flora associated with seafood, with emphasis on *Vibrio parahaemolyticus* and the mitigation processes.

Conclusion

This article conducts a general overview on FOOD BORNE OUTBREAKS ASSOCIATED WITH SOME PATHOGENS FOUND IN SEAFOOD in Nigeria. The immediate aim is to create awareness of the existence of such PATHOGENS as a source of microbiological and public health hazzard and to call the attention of public health policy makers to conduct overreaching research to proffer relevant and far reaching solutions. FOOD BORNE OUTBREAKS ASSOCIATED WITH SOME PATHOGENS FOUND IN SEAFOOD in Nigeria could be outlined as *Vibrio cholerae, Vibrio parahaemolyticus, Psychrobacter, Photobacterium etc. The article therefore recommends* routine surveillance, stringent hygiene practices, and public health education to stem the tide. It also advocates for preventative strategies—such as monitoring harvest waters, enforcing seafood safety regulations, proper cooking of seafood, continued Research and a One Health approach to safeguard public health.

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