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REVIEW ARTICLE

Motile Aeromonads as a Nile Tilapia Bacterial Infection: A Review on Prevalence, Molecular Characterization, Effect on Immune Response and Alternatives Control Measures

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Abstract

Nile tilapia (*Oreochromis niloticus*) constitutes the maximum essential and financial fish species in Egypt representing 71.38 % of overall cultured fish in Africa and 1.54 % of overall cultured fish everywhere in the world. They compromise many vital amino acids, vitamins, poly saturated fatty acids, omega-3, vital minerals in addition to quantities of hint elements. Egypt is the third biggest tilapia generating country after China and Indonesia. The maximum crucial governorates in Egypt that produce 80 % of the farmed tilapia in Egypt are Kafr-Elsheikh, Behira and Sharkia. Aeromonas infection in fish causes world economic problems because of the high number of fish mortalities particularly in China and India .*Aeromonas hydrophila* (*A. hydrophila*) is one of the most important agents of the outbreaks in fresh water fish, in which skinulcers, hemorrhage and necrosis of the visceral organs are the major symptoms. Synonyms are bacterial hemorrhagic septicemia, septicemia, or pest. The application of medicinal plantsin aquaculture has been a new approach. The adequate use of antibiotics and other chemotherapeutics in fish culture criticized because of the potential improvement of antibiotic-resistant bacteria, environmental pollution and the accumulation of residues in fish tissue. Based on current information about the ecology, pathogenicity and epidemiology, of the Genus Aeromonas, we should assume that infection with aeromonad will remain a great health problem in the future. The ubiquitous distribution of Aeromonas infection and the increasing elderly population, to whom these bacteria are an opportunistic pathogen, will facilitate this problem.

Keywords:

Aeromonas hydrophila, Nile tilapia (*Oreochromis niloticus*), Immunostimulant, Bacterial disease.

Introduction

Aquaculture production has increased steadily in recent years. It has become a valuable component of national development and poverty reduction plans in many areas of the world [1]. Also, it is one of the fastest growing sectors of the global livestock production [2]. Approximately, 40% of fish from aquaculture originated from tilapia production [3]. It is currently playing, and will continue to play, a big part in boosting global fish production and in meeting the rising demand of fishery products. Global inland waters capture production reached 11.6 million tons in 2012. Total farmed food fish production has increased from 50 % in 1980 to 63 %

in 2012. In the world scenario, 15 countries produced 92.7 % of all farmed food fish in 2012. India, Bangladesh, Egypt, Myanmar and Brazil depend mainly on inland aquaculture of finfish while their potential for marine culture production of finfish remains largely untapped [4].Capture fisheries production has level led off and considered capable of sustaining the supply of fisheries products needed to meet the growing global demand [5]. Aquaculture, especially of tilapias, has the potential to play a leading role in the fight against food insecurity, malnutrition, and poverty in Africa [6]. Tilapia is the common name for several species of cichlid fish inhabiting freshwater streams, ponds, rivers and lakes and less commonly in brackish water. Considered as an invasive species, tilapias are now of increasing importance in Aquaculture. Tilapia is the second most farmed fish worldwide and its production has quadrupled over the past decade because of its suitability for aquaculture, marketability and stable market prices [7]. The Nile tilapia, *Oreochromis niloticus* considered as one of the most important species of fish in tropical and sub-tropical aquaculture [8]. It serves as important sources of animal protein and income throughout the world [9]. Tilapia can grow and reproduce facing a wide range of environmental conditions and tolerate stress induced by handling [10]. The mono-sex male population of tilapia well recognized for increased production potential and low management requirements [11]. Today, tilapia has become the shining star of aquaculture and popularly known as 'aquatic chicken' and the rate of consumption has increased across the globe [12]. Annual global production of cultured tilapia has increased continuously in recent years [13]. Native to Africa and Middle East, tilapias introduced into some 90 countries for aquaculture and fisheries, through pan-African transplants [14-15] during the 20th century. Presently, a major part of the global tilapia production is outside the fish's native ranges. Tilapias are now growing commercially in almost 10 countries and have become one of the most important food fishes in the world. It is the second most important farmed fish species after the carps. Unlike most other finfish species, tilapias are extremely hardy fish equally adaptable to a range of culture systems such as low-density pond systems, cage culture systems, raceway systems and super-intensive culture systems under a wide range of environmental conditions. Due to its easiness of breeding and farming, low protein requirement and ability to assimilate plant protein, it became the species of interest among the poor resources especially in rural areas. This fish is also popular and prized in many Asian countries, including the Philippines and Indonesia, where local people adopted it as a vital part of the national cuisine and as a native species of their country [16].

Kompanets *et al*. [17], listed the major reasons for its popularity among aqua farmers as follows;

✓Feeding habits (Herbivore / Omnivore, Low trophic level feeder).
✓Algae, bacteria and detritus (bioflocs) are important food sources.
✓Prepared feeds are mostly grains and agriculture by-products.
✓ Fast growth rate.

✓Easy adaptability to different conditions including high stocking densities.
✓Highly disease resistance and tolerance of poor water quality.

✓Antibiotics and chemicals not needed for commercial farming.
✓Prolific breeders, easy breeding in captivity.

✓Fries that do not pass through a planktonic phase, in its life cycle.
✓ Low production costs.

The fish disease is a major constrain to aquaculture production. It is a simple association between the pathogen, a fish host and environmental problems, such as poor water quality or other stressors often which contribute to the outbreak of disease. Fish diseases caused by pathogenic organisms present in the environment, are mostly contagious and treatment may be necessary to control the disease outbreak. Therefore, intensive farming practices and infectious diseases induced major problems in aquaculture industry causing heavy loss to farmers. Several studies conducted on the modulation of fish immune system in order to prevent the outbreaks. Disease outbreaks recognized as a potential constraint on aquaculture production and trade and cause massive financial loss through mortality or reduced meat quality, resulting in reduced profit margins [17]. Diseases are among the primary limiting factors for the growing of aquaculture, where bacterial infections are responsible for heavy mortality in both wild and cultured fish. Short, Gram-negative rods belonging to the families *Enterobacteriaceae, pseudomonadaceae* or *Vibrionacea* cause the majority of bacterial diseases in fish. They cause septicemic and ulcerative disease conditions. The long Gram negative *Myxobacteria* of the family *cytophagaceae* caused heavy mortality in fish stock. However, acid fast Gram positive microorganisms are of less frequent encountered as dangerous for fish stocks [18]. It is accountable for large economic losses resulting from high death rates and poor product quality [19]. *A. hydrophila* is one of the most important agents of the outbreaks in fresh water fish, in which skin ulcers, hemorrhage and necrosis of the visceral organs are the major symptoms. Synonyms are; Bacterial hemorrhagic septicemia, aeromonad septicemia, or red pest [20]. *Aeromonas* are opportunistic pathogens for fish, and their prevalence rate linked to stress conditions such as overcrowding, rough handling, or poor water quality leading to significant epidemic outbreaks [21,22]. There are other possible risk factors connected to the primary fish diseases, such as the season and water temperature [23]. *Aeromonas* was responsible for 80% of the mortality in highly thermally stressed fish[24].The peak period of *A. hydrophila* infection-related mortality in intensive fish culture was in the late spring and early summer [25]. Usually, clinical abnormalities of *A. hydrophila* are in the form of skin darkness, scales detachment, extensive irregular hemorrhages on the body surface, ulcers on the skin varied from shallow to deep necrotizing ulcers, exophthalmia, fin erosions, and abdominal distension (Figure 1) Postmortem examination revealed hemorrhage and enlargement in internal organs [26]. Extracellular enzymes such as hemolysis, lipases, proteases, β-lactamases, amylases, chitinases and nucleases produced by *Aeromonas* have involved in their ecology, survival pathogenicity [27] and contribute to the ability for their attachment to the host cells and finally, disease development [28-30].

Therefore, the objectives of this review is to provide an update on the genus *Aeromonas*, including recent acquired knowledge of the ecology, prevalence and

seasonal variations, symptoms of disease, diagnosis by using molecular techniques, immune response against infection, zoonotic aspect and how to control the infection.

Figure (1): ***Oreochromis niloticus*** **naturally infected with** ***Aeromonas hydrophila*** **showing skin hemorrhage [31].**

Aeromonas species: etiological agent, isolation, and identification

The aeromonads are Gram-negative, rod-shaped, facultative anaerobic, non-spore forming bacteria that are autochthonous and widely distributed in aquatic environments [32]. These bacteria, mainly *A. hydrophila*, have emerged as a foodborne pathogen of extreme importance [33, 34]. *Aeromonas* spp. linked to both food and water-borne diseases in different parts of the world especially developing countries due to poor hygiene and poor quality water [35].*A. hydrophila* strains are known to produce the extracellular, soluble, and hydrophilic protein known as aerolysin, which has both hemolytic and cytolytic capabilities, as their probable virulence genes. Additionally, it interacts with host red blood cells' proteins to produce pores in the cell membrane that lead to hemolysis. Consequently, it can be utilized to determine whether fishes are infected with *A. hydrophila*[36].

The facultative anaerobes *Aeromonas* species can grow as separate colonies on blood agar with or without hemolysis.

They tolerate up to 4% NaCl in the culture media and do not need sodium ions to reproduce[37]. *Aeromonas* phenotypic markers comprise Gram-negative staining, an oxidase-positive reaction, the fermentation of glucose to produce gas and acid, a decrease in nitrate, and the growth inhibitor vibrio static factor O/129 [38].

Samples taken from the kidney, liver, and spleen of the moribund fish were inoculated on enrichment media as tryptic soy broth (TSB), while selective media as Rimler Shotts agar (RS) with ampicillin selective supplement 5mg/L was used for selective differential isolation of *Aeromonas* species, incubated at 28°C for 24-48 h to appear yellow colonies.

The traditional microbiological techniques for identifying harmful germs are very time-consuming and labor-intensive. These issues have been resolved by molecular techniques like the polymerase chain reaction (PCR), which, unlike other conventional microbiological techniques, enables the quick and accurate identification of bacteria as well as the discovery of virulence genes that contribute to bacterial pathogenicity [39].

Prevalence and seasonal variations

The genus *Aeromonas* is widely distributed across numerous ecosystems, although it is more commonly found in various aquatic environments. *Aeromonas* have also been isolated from several environmental and indigenous to aquatic environments and have been isolated from surface, underground, potable, bottled, residual, seawater, and irrigation waters. In Egypt, research has been performed with seasonal frequency of *A. hydrophila* infection in wild and farmed *O. niloticus*. The motile *Aeromonas* septicemia (MAS)-causing *A. hydrophila* infection has a varied temporal distribution in wild and cultivated *O. niloticus* fish; it is more common in the summer in cultured fish than in wild fish. Infection rates in the wild stock were 6% in summer, 2% in spring, 0% in fall, and 0% in winter, respectively. Infected farmed tilapia fish made up 10% of the population in the summer, 4% in the spring, 3% in fall, and 0% in winter [40]. It was stated that the spawning season, water temperature changes, and unfavorable conditions during intensification were when the majority of infections occurred. The bred fish become more sensitive to stress than the natural population in addition to the increased environmental diversity.

In the literature, prevalence rates of *A. hydrophila* infection were ranged from12.5 - 47.3 % in *O. niloticus*[41, 43],In all, *O.niloticus* infection rates between 2015 and 2016 were 60% in winter and 24% in summer [44] .

Clinical symptoms and diagnosis including serological and molecular techniques

The incubation period of the disease, depend on fish species and resistance, environmental conditions and the season. This period varies 2-4 days in natural infections and 8-48 hours in experimental infection models [45]. In the acute form of disease, a fatal septicemia may occur so rapidly that fish die before they have time to develop anything but a few gross signs of disease. When clinical signs of infection are present, affected fish may show exophthalmia, reddening of the skin, and an accumulation of fluid in the scale pockets [46].The abdomen may become distended because of an edema and the scales may bristle out from the skin to give a “washboard” appearance. The gills may hemorrhage and ulcers may

develop on the dermis, and motile aeromonads were isolated from the eyes, liver and kidneys of affected fish [20]. The condition at first affected one eye, progressed into the other eye, after which the orbits ruptured causing blindness and death. Similarly, an acute mortality among *O.niloticus* in which the most apparent clinical signs included an opaqueness in one or both eyes, accompanied by exophthalmia and eventual bursting of the orbit [47].

Systemic infections are characterized by diffuse necrosis in several internal organs and presence of melanin-containing macrophages in the blood [48]. Internally, the liver and kidneys are target organs of an acute septicemia. The liver may become pale or have a greenish coloration, while the kidney may become swollen and friable. These organs are apparently attacked by bacterial toxins and lose their structural integrity [49].

The somatic O-antigen, a highly changeable surface antigen that establishes the specificity of each bacterial species and serves as the foundation for their serological classification, is the O-specific polysaccharide. Since numerous O-serotypes are linked to particular illness syndromes, serotyping is essential for epidemiological investigations in order to identify bacterial strains [50-51] . *Aeromonas* strains were identified and divided into 44 serogroups using the NIH (National Institute of Health, Japan) system created by Sakazaki and Shimada based on O-antigens. *Aeromonas* strains are serologically diverse [52].

Numerous virulence factors that can work singly or in conjunction with one another enable pathogenic bacteria to infect vulnerable hosts and to create a variety of chemicals that are either directly or indirectly poisonous to host cells [46]. The genes for aerolysin *(aer)*, cytotonic heat-stable enterotoxin *(ast)*, cytotoxic enterotoxin *(act)*, and hemolysin A *(hly A)*are among those that contribute to the pathogenicity of *A.hydrophila* [53 , 36].The traditional microbiological techniques for identifying harmful germs are very time-consuming and labor-intensive. These issues resolved by molecular techniques like PCR, which, unlike other conventional microbiological techniques, enables the quick and accurate identification of bacteria as well as the discovery of virulence genes that contribute to bacterial pathogenicity. The *16S rRNA* gene is considered a stable molecular marker for identifying bacterial species, since its distribution is universal and allows comparison of microorganisms. In addition, its structure presents a mosaic of variable regions, suitable in differentiation of closely related organisms, and their conserved regions are useful for the distant organism's comparison and this allows for the design of "universal" primers. In the genus *Aeromonas*, the *16S rRNA* gene has an interspecies similarity range from 96.7–100% and the informative nucleotide positions are located mainly on region V3. Additionally, the presence of microheterogeneities (i.e., mutations on specific positions of the sequence of one of several copies of the *16S rRNA* gene) in combination with the high similarity of the sequences for closely related species makes this gene not suitable for the *Aeromonas* spp. identification [54].

Numerous studies from around the world, notably when employing analysis of the *16S rRNA* gene sequence, demonstrate that the species *Aeromonas* has enough phylogenetic depth for the name to be elevated to the rank of family and that its members represent an unique

line within the Gamma proteobacteria [55-57]. The PCR amplification with *Aeromonas* spp. specific primer identified twelve *Aeromonas* spp. isolate as specific band appeared by electrophoresis at a molecular weight of 953 bp that is specific for *Aeromonas* spp. [58-59].

Experimental infection and the impacts on fish health including immune response

In fish, it is considered as a significant pathogen causing the motile aeromonad septicemia (MAS), also known as epizootic ulcerative syndrome (EUS) [60]. The symptoms of *A.hydrophila* infections include swelling of tissues, dropsy, red sores, necrosis, ulceration, and hemorrhagic septicemia [61]. This bacterium has been found in several fish species, including Nile Tilapia [62]. Immunization has played an important role in the control of infectious disease. Both specific and non-specific immune mechanisms are important elements to protect the fish against invading pathogens. In fish, the skin and mucus are the primary line of non-specific defenses. When pathogens enter the body, cellular and humoral non-specific defense mobilized. cellular defense system including phagocytic cells similar to macrophages, neutrophils and natural killer (NK) cells as well as T and B lymphocytes, this in addition to having various humoral defense components such as complement (classical and alternative pathways), lysozyme, natural hemolysin, transferring and C-reactive protein. Inflammatory mediators such as cytokines (interferon, interleukin 2 and macrophage activating factors) are also discovered [63- 65]. The innate defense includes both humoral and cellular defense mechanisms such as the complement system and the processes played by granulocytes and macrophages [16]. The innate immune system is the only defense weapon of fish where it plays an instructive role in the acquired immune response and homeostasis. The immune system is responsible to maintain the organism's homeostasis when invaded by foreign object or organisms [66]. Most pathogens and danger particles can be recognized by immune cells through expressed pathogen or danger–associated molecular patterns (PAMP or DAMPS, respectively), through non-self (e.g. allogenic or zenogenic cells) or missing major histocompatibility (MHC) class I molecules (some virus–infected target cells), presenting foreign non–self-peptides of intracellular (through MHC class 1-e.g. virus–infected target cells) or extracellular (through MHC class II–e.g. from bacteria) origin. Specialized immune cells of the innate and adaptive responses are involved to eliminate invaders directly or by destroying their ability to replicate (e.g. virus–infected cells).The expression of different immune-related genes in the host following an *Aeromonas* infection, including those involved in pathogen recognition, the proteins involved in cell signaling and apoptosis. *A.hydrophila* might induce an overexpression of the pro-inflammatory cytokine gene TNF in the intestine of fish, deteriorating the integrity of the mucosal barrier structure. Similarly, the expression of different chemokines, which are a family of small cytokines with an important role in the immune response [67].

Zoonotic aspect of Aeromonas hydrophila

Aeromonas are an emerging pathogen that cause a wide range of diseases in humans, commonly gastroenteritis, septicemia, and wound infections, and are able to infect both immune compromised and immune competent patients. According to earlier studies, *A.*

hydrophila, *A.caviae*, and *A.veronii* were 85% of all human infections and clinical isolations from the genus *Aeromonas* have been linked to it [68]. The pathogenicity of *Aeromonas* species attributed to the release of various virulence factors that are associated with exotoxin, cytotoxic and hemolytic activity that causes adhesion and colonization of mucosa, followed by fluid accumulation or epithelial change are likely events leading to human disease. The ability of *Aeromonas* to adhere, invade, and produce cytotoxicity has been defined, mainly following *A. hydrophila* and *A. caviae* infections, using human larynx carcinoma (HEp-2) and human Caucasian colon adenocarcinoma (Caco-2) cells [69]. *A. hydrophila*is the most important species causing disease in humans. They can produce virulence factors including a relatively heat stable cholera-like enterotoxin and heat labile cytotoxic enterotoxin and recognized as a potential cause of food associated out breaks of gastroenteritis and as etiological agent of acute diarrheal in particular among children[70]. Moreover, *Aeromonas* caused other human infection including septicemia, meningitis, wound and eye infection and urinary tract infection [29].Although the methods used for analysis, the types and sources of commercial products analyzed, and the use of selective and enrichment media regardless of where they came from, the general conclusions from these analyses indicate that aeromonads are a common presence in the majority of food kinds [71]. All items found that were tested for *Aeromonas* isolates had them, including raw milk, poultry, ground beef, veal, pork, and lamb. These items' initial counts at 5°C varied from 102 to 105 CFU/g however, after 7 days at refrigerated settings, *Aeromonas* populations had climbed one to three logs in the majority of the products. Dairy products (4%), vegetables (26%-41%), meats and poultry (3%-70%), and shellfish (31%) and fish (72%) have all been found to contain aeromonads [72, 73].

Aeromonads have been implicated in food-borne disease outbreaks, particularly in developing countries where hygiene is a challenge [74]. Strains of *A. hydrophila, A. sobria,* and *A. caviae* have been shown as emergent food-borne pathogens implicated in human gastroenteritis and extra-intestinal diseases [75]. However, the pathogenesis and virulence factors associated with aeromonads in different hosts are not fully understood [76]. *Aeromonas* spp. found in food can produce different exotoxins, some of which are enterotoxins [77].Aeromonads are identified as causative agents of diarrhea with a public health hazard importance [78]. Infants and the elderly are more severely affected by aeromonas-diarrheal conditions than other ages [79]. Moreover, they are involved in human's extra-intestinal infections [80-82]. For example, *Aeromonas* spp. infections were reported to cause severe meningitis, cellulites, otitis, septicemia, endocarditis, osteomyelitis, peritonitis, bacteremia, septicemia, and respiratory tract disease in humans [83]. Besides, the organisms were implicated as the cause of traveler's diarrhea in 18 (2%) out of 863 patients [84]. Aquatic environment as well as different food including fish, seafood, and raw and cooked meat and chickens can be a potential vehicle for human's infections with aeromonads [85-89]. Examined 563 samples of fish, raw and cooked meat, and pre-prepared salads revealed the presence of mesophilic *Aeromonas* spp. in 287 samples as most of contaminated samples were offals (84.3%) and chickens (79.3%) [90].

Most common symptoms associated with *Aeromonas* bacteremia according to Janda and Abbott [70] included fever (74–89%), jaundice (57%), abdominal pain (16–45%), septic shock (40–45%), and dyspnea (12–24%). That same study also classified the bacteremia in four groups based on the affected populations, the main one being immune compromised individuals (>80%), followed by those who suffered a traumatic accident, then the cases that affect healthy people, and finally those that involve patients undergoing reconstructive surgery and/or leech therapy [70].

Wounds are the second most frequent route of entry of *Aeromonas* to humans after the oral–fecal route [70,91]. Infections caused by *Aeromonas* can occur on any skin or mucous surface, although the extremities are the most common sites [70]. Most cases affect healthy people and are often associated with traumatic events and burns and scolds related to water and soil [92]. In a retrospective study of 129 cases of skin and soft tissue infections in Taiwan attributed to *Aeromonas*, 78% of patients had suffered previous trauma, and in 30% of cases there was exposure to water [93]. Additionally, *Aeromonas* was the most isolated microorganism following natural disasters such as the tsunami in Thailand in 2001 (*Aeromonas* accounted for 22.6% of all isolates) and Hurricane Katrina in the southeastern United States (2005), mainly associated with wound infection [94,95].

Ways to control Aeromonas septicemic disease (immune-stimulants as an alternative to conventional measures)

Antibiotic drugs have the capacity to kill or inhibit the growth of microorganisms. So, the use of antibiotics to control fish disease needs to be limited due to the emergence of drug-resistant bacteria and concerns about environmental hazards and food safety [96]. Therefore, several alternative strategies to the use of antimicrobials have been proposed such as the use of probiotics as biological control agents. Also, probiotics are live microbes that may serve as dietary supplements to improve fish growth and immune responses, have received some attention in aquaculture [97]. Recently, the researchers have been targeted to search in nature to find acceptable and economically viable natural products be suitable for treating various chronic diseases. Marine algae exhibit different biological activities as a result of the presence of a variety of useful phyto constituents [39]. The primary or secondary metabolites that are synthesized under the action of the metabolic enzymes have been isolated to be developed as an effective alternative to antibiotics to be gained importance specially to combat disease problem [98]. It is worth to mention that algae can produce like these effective and valuable natural products. Of these are in concern Chlorella, Spirulina and Amphora algae.

When used on tilapia, a variety of commercial probiotics including one or more of the bacteria *Bacillus, Streptococcus, Lactobacillus,* or the yeast Saccharomyces exhibited improved immune response and higher growth performance than the untreated fish [99]. Recent years have seen a significant increase in interest in the use of environmentally acceptable feed additives, such as microbial supplements, to enhance the physiology, growth performance, and immune responses of species connected to aquaculture [100].The fish's innate immune system, which allows for a quick response to

invasive diseases, is crucial, and the intensification of culture procedures necessitates the use of external feed additives [101]. Growing in popularity is the use of medicinal herbs as immune stimulant in aquaculture. A range of compounds with immune stimulant, growth-promoting, anti-inflammatory, antioxidant, antibacterial, antiviral, and anti-parasitic properties can be found in green tea (*Camellia sinensis* L.), which is produced from non-oxidized, unfermented leaves [102]. Clove, *Syzygium aromaticum*, is an aromatic medical plant of the family *Myrtaceae*. It is frequently used in dentistry, as a local anaesthetic, as an antiseptic against infectious disorders, and as a natural food ingredient [103]. Major components of the clove, including eugenol, eugenyl acetate, carvacrol, tanene, and thymol were discovered [104]. The use of probiotic bacteria to improve growth performance has recently attracted a lot of attention in aquaculture. Probiotic use in aquaculture has been shown to have positive outcomes [105].Additionally, the use of probiotics for improving fish bio-growth characteristics has a long history [106]. When it was used on tilapia, a variety of commercial probiotics including one or more of the bacteria *Bacillus, Streptococcus, Lactobacillus,* or the yeast Saccharomyces exhibited improved immune response and higher growth performance than the untreated fish [107].

Conclusions

It could be concluded that *Aeromonas hydrophila* was the major cause of the outbreak affecting tilapia farms in Egypt. Since *Aeromonas* is a zoonotic bacteria, it is suggested that producers should utilize the bacteriological identification and molecular techniques to check the presence of this infectious agent and determine virulence genes to guarantee public health and avoid economic losses.

Conflict of interest

Authors have no conflict of interest.

References

[1] Prabu.E., Santhiya, A.A.V (2016): An overview of bioremediation towards aquaculture.Journal of Aquaculture in the Tropics. 31 (3-4):155.

[2] FAO (2010): The State of World Fisheries and Aquaculture. Edited by FAO. Rome: FAO.

[3] Scorvo Filho J.D., Frascá-Scorvo C.M.D., Alves J.M.C.G.N.A, Souza F.R.A.D.A (2010): tilapi culture seusinsumos, relaçõeseconômicas. Revista Brasileira de Zootecnia.

[4] FAO (2012): The State of World Fisheries and Aquaculture. FAO Fisheries and Aquaculture Department, Rome, Italy.

[5] Subasinghe R., Soto D., Jia J., (2009): Global aquaculture and its role in sustainable development. Reviews in Aquaculture 1(1):2-9.

[6] Bene C., Heck S., (2015): Fish and food security in Africa. *NAGA* World Fish Center Quarterly. 28 (3-4):8-13.

[7] Wang M., Lu M., Tilapia polyculture (2016): A global review. Aquaculture Research.47(8):2363-2374.

[8] Sosa, I.D.; Adillo, L.A.B.; Ibanez L.J.; Figueroa, I.A.; (2005): Variability of tilapia (*Oreochromis* spp.) introduced in Mexico.Morphometric, meristic and genetic characters. Journal of Applied Ichthyology. 20:7-10.

[9] Ahsan, M.E.; Wahab, M.A.; Siddik, M.A.B.; Alam, M.A.; Sharker, M.R.; Nahar, A. (2013): Impacts of Inclusion of Column Feeder Rohu (*Labeorohita*) at different stocking densities on growth and production in freshwater prawn-finfish polyculture system. International

Journal of Biological Research. 1(2):48-54.

[10] El-Sayed, A.F.M. (2006): Tilapia culture. CABI.

[11] Fitzsimmons, K., (2015): Tilapia culture In American Fisheries Society Symposium. (46):563-590.

[12] Courtenay, W.R. (1997): Tilapias as non-indigenous species in the Americas: environmental, regulatory and legal issues. Tilapia Aquaculture in the Americas. 1:18-33.

[13] Pullin, R.S.; Eknath, A.E.; Gjedrem, T.; Tayamen, M.M.; Macaranas, J.M.; Abella, T.A. (1991): The genetic improvement of farmed tilapias (GIFT) project: The story so far. Naga, the ICLARM Quarterly. 14(2):3-6.

[14] Costa-Pierce, B.A.; Doyle, R.W. (1997): Genetic identification and status of tilapia regional strains in southern California. Tilapia aquaculture in the Americas.1:1-17.

[15] Smith, V.J.; Brown, J.H.; Hauton, C.(2003): Immuno stimulation in crustaceans: Does it really protect against infection. Fish and Shellfish Immunology.15 (1):71-90.

[16] Iwama, G., Nakanishi T. (1991): The fish immune system. Organ, Pathogen and Environment. Academic Press,San Diego.1-380.

[17] Kompanets, E.V., N. M. Isaeva and I. A. Balakhnin (1992): Bacteria of genus Aeromonas and their role in aquaculture .Microbial .Zh; 54 (4): 89-99.

[18] Cipriano, C.R.A.h.a.M.A.S.o.f.F.d.l.C., R., A. Sitja-Bobadilla, M. J. Pujalte, E. Garay, P. Alverez- Pellitero, J. Perez-Sanchez. (1999): Bacterial and parasitic pathogens in cultured common dentex, Dentex dentex L. J. fish diseases 22, 299-309.

[19] Noga, E.J. (2010): Fish diseases: Wiley Online Library.

[20] Roberts, R.J. (2001): The bacteriology of teleosts. 315-321. In: RJ Roberts (Ed), Fish Pathology, WB Saunders, Philadelphia.

[21] Beaz-Hidalgo, R., Figueras, M. (2013): Aeromonas spp. whole genomes and virulence factors implicated in fish disease. J Fish Dis. 36:371-88.

[22] El Deen, A.N.; Dorgham-Sohad M., Hassan-Azza H., Hakim A. (2014): Studies on *Aeromonas hydrophila*in cultured *Oreochromis niloticus* at Kafr El Sheikh Governorate, Egypt with reference to histopathological alterations in some vital organs. World J Fish Mar Sci.6:233-40.

[23] Ortega, C., uzquiz, J. Docando, E. Planas, J. L. Alonso and M. C. Simon. (1995): Ecopathology in aquaculture: risk factors in infectious disease outbreak. Vet. Res; 26 (1) : 57-62.

[24] Noga E. J.(1996): Fish Disease: diagnosis and treatment. Moshy-Year book, I., Naples, Tokyo, New York pp. 294.

[25] Faisal, M., W. Popp and M. Refai. (1989): *Aeromonas hydrophila*-related septicemia in the Nile tilapia (Oreochromis niloticus). Berl Munch TierarztlWochenschr;102:87-93.

[26] Singh V., Rathore G., Kapoor D., and Mishra B., Lakra, W. (2008): Detection of aerolysin gene in *Aeromonas hydrophila* isolated from fish and pond water.Indian J Microbiol. 48:453-458.

[27] Viji, V.T.; Babu, M.M.; Velmurugan, S.; Kumaran, T.; Anand, S.; Gunasekaran, P. (2011): Virulence factors and molecular cloning of outer membrane protein (OMP) gene from virulent *Aeromonas hyrophila* isolated from infected gold fish *Carassius auratus*. Bangladesh J Microbiol 28:70-5.

[28] Reyes-Becerril, M.; Guardiola, F.; Rojas, M.; Ascencio-Valle, F.; Esteban

MÁ. (2013): Dietary administration of microalgae *Navicula sp.* affects immune status and gene expression of gilthead seabream (*Sparus aurata*). Fish Shellfish Immunol 35:883-9.

[29] Daskalov, H. (2006): The importance of *Aeromonas hydrophila*in food safety. Food Control, 17: 474-483.

[30] P. K. Praveen, C. Debnath, S. Shekhar, N. Dalai and S. Ganguly (2016): Incidence of *Aeromonas* spp. infection in fish and chicken meat and its related public health hazards: A review. Vet. World, 9: 6-11.

[31] Aboyadak, I.M.; Ali, N.G.M; Goda, A.M.A.S; Aboelgalagel, W.H and Salam, A. (2015): Molecular Detection of *Aeromonas hydrophila*as the Main Cause of Outbreak in Tilapia Farms in Egypt. J Aquac Mar Biol 2(6): 00045.

[32] O. A. Odeyemi and A. Ahmad (2014): Anti-biogram and resistogram profiling of *Aeromonas* species isolated from Malaysian coastal seawater. Pollution Research, 33: 487-492.

[33] Popoff, M.G.I.A.K.a.V.N., 398AL. In bergey's manual of systematic bacteriology. 545–548.

[34] Abbott, L.S., Cheung, K.W. and Janda, M. (2003): The genus, a.r.a. Aeromonas: biochemical characteristics, and phenotypic identification schemes. J. Clin. Microbiol., 2348–2357.

[35] Eissa, I.A.M., A. F. Badran and M. Moustafa and H. Fetaih. (1994): Contribution to Motile Aeromonas Septicemia in some cultured and wild freshwater fish. Vet.Med. J., (Giza), 42: (1), 63 69.

[36] Bin Kingombe, C.I., et al., *Multiplex PCR method for detection of three Aeromonas enterotoxin genes.* Applied and environmental microbiology, 2010. **76**(2): p. 425-433.

[37] Ahmed, M.M.; El-Ashram, O.A.(2012): histopathological and management study. Egypt. J. Aquat. BioL & Fish., 6 (3): 181-202.

[38] Ebeed, A.S.A.E., M.A. Morshdy; A.M. Mohamed and Basma, F. Elsobary, (2017): Prevalence of Aeromonas Species and Their Herbal Control in Fish.Global Veterinaria., 18 (4): 286-293.

[39] Serrano, P.H. (2005): Responsible use of antibiotics in aquaculture (No. 469). Food & Agriculture Org.

[40] Ebeed, A.S.A.E., M.A. Morshdy; A.M. Mohamed and Basma, F. Elsobary, (2017): Prevalence of Aeromonas Species and Their Herbal Control in Fish.Global Veterinaria., 18 (4): 286-293.

[41] Saad, M.S.M., M. S. and Hania, E.A. (2015): Incidence of Vibrio species in fish with special emphasis on the effect of heat treatments. benha veterinary medical journal.,29 (1):38-44.

[42] Younes, A.M.F., M.O.; Gaafar, A.Y. and Laila, A. M. (2016): Isolation of Vibrio alginolyticus and Vibrio vulnificus Strains from Cultured Oreochromis niloticus Around Qarun Lake, Egypt. Global Veterinaria., 16 (1): 1-5.

[43] Elham, M.I.M., M.I.; Maather, M.E. and Heba, I.A. (2017): Studies on Pseudomonas Septicemia in Some Tilapia in Ismailia. SCVMJ. , 12 (1): 107- 117.

[44] Faktorovich, K.A. (1969): Histological changes in the liver, kidneys, skin and brain of fish sick with red rot.83-101.In: KA Faktorovich (Ed), Infectious Diseases of Fish and Their Control, Division of Fisheries Research, Bureau of Sport Fisheries and Wildlife, Washington, DC.

[45] Ventura, M.T.; Grizzle, J.M. (1988): Lesions associated with natural and experimental infections of *Aeromonas hydrophila* in channel catfish Ictalurus

punctatus (Rafinesque). J Fish Dis, 11, 397-407.

[46] Bach, R.; Chen, P.K.; Chapman, C.B. (1978): Changes in the spleen of the channel catfish Ictalurus punctatus rafinesque induced by *Aeromonas hydrophila.* J Fish Dis, 1, 205-207.

[47] Yambot AV, Inglis V (1994): *Aeromonas hydrophila* isolated from Nile tilapia (Oreochromis niloticus L.) with "Eye Disease". International Symposium on Aquatic Animal Health, Seattle, WA (USA), 4th-8th September, University of California, School of Veterinary Medicine, Davis, CA: 103.

[48] Huizinga, H.W.; Esch, G.W.; Hazen, T.C. (1979): Histopathology of red-sore disease (*Aeromonas hydrophila*) in naturally and experimentally infected largemouth bass Micropterus salmoides (Lacépéde).J Fish Dis, 2 263-277.

[49] Afifi SH, Al-Thobiati S, Hazaa MS (2000): Bacteriological and histopathological studies on *Aeromonas hydrophila* infection of Nile tilapia (Oreochromis niloticus) from fish farms in Saudi Arabia. Assiut Vet Med J, 84, 195-205.

[50] Caroff, M.K., D. (2003): Structure of bacterial lipopolysaccharides. Carbohydr. Res. 338, 2431–2447.

[51] Cao, H.W., M.; Wang, Q.; Xu, T.; Du, Y.; Li, H. (2018): Identifying genetic diversity of O antigens in *Aeromonas hydrophila* for molecular serotype detection. PLoS ONE 13, e0203445.

[52] Sakazaki, R.a.S., T.(1984): O-Serogrouping for mesophilic Aeromonas strains. Jpn. J. Med. Sci. Biol. 37,247–255.

[53] Rather MA, W.M., Wani SA, Munshi ZH, Hussain SA (2014): A multiplex PCR for detection of enterotoxin genes in Aeromonas species isolated from foods of animal origin and human diarrhoeal samples. J Appl Microbiol 117:1721–1729.

[54] Ahmed, A.M.; Motoi, Y.; Sato, M.; Maruyama, A.; Watanabe, H.; Fukumoto, Y. and Shimamoto, T. (2007): Zoo animals as a reservoir of gram-negative Bacteria Harboring Integrones and Antimicrobial Resistance Genes. Appl Environ Microbiol 73(20): 6686-6690.

[55] Martinez-Murcia, A.J., S. Benlloch, and M. D. Collins (1992): Phylogenetic interrelationships of members of the genera Aeromonas and Plesiomonas as determined by 16S ribosomal DNA sequencing: lack of congruence with results of DNA-DNA hybridizations. Int. J. Syst. Bacteriol. 42:412–421.

[56] Ruimy, R., V. Breittmayer, P. Elbaze, B. Lafay, O.Boussemart, M. Gauthier, and R. Christen (1994): Phylogenetic analysis and assessment of the genera Vibrio, Photobacterium, Aeromonas, and Plesiomonas deduced from small-subunit rRNA sequences. Int. J. Syst. Bacteriol. 44:416–426.

[57] Ya´n˜ez, M.A., V. Catala´n, D. Apra´iz, M. J. Figueras, and A. J. MartínezMurcia (2003): Phylogenetic analysis of members of the genus Aeromonas based on gyrB gene sequences. Int. J. Syst. Evol. Microbiol. 53:875–883.

[58] Lee, C.; Cho, J.C.; Lee, S.H.; Lee, D.G.; Kim, S.J. (2002): Distribution of *Aeromonas* spp. as identified by 16S rDNA restriction fragment length polymorphism analysis in a trout farm. J Appl Microbiol 93(6): 976-985.

[59] Aboelgalagel, W.H. (2015): Bacteriological and molecular studies of some pathogenic bacteria isolated from *Oreochromis niloticus* in fish farms. MV Sc Thesis, Microbiology, Faculty of Veterinary Medicine Kafrelsheikh University, Egypt.

[60] B. Austin and D. A. Austin (2012): Bacterial fish pathogens. Disease of farmed and wild fish. Netherlands: Springer.

[61] I. S. Azad, K. V. Rajendran, J. J. S. Rajan, K. K. Vijayan and T. C. Santiago (2001): Virulence and histopathology of *Aeromonas hydrophila* (Sah 93) in experimentally infected tilapia, Oreochromis mossambicus (L.). J. Aqua. Trop., 16: 265-275.

[62] N. Abu-Elala, M. Abdelsalam, Sh. Marouf and A. Setta (2015). Comparative analysis of virulence genes, antibiotic resistance and gyrB-based phylogeny of motile Aeromonas species isolates from Nile tilapia and domestic fowl. Lett. Appl. Microbiol., 61: 429-436.

[63] Suheyla, K.D., Nazli, A., Kin, A.C (2003): Some medicinal plants as immune stimulant for fish. Journal of Ethanopharmacology. 88:99-106.

[64] Secombes, C.J., Hardie, L.J., Daniel, S.G. (1996): Cytokines in fish: An update. Fish and Shellfish Immunology.6:291-304.

[65] Ian, B., Roy, A.D. (2005): The use of immune stimulants in fish larval Aquaculture. Fish and Shellfish Immunology.19:457-472.

[66] Berglojot, M.(2006): Innate immunity of fish. Fish and Shellfish immunology.20 (2):137- 151.

[67] Fisher, U., Erling, O.K., Teruyuki, N. Teleost, T. and N.K. (2013): cell immunity. Fish and Shellfish Immunology. 34(6):1395-1752.

[68] Janda, J.M., and S. L. Abbott (1998): Evolving concepts regarding the genus Aeromonas: an expanding panorama of species, disease presentation, and unanswered questions. Clin. Infect. Dis. 27:332–344.

[69] El-Shenawy, M.A. and Marth, E.H. (1990): *Aeromonas hydrophila* in foods: A review. Egyptian J. Dairy Sci, 18: 219-234.

[70] Abbott, S.L and Janda, J.M.(2010):The genus *Aeromonas***:** taxonomy, pathogenicity, and infection. Clinical Microbiology Reviews, 23.35-73.

[71] Palumbo, S.A., F. Maxino, A. C. Williams, R. L. Buchanan, and D. T. W.Thayer (1985): Starch-ampicillin agar for the quantitative detection of *Aeromonas hydrophila*. Appl. Environ. Microbiol. 50:1027–1030.

[72] Borrell, N., M. J. Figueras, and J. Guarro. (1998): Phenotypic identification of Aeromonas genomo species from clinical and environmental sources. Can. J. Microbiol. 44:103–108.

[73] Neyts, K., G. Huys, M. Uyttendaele, J. Swings, and J. Debevere (2000): Incidence and identification of mesophilic Aeromonas spp. from retail foods. Lett. Appl. Microbiol. 31:359–363.

[74] Odeyemi, O.A., Ahmad, A. (2013): Anti-biogram and resistogram profiling of Aeromonas species isolated from Malaysian aquatic sources. J Coastal Life Med 1: 108–112. 13.

[75] Batra, P., Mathur P., Misra, M.C. (2016): Aeromonas spp.: An emerging nosocomial pathogen. J Lab Physicians 8: 1–4. 14.

[76] El-Bahar, H.M., Ali N.G., Aboyadak, I.M., Khalil, SAES, Ibrahim, M.S. (2019): Virulence genes contributing to *Aeromonas hydrophila* pathogenicity in Oreochromis niloticus. Int Microbiol 22: 479–490. 15.

[77] Bhowmick, U.D., Bhattacharjee, S. (2018): Bacteriological, clinical and virulence aspects of Aeromonas-associated diseases in humans. Pol J Microbiol 67: 137–149.

[78] Hatha, M., Vivekanandhan, A.A., Joice, G.J., Christol (2005): Antibiotic resistance pattern of motile aeromonads

from farm raised fresh water fish. Int J Food Microbiol 98: 131–134.

[79] Nzeako, B., Okafor, N. (2002) Bacterial enteropathogens and factors associated with seasonal episodes of gastroenteritis in Nsukka, Nigeria. Br J Biomed Sci 59: 76–79.

[80] Vila, J., Ruiz, J., Gallardo, F., Vargas, M., Soler, L., Figueras, M.J., Gascon, J. (2003): Aeromonas spp. and traveler's diarrhea: Clinical features and antimicrobial resistance. Emerg Infect Dis 9: 552–555.

[81] Agger, W.A., Callister, S.M. (1987): Intestinal infections with Aeromonas. Ann Int Med 106: 497.

[82] Xu, D.H., Pridgeon, J.W., Klesius, P.H., Shoemaker, C.A. (2012): Parasitism by protozoan Ichthyophthirius multifiliis enhanced invasion of Aeromonas hydrophila in tissues of channel catfish. Vet Parasitol 184: 101–107.

[83] Gowda, T.K., Reddy, V.R., Devlees schauwer, B., Zade, N.N., Chaudhari, S.P., Khan, W.A., Shinde, S.V., Patil, A.R. (2015): Isolation and seroprevalence of Aeromon as spp. among common food animals slaughtered in Nagpur, central India. Foodborne Pathog. Dis. 12: 626–630.

[84] Albert, M.J., Ansaruzzaman, M., Talukder, K.A., Chopra, A.K., Kuhn, I., Rahman, M., Faruque, A.S., Islam, M.S., Sack, R.B., Mollby, R. (2000): Prevalence of enterotoxin genes in Aeromonas spp. isolated from children with diarrhea, healthy controls, and the environment. J Clin Microbiol 38: 3785–3790.

[85] Hofer, E., Reis, C.M., Theophilo, G.N., Cavalcanti, V.O., Lima, N.V., Henriques ,Mde.F .(2006): Aeromonas associated with an acute diarrhea outbreak in São Bento do Una, Pernambuco. Rev Soc Bras Med Trop 39: 217–220.

[86] Kirov, S.M., Anderson, M.J., McMeekin, T.A. (1990): A note on Aeromonas spp. from chickens as possible food-borne pathogens. J Appl Bacteriol. 68: 327–334.

[87] Gray, S.J., Stickler, D.J., Bryant, T.N. (1990): The incidence of virulence factors in mesophilic Aeromonas species isolated from farm animals and their environment. Epidemiol Infect 105: 277–294.

[88] Josheph, S.W., Carnahan, A. (1994): The isolation, identification and systematic of motile Aeromonas spp. Ann Rev Fish Dis 4: 315–343.

[89] Ghenghesh, K.S., Ahmed, S.F., El-Khalek, R.A., Al-Gendy, A., Klena, J. (2008) :Aeromonas infections in developing countries. J Infect Dev Ctries 2: 81–98.

[90] Fricker, C.R., Tompsett S (1989): Aeromonas spp. in foods: A significant cause of food poisoning. Int. J. Food Microbiol. 9: 17–23.

[91] Figueras, M.J (2005): Clinical relevance of Aeromonas sM503. Rev. Med. Microbiol. 16, 145–153.

[92] Igbinosa, I.H.; Igumbor, E.U.; Aghdasi, F.; Tom, M.; Okoh, A.I. (2012): Emerging Aeromonas species infections and their significance in public health. Sci. World J. 2012, 1–13.

[93] Chao, C.-M.; Lai, C.-C.; Gau, S.-J.; Hsueh, P.-R.(2013): Skin and soft tissue infection caused by Aeromonas species in cancer patients. J. Microbiol. Immunol. Infect. 46, 144–146.

[94] Hiransuthikul, N.; Tantisiriwat, W.; Lertutsahakul, K.; Vibhagool, A.; Boonma, P. (2005): Skin and soft-tissue infections among tsunami survivors in Southern Thailand. Clin. Infect. Dis. 41, 93–96.

[95] Presley, S.M.; Rainwater, T.R.; Austin, G.P.; Platt, S.G.; Zak, J.C.; Cobb, G.P.; Marsland, E.J.; Tian, K.; Zhang, B.;

Anderson, T.A.; et al.(2006): Assessment of pathogens and toxicants in New Orleans, LA following Hurricane Katrina. Environ. Sci. Technol. 40, 468–474.

[96] Irianto, A. and Austin, B. (2002). Use of probiotics to control furunculosis in rainbow trout, Oncorhynchus mykiss (Walbaum). Journal of Fish Diseases, (25): 333-342.

[97] Barros, M.P.; Pinto, E.; Sigaud-Kutner, T.C.S.; Cardozo, K.H.M. and Colepicolo, P. (2005). Rhythmicity and oxidative/nitro-sative stress in algae. Biol Rhythm Res., 36(1–2):67–82.

[98] Selvendran, M. (2013). Studies on antimicrobial compounds from selected marine phytoplanktons. Int. J. Pharm. Bio. Sci., 4(2):876–888.

[99] Nayak, S.K., (2010b): Role of gastrointestinal microbiota in fish. Aquac. Res 41: 1553–1573.

[100] Dawood, M.A.O.; Koshio, S. (2016): Recent advances in the role of probiotics and prebiotics in carp aquaculture: A review. Aquaculture 454, 243-51.

[101] Essa, M.A.a.S., M.E., (1994): Salinity tolerance and reproductive performance of Nile tilapia, Oreochromis niloticus. Delta J.Sci., 18: 239-261.

[102] Crespy, V. and Williamson, G. (2004): A review of the health effects of green tea catechins in in vivo animal models. J. Nutr. 134.

[103] Cortés-Rojas, D.F.d.S.; C.R.F. and Oliveira, W.P. (2014): Clove (Syzygium aromaticum): a precious spice. Asian Pac. J. Trop. Biomed.,4: 90–96.

[104] Amelia, B.S., E.; Cahyana, A.H.; Rahayu, D.; Sulistyoningrum, A. and Haib, J. (2017): GC-MS analysis of clove (Syzygium aromaticum) bud essential oil from Java and Manado, AIP Conference Proceedings, AIP Publishing LLC, pp. 030:082.

[105] Balcázar, J.L.D.B., I.; Ruiz-Zarzuela, I.;Cunningham, D.; Vendrell, D. and Muzquiz, J. L. (2006): The role of probiotics in aquaculture. Veterinary microbiology, 114(3-4), 173-186.

[106] Robertson, P.A.W.O.D., C.; Burrells, C.;Williams, P. and Austin, B., (2000): Use of Carnobacterium sp. as a probiotic for Atlantic salmon (Salmo salar L.) and rainbow trout (Oncorhynchus mykiss, Walbaum).Aquaculture, 185(3-4), 235-243.

[107] El Haroun, E.R.G., A.S. and Kabir Chowdhury, M.A. (2006): Effect of dietary probiotic Biogen® supplementation as a growth promoter on growth performance and feed utilization of Nile tilapia Oreochromis niloticus (L.). Aquaculture Research, 37(14), 1473-1480.

الملخص العربى

الأيروموناد المتحركة كعدوى بكتيرية فى البلطي النيلي: مقال عن الإنتشار والخصائص الجزيئية والتأثير على الاستجابة المناعية وتدابير الرقابة البديلة

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يشكل البلطي النيلي (*Oreochromis niloticus*) أهم أنواع الأسماك وأكثرها ربحية في مصر ، حيث يمثل 71.38٪ من إجمالي الأسماك المستزرعة في إفريقيا و 1.54٪ من إجمالي الأسماك التي يتم تربيتها على مستوى العالم. عضلات البلطي غنية بمجموعة متنوعة من العناصر الغذائية الأساسية ، بما في ذلك الفيتامينات والأحماض الدهنية المتعددة غير المشبعة وأحماض أوميغا 3 الدهنية والمعادن الأساسية وكميات كبيرة من العناصر النادرة. تعد مصر ثالث أكبر دولة منتجة للبلطي بعد الصين وإندونيسيا، أما المحافظات الأكثر أهمية في مصر والتي تنتج 80٪ من أسماك البلطي المستزرعة في مصر فهي كفر الشيخ والبحيرة والشرقية. تسبب عدوى الإيروموناسفي الأسماك مشاكل اقتصادية عالمية بسبب ارتفاع عدد نفوق الأسماك خاصة في الصين والهند. يعتبر الإيروموناسهيدروفيلا أحد أهم العوامل المسببة لانتشار المرض في أسماك المياه العذبة ، حيث

تكون قرح الجلد ونزيف ونخر الأعضاء الحشوية هي تمثل الأعراض الرئيسية. وله مرادفات اخريوهي تسمم الدم النزفي البكتيري ، تعفن الدم بالإيرموناد.ثبت أن إستخدام المضادات الحيوية والعلاجات الكيميائية الأخرى في تربية الأسماك يمثل مشكلة بسبب إمكانية تطور البكتيريا المقاومة للمضادات الحيوية ، والتلوث البيئي ، وتراكم المخلفات في أنسجة الأسماك. لذلك ، أصبح تطبيق النباتات الطبية في تربية الأحياء المائية نهجًا جديدًا مؤخرًا.في هذه المراجعة ، سنوضح كيف يمكن إستخدامالبروبيوتيك والشاي الأخضر وزيت القرنفل في وجبات الأسماك كمنشطات مناعية لمنع العدوى. تم أخذ في الاعتبار في هذه المقاله العامل المسبب للمرض ، والعزل ، والتعرف على الايرومونس هيدروفيلا، والانتشار، والتقلبات الموسمية، والتشخيص الجزيئي، والاستجابة المناعية للبلطي النيلي ضد العدوى ، وإدارة المرض .بناءًا على ما نعرفة من الظروفالبيئية ،والإمراضية و الوبائية عن جنس الإيرومونسيمككننا أن نفترض أن الإصابة بـعدوى الإيروموناس ، ستظل مشكلة صحية كبيرة في المستقبل حيث أن الإنتشارالواسع لعدوى الإيروموناس وزيادة الفئات العمرية الكبيرة التي يستهدفها المرض ، سيسهل هذه المشكلة.