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Escherichia coli in seafood: A brief overview

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ABSTRACT

Considering the importance of researching the bacteriological quality of seafood, the following study aimed to make a brief overview on the occurrence of *Escherichia coli* in marine fish and shellfish, and to discuss the sanitary importance that the isolation of this enterobacteria represents to public health.

Keywords: Enterobacteria; Fish; Shellfish; Public Health

1. INTRODUCTION

Seafood has traditionally been part of the human diet in many countries [1] and is an important source of nutrients, especially of high digestible proteins [2]. However, it is also known that seafood can be a source of foodborne toxinfections, which emphasizes the need of a thorough control of its bacteriological characteristics [3, 4].

A bacterial species associated with infection via ingestion of edible products of marine origin is *Escherichia coli*. The occurrence of this bacterium in food is directly related to fecal contamination. On what seafood is regarded, the occurrence of *E. coli* is related to water contamination and/or unhygienic conditions during the handling process [1]. Often cited as potential cause for *E. coli* contamination are: The quality of the ice used for conservation [5,6], and also the food processing plants [7].

Escherichia coli is a commensal microorganism whose niche is the mucous layer of the mammalian colon. This bacterium is the most abundant facultative anaerobe of the human intestinal microflora [8]. Furthermore, *E. coli* is widely distributed in the intestinal tracts of warm-blooded animals [9]. *E. coli* is often nonpathogenic, although different strains may cause diseases in gastrointestinal, urinary, or central nervous systems [10]. Currently, six categories of diarrheagenic *E. coli* have been acknowledged: enterotoxigenic *E. coli* (ETEC) [11], enteropathogenic *E. coli* (EPEC) [12], enteroinvasive *E. coli* (EIEC) [13], enterohemorrhagic *E. coli* (EHEC, Shiga toxin-producing *E. coli* or STEC) [14], enteroaggregative *E. coli* (EAEC or EAggEc) [15], and diffusely adherent *E. coli* (DAEC) [16].

Despite not being very common, the isolation of diarrheagenic *E. coli* from seafood is reported. Kumar *et al.* [17] detected Shiga-toxigenic *E. coli* in fish and clams marketed in Mangalore, India. According to the authors, STEC is prevalent in seafoods in India, and non-O157 serotype is more common. In Brazil, Ayulo *et al.* [18] isolated only one strain of STEC from shellfish, and evidence that preventive measures—especially during harvest and post-harvest—are of major importance to avoid contamination of any nature. For Feldhusen [19], when present in marine seafood or fresh cultured products, pathogenic bacteria levels are considerably moderate. If properly cooked, the hazards of food infection are practically null. Unfortunately, contamination through bacteria related to human fecal matter due to seafood consumption continues to be considered a health threat.

Considering the importance of researching the bacteriological quality of seafood, the following study aimed to make a brief overview on the occurrence of *E. coli* in fish and shellfish to discuss the sanitary importance that the isolation of this enterobacteria represents to the health of seafood consumers.

2. *ESCHERICHIA COLI* IN FISH

The quality of fresh fish is strongly determined for bacterial microbiota [20]. In this context, the use of *E. coli* as a sanitary indicator for fish samples has been first reported in the 1930s [21] and since then widely applied as a microbiological quality parameter, especially on what fecal contamination is concerned [22-25].

According to Thampuran *et al.* [26], *E. coli* is commonly associated with seafood contamination in the tropics, where it is encountered in high numbers. The authors isolated *E. coli* in finfish samples acquired at the retail market in Cochin (India) and, although typical *E. coli* O157 or labile toxin-producing *E. coli* were not detected, the isolation of strains with the ability to produce hemolysis in human blood was a fact worth mentioning.

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Marin *et al*. [27] detected *E. coli* when researching the bacteriological quality of *Cynoscion squamipinnis* and *Lutjanus gutattus* fish samples marketed in Costa Rica. Koo *et al*. [28] reported having isolated ETEC strain from rockfish sold in South Korea, and alerting to the presence of *E. coli* pathogen in seafood.

Akoachere *et al*. [29] performed phenotypic characterization of human pathogenic bacteria in fish from the coastal waters of South West Cameroon and identified 11 bacterial species, including *E. coli* Type 1 (20.8% of total strains). The samples were considered a source of human pathogenic, which makes it a case of public health implications. According to the authors, microbial pollutants contaminate the coastal water as well as the aquatic food sources, thus posing a substantially hazardous exposure to consumers.

The assertive that commercial fish and seafood may constitute repositories of multiresistant bacteria to antibiotics was reported by Ryu *et al*. [30]. The authors found high index taxes of resistance to tetracycline (30.7%), streptomycin (12.8%), cephalothin (11.7%), ampicillin (6.7%) and ticarcillin (6.1%) in strains of *E. coli* isolated from fish and seafood collected from wholesale and retail markets in Seoul, Korea. Moreover, the authors found resistance genes for tetracycline (tetB and tetD), beta-lactams (blaTEM), aminoglycoside (aadA).

3. *ESCHERICHIA COLI* IN SHELLFISH

The term shellfish covers the following animals: the bivalve and gastropods mollusks (oysters, cockles, clams, mussels, periwinkles, sea-snails), and the crustacean shellfish (crab, lobster, shrimp) [1]. In order to prevent bacterial etiology outbreaks associated with the consumption of those invertebrates, there must be a meticulous control of the microbiological characteristics. From 1973 to 2006, 28 crustacean-associated outbreaks were reported in the United States; two of which registered enteroaggregative *E. coli* and enterohemorrhagic *E. coli* as etiological agents. In the same period, 65 molluk-associated outbreaks were documented, none caused by *E. coli* [31]. Jain *et al*. [32] reported an outbreak of enterotoxigenic *E. coli* associated with consumption of butterfly shrimp in sushi restaurants in Nevada (USA) in 2004. For the authors, poor food-handling practices and infected food-handlers contributed to this outbreak.

A survey conducted by Ozogu *et al*. [33], on the bacteriological quality of food prepared with shellfish, pointed absence reported absence of *E. coli*, after 3 months of storage at 4 degrees, in mixed marinated seafood salad containing common octopus (*Octopus vulgaris*), shrimp (*Parapenaeus longirostris*), European squid (*Loligo vulgaris*), sea snail (*Rapana thomasiana*) and common cuttlefish (*Sepia officinalis*).

On the other hand, the occurrence of *E. coli* in shellfish has been accounted in different parts of the world [22,34-37]. Gourmelon *et al*. [38] suggested that shellfish collected in coastal environments can serve as a vehicle for Shiga toxin-producing *E. coli* transmission. These authors analyzed samples of mussels (*Mytilus edulis* and *Mytilus galloprovincialis*), oysters (*Crassostrea gigas*) and cockles (*Cerastoderma edule*) collected from coastal and estuarine environments, and performed the first isolation of ETEC *stx*1*d* strains in France.

Considering bivalve mollusks, DePaola *et al*. [39] analyzed oysters originated from nine US states and verified that the highest geometric mean levels of *E. coli* (~200 MPN/100g) were found in Gulf region oysters during the summer. Watkinson *et al*. [40] detected cephalothin and gentamicin-resistant *E. coli* in oysters (*Saccostrea commercialis*) affected by wastewater treatment plants.

Regarding the crustaceans, during the 1970s, a study by Yap [41] showed a low index rate of contamination by *E. coli* in pre-cooked rock lobster meat from South Australian fish-processing plants. The authors state that the microbiological quality is related to good manufacturing practices. Swartzentruber *et al*. [42] examined the bacteriological profile of frozen lobster tail and frozen shrimp products and had geometric means for *E. coli* < 10 per g for all products.

Enterohemorrhagic *E. coli* O157:H7 in shrimp from India was first reported by Surendraraj *et al*. [43]. The authors suggested that the isolation of EHEC strains from *Fenneropenaeus indicus* shrimp samples indicates a severe adherence to hygienic handling methods, also stating the major importance that proper cooking and processing has for a safe consumption of the product.

Teophilo *et al*. [44] isolated *E. coli* strains from seabob shrimp (*Xiphopenaeus kroyeri*) samples marketed in Brazil, and also detected LT- and ST-toxin-producing *E. coli* strains. Manna *et al*. [45] acknowledged the presence of non-sorbitol-fermenting *E. coli* in foods— shrimp, raw meat, milk, and cattle stool—those of which belonged to 38 different serogroups, with *E. coli* O157 constituting 14.6% from the total of isolates.

The bacteriological quality of farmed shrimp must be duly addressed. Mohamed Hatha *et al*. [46] evaluated the microbiological of shrimp products for export trade produced from aquacultured shrimp, observing the high prevalence of *E. coli* in headless shell-on shrimps. *E. coli* was also detected in cooked, peeled tail-on shrimp samples. Koonse *et al*. [47] suggest that the concentration of fecal bacteria—*E. coli* included—in the source and grow-out pond water is associated to the occurrence of *Salmonella* bacteria in shrimp from aquaculture operations.

In Turkey, Matyar *et al*. [48] isolated *E. coli* strains

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resistant to heavy metal (cadmium) and antibiotics (cefazolin, nitrofurantoin, cefuroxime and ampicillin) from shrimp samples originally from Iskenderun Bay. The authors recognized the presence of these bacteria in foods as a potential risk for public health. In Brazil, there have been reports on the presence of non-resistant and antibiotic-resistant *E. coli* in farming area and in fresh shrimp (*Litopenaeus vannamei*) [49,50]. Likewise, Duran and Marshall [51] isolated antibiotic-resistant bacteria, including *E. coli*, from ready-to-eat shrimp and concluded that this product may be considered as an international vehicle of antibiotic-resistant human pathogens.

4. CONCLUSION

E. coli occurrence in seafood is considered a sanitary case and may represent a risk to the consumers if related to pathogenic strains, especially diarrheagenic *E. coli*. However, the presence of non-pathogenic *E. coli* in fish and shellfish should also alert to public health, since this bacterium is recognized as an indicator of fecal contamination, possibly indicating the presence of other enteric pathogens. In order to ensure that the seafood is not a vehicle for *E. coli*, some key measures should be considered, namely: 1) maintaining the microbiological water quality of local capture; 2) post-harvest care; 3) adequate hygiene conditions in the handling process; 4) in cases of processed foods, measures should be taken to ensure the bacteriological safety during all the process. Besides that, it is extremely not recommended to consume raw or undercooked seafood.

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