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Potential Role of Anaerobic Bacteria as Fish Pathogens

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Abstract

With the expansion of aquaculture practice worldwide, newly emerged diseases might be discovered among intensively farmed fishes. However, the real role of anaerobic bacterial pathogens in moribund fish is still obscure. This might be due to the difficulties in the isolation of anaerobes because of their fastidious nature. Effort should be gathered to reevaluate the actual role of anaerobes as primary or secondary pathogens in reared fishes.

Keywords: Aquaculture; Shellfish production; Organic fertilizers; Moribund fishes

Introduction

The farmed fish and shellfish production has doubled worldwide in the last decade [1], to minimize the shortage of animal protein production. The application of animal manure and poultry droppings (organic fertilizers) as natural food in earthen pond is the main economic pillar to produce cheap fishes in Egypt by supporting the growth of phytoplankton and zooplankton [2]. On the other hand, the untreated organic fertilizers are good sources of anaerobic bacteria that may penetrate and accumulate in fish tissue, and constitute a potential public health hazard [3]. Moreover, the improper application of organic fertilizers may induce rapid deterioration of water parameters, resulting in accumulation of ammonia, nitrites and nitrates allowing many genera of anaerobic bacteria to thrive in this water [4], and may be accompanied with new infectious conditions.

Most bacterial pathogens of fish are aerobic gram-negative rods. However, the role of anaerobic bacteria as fish pathogens is almost scanty. This gap in knowledge is the main reason behind inability to reveal the actual role of anaerobic bacteria as fish pathogens. There are 23 documented genera of obligatory anaerobic bacteria. Many of them are pathogens of man, mammals, avian and reptiles. Anaerobes should be gained special attention by aquatic health experts due to its veterinary and public health importance. The most familiar genus, *Clostridium*, contains the species *C. botulinum, C. tetani* and *C. perfringens*, causing botulism toxicity, tetanus, and gas gangrene, respectively. Other genera of anaerobes such as Propionibacterium, Fusobacterium, Bacteroides, and Eubacterium are less familiar, but also significantly involved in human disease. Investigation the types of anaerobic bacteria isolated from fish might help to clarify the role of anaerobes in occurrence of disease outbreaks among fish. In conclusion, the current based review has emphasized the current knowledge gap in the contribution of anaerobes to aquatic diseases outbreak. To bridge this current gap, a swift future development of high tech/accurate molecular research is highly needed to identify pathogenic anaerobes from fish and environmental samples. This review summarizes the information that supports the potential importance of anaerobic bacteria in fish pathology.

Anaerobic Infections in Fish

The most common anaerobic bacteria recovered from moribund fishes are either clostridial micro-organisms, namely *C. botulinum, C. perfringens* and *C. bifermentans*, or *Actinomyces* and *Eubacterium tarentallus*. The slime, gills and the intestines of fish might be subjected to many risk of contamination during their aquatic environment or after being harvested via *C. botulinum* types A, B, C, E and F, *C. perfringens* type A and D, *C. bifermentans* and *C. sporogenes* [5].

Toxigenic *Clostridium perfringens*

Types A and D *C. perfringens* were the most common isolates recorded in fishes from earthen pond although some authors assumed that *C. perfringens* in fish does not belong to the normal bacterial flora, it may be contributed to the contamination of their habitat [6]. This may increase the health risk to the consumer, as *C. perfringens* may cause outbreaks of food poisoning associated with the consumption of fish and its products [7]. It produces an enterotoxin which is released upon lysis of the vegetative cell during sporulation in the intestinal tract [8]. *C. perfringens* causes clinical signs of gastroenteritis, which often resolve within 24 hours with minimal or no treatment. *C. perfringens* type A from Atlantic cod is encoding genes for alpha, beta2, epsilon, and iota toxins and enterotoxin were not found [9]. In Egypt, studies proved that animal manure and poultry droppings are the main sources of *C. perfringens* in earthen fish farms. In previous study of my research group, toxigenic types A& D were the most isolated types from *C. perfringens* in moribund tilapia, and I/M injection provoked high number of mortalities than other sites (Figures 1 and 2) [10,11].

C. botulinum

C. botulinum type E is considered as one of the major cause of fish mortality in the USA of juvenile salmon in earth bottom ponds [12].

Figure 1: *Oreochromis niloticus* experimentally inoculated via I/M route with *C. perfringens* type A, showing after 4 days of inoculation deep muscular ulceration at site of injection. Photo adopted from reference [10 and 11].

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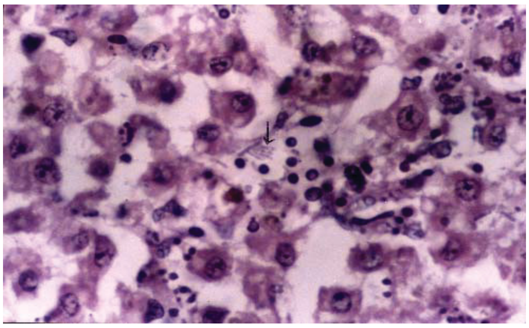

Figure 2: Kidney of common carp *Cyprinius carpio* experimentally infected via I/M route with *C. perfringens* type A, showing aggregation of bacilli in the renal interstitial tissues, accompanied with degenerative changes in renal tubules (H& E 1000X). Photo adopted from reference [10 and 11].

The existing literature supports classification of *C. botulinum* as fish-borne zoonoses in the strict sense. The continual discharge of organic materials into the environment may contribute to the perpetuation of botulinum spores. It is also speculated that type E spores may originate in the sea bed and be spread by fish and water currents.

C. bifermentans

C. bifermentans is associated with a severe outbreak in grass carp reared in a poly-culture fish farm pond in Germany [13]. On the other hand, *C. bifermentans* serovar Malaysia were not toxic to goldfish at a dose 1000 times higher [14].

Eubacterium tarantellas

E. tarantellas, an asporogenous, Gram positive, anaerobic bacterium, was isolated in pure culture from the brain of numerous dead and moribund striped mullet showing nervous manifestation from Biscayne Bay [15]. All isolates were pathogenic for channel catfish but not for mice or guinea pigs. Subsequently, *E. tarantellus* was isolated from the brain of ten additional estuarine fish species, but not from any marine fishes. The anaerobe may grow slowly in the host and produce disease only after a protracted period.

The previous investigations through dim light on the real role of anaerobic bacteria as fish pathogens, much effort should be gathered to uncover the newly emerged diseases induced by a wide group of anaerobic bacteria in fishes.

Sources of Anaerobic Bacteria

Anaerobic bacteria of endospores nature are commonly found in the terrestrial ecosystem, predominantly, in cultivated soil, contaminated ground water, organic polluted surface water, marine and river sediments, besides in the intestinal tract of terrestrial mammals [10].

In aquaculture, the animal manure and poultry droppings; the good sources of enteric anaerobic bacteria [10]. Rearing of fish in sewage contaminated water may increase the chance of anaerobic bacterial contaminants of reared fish.

Conclusion

In conclusion, comprehensive biochemical, molecular and pathophysiological research is extremely required to better understand the pathogenic mechanisms of anaerobic bacterial infections and to overcome the knowledge gap in epidemiology and virulent types of fish anaerobes related diseases.

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