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REVIEW ON BACTERIAL INFECTION IN FRESHWATER FISHESH

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Abstract: Fishes are the main element of aquatic communities, and they can directly affect the exploitation of all its communities as a protein source for human consumption. Pathogenic infection can strongly affect the rate of reproduction and survival capacity of fish. Therefore, knowledge of fish diseases has a great relevance through both from a scientific as well as an applied point of view. In this review, we focus on the individual and co-infections by homologous or heterologous pathogens in fish. More research is needed to better understand the immune response of fish during single or mixed infections as these could have an important impact on the development of new strategies for disease control programs in the field of fishery.

Key Words: Freshwater fishes, pathogenic exploitation, bacterial infection.

Introduction: Fishes are the main element of aquatic communities, and they can directly affect the exploitation of all its communities as a protein source for human consumption. Last from three decades, culture fishery strongly developed along with capture fishery and the percentage contribution of inland fish production increased to 71% out of the total fish production. More than Rs. 45000 crores had been credited to national treasury by means of inland fishery every year. The number of culturable fish species is steadily increasing and the search for suitable species for fish-farming is still being on. (Handbook on fisheries Statics, 2019). As fish is daily consuming and luxury food, it gives much importance to the fish community. For all of this must have credited to scientist, researchers and fish farmers, as they take lots of efforts for this big achievement.

Many times, much of the fish stocks available for rearing and fishing are decline due to many reasons. Fish diseases are one of the main abstracts in the success of the fishery industry. Disease-related economic losses can be destructive, where disease outbreaks occur suddenly, spread progressively with much of mortality rate and disappear with same speed or develops very slowly with less severity, but persist for long time. Diseases are a major threat to all types of fishes. Much of the factors associated with ecosystem regarding the fish farming supports and promotes the action of pathogens. As a matter of fact, disease outbreaks occur more often in culture environment than free ecosystem. It can be a major factor that influence the abundance and distribution of fish species in distinct geographical areas. Pathogen induced alterations in health and growth of fish community. It can strongly affect the rate of reproduction and survival capacity of fish also. Therefore, knowledge of fish diseases is of great significance through both scientific as well as applied point of view. (Jorge C, 2008). This literature tries to focus on bacterial infection in fish.

Bacterial species infected in fish community: Normally disease is the result of an interaction between the host (fish body) and the disease-causing factor of concern environment. It may be pathogens, physical factor, unfavorable environmental change, low hygiene and external stress regarding the ecosystem. Before the appearance of symptoms of disease, there may be demonstrable damage and weakening of the host body occurs. The list of fish pathogens has extended substantially since 1980, but the current literature focused on bacterial infection only. Until today, various techniques are discovered to detect and isolate the pathogen from host body. The isolation of bacteria from diseased fish is taken as evidence of infection. Commonly infective species of bacteria found in fresh water fishes are as:

Anaerobes: fish infected by these members have been observed to exhibit sluggish, erratic swimming, appeared to be restless, and may alternately float and sink, before showing temporary rejuvenation, repeated pattern was continued until death. (Cann and Taylor, 1982). Anaerobic bacteria include *Eubacterium tarantellae, Catenabacterium* spp.

Gram-positive bacteria: Infection by member of this group cause extensive damage in the liver, kidney and spleen. In some cases, petechial hemorrhages in the muscle and hyperemic air bladder occurs. (Hiu *et al*., 1984), Generally the fish which are under stress due to handling and spawning are more susceptible to this infection. Disease symptoms were varied to specimen. Muscle abscesses and internal hemorrhaging is noticed in some fish. Some of the members of this group are *Enterococcus faecalis, Vagococcus salmoninarum, Lactococcus garvieae, Lactococcus piscium, Streptococcus dysgalactiae, Streptococcus agalactiae, Streptococcus shiloi,* (Duremdez *et al*, 2004; Eldar *et al*., 1994; Nomoto *et al*, 2004; Teskeredzic *et al*., 1993).

Aerobic, Gram-positive rods and cocci: Infection of this members reported to occur in 13 species of salmonids. Wounds create in the snout caused by tagging can become infected by bacteria may spread to internal organ. Salmon infected by this pathogen shows exophthalmia, lesions in eyes, swollen abdomen, formation of ulcers/abscesses (Fryer and Sanders, 1981;). Lesions may develop in the kidney, brain, liver, heart and spleen (Speare, 1997). Some of the members of this group are (*Bacillus cereus, Bacillus mycoides, Bacillus subtilis* (Goodwin et al, 1994). *Corynebacterium aquaticum, Micrococcus luteus, Mycobacterium abscessus* (Teska *et al*, 1997; Chang *et al*, 2006), *Staphylococcus aureus* (Wang *et al*, 1996), *Staphylococcus epidermidis* (Kubilay and Ulokoy, 2004), *Staphylococcus warned* (Gil *et al*, 2000). Nocardia spp (Chen *et al*., 2000). Rhodococcus spp. (Claveau, 1991).

Gram-negative bacteria: Infected fish indicate signs of hemorrhages on the body, intestine filled with bloody exudate, bulging liver and spleen, and liquefying kidney. Infected individual suffers with eye disease and haemorrhagic septicaemia. (Ogara *et al*, 1998). Infection mostly occurs to cyprinidae by cutaneous ulcer. *Pseudoalteromonas piscicida, Shewanella putrefaciens* are related to whitening of eggs and mortality of eggs (Nelson and Ghiorse, 1999). *Arcobacter cryaerophilus* cause upper jaw darkening or alternatively pale pigment, fin rot, pale gills, hemorrhaging in the muscle, hemorrhage, ulcer formation in intestine and skin (Aydin *et al*, 2002). Some members of this group are *Aeromonas spp, Citrobacter freundii, Escherichia vulnevi, Flavobacterium spp. Janthinobacterium lividum, Pseudomonas spp., Vibrio anguillavum*

Table-1: list of Infective bacterial species along with host fish

Sr.No.	Bacterial Type:	Bacterial Species:	Infected Host Fish:	Disease:
1	**Anaerobes:**	*Catenabacterium* spp:	- *Mugil auratus*	- visceral toxicosis

		Clostridium botulinum	-*Salmonids & Ictalurus punctatus*	-botulism, visceral toxicosis
2	**Gram-positive bacteria:**	*Eubacterium tarantellae*	- *Mugil cephalus*	-eubacterial meningitis
		Carnobacterium maltaromaticum	- *Coregonus clupeaformis & Oncorhynchus spp.*	- pseudokidney disease meningoencephalitis
3	**Aerobic, Gram-positive rods and cocci:**	*Bacillus cereus, B. mycoides, B. subtilis*	-Many freshwater fishes including *Pangasius hypophthalmus, Morone saxatilis, Ictalurus punctatus, Cyprinus* spp.	- branchionecrosis, ulceration
		Staphylococcus aureus	-*Hypophthalmichthys molitrix, Clarias gariepinus*	- eye disease, jaundice.
4	**Gram-negative bacteria**:	*Aeromonas salmonicida*	-salmonids, cyprinids	- furunculosis, carp erythron-dermatitis, ulcer disease.
		Providencia vermicola Salmonella enterica	- Indian major carps	- fin and tail disease, septicaemia
		Flavobacterium columnare	- many freshwater fish species	- columnaris, saddleback disease

(Campbell et al., 1979; Kinne O, 1980; Koskiniemi et al.,2012; Pennisi E., 2002; Skerman etal., 1980; Stevenson L. H., 1978; Torrella F, Morita R. Y., 1981; Brian Austin and Dawn A. Austin, 2016)

External signs associate with bacterial infection: Twirling, spiral or erratic movement. Faded pigments, darkened pigment/melanosis, eye damage (exophthalmia), hemorrhaging in the eye, mouth, Erosion of the jaws or mouth, opercula region, gills, gill damage, white nodules on the gills or skin, damaged or rotted fins,

Internal signs associate with bacterial infection: Hemorrhaging on the surface and in the muscle, Necrotizing dermatitis, Ulcers section, Furuncles or boils on internal organs, hemorrhaging around the vent, Inappetence Nevertheless, loss of appetite, Stunted growth, Sloughing off of skin or external surface lesions, dorsal rigidity skin/external surface lesions. These are common signs of many infections caused by bacterial pathogens in fish.

Pattern of Infection: However, it is considered that disease is not necessarily caused by single bacterial taxa. Instead, there may will be synergistic interactions between two or more taxa. It also referred as co-infection.

Infection by single species: some of the members of bacteria are very specific able to cause deformities in host body alone. According to Kanno *et al*. (1989) the primary mode of transmission of *Vibrio anguillarum* to host body is by direct contact in crowded conditions. (Ronald *et al.*, 1993)

Infection by multiple species: It also referred as co-infections or mutual infection. It defined as infection of the host by two or more genetically different pathogenic member and cause individual effects on host body. (Cox FEG, 2001; Bakaletz L O, 2004). In such infection, pathogen is of two types, homologous and heterologous. In homologous mode of infection both pathogens are bacteria. In heterologous mode of infection bacteria infect the host along with virus, fungus or with any other parasite. Naturally, it is conformed that some taxa are secondary pathogens which invades through already damaged tissues, whereas other taxa are already infect the host as a primary pathogen. Details indicates in table-2

Table- 2: Bacterial co-infection

Sr. No.	Type of co-infection:	Infected Host fish species:	First Pathogen:	Second Pathogen:
1	Bacterial co-infections	*Chinook salmon, Oncorhynchus tshawytscha*	*Renibacterium salmoninarum*	*Aeromonas. hydrophila*
2	Bacterial and viral co-infections	*Rainbow trout, Oncorhynchus mykiss*	*Flavobacterium psychrophilum*	*Infectious pancreatic necrosis virus*
3	Parasitic and bacterial co-infections	*Nile tilapia, Oreochromis niloticus*	*Gyrodactylus niloticus (Helminth)*	*Streptococcus iniae*
4	Fungal and bacterial co-infections	*Nile tilapia, Oreochromis niloticus*	*Fusarium oxysporum*	*Aeromonas. hydrophila*

(Loch TP et al, 2012; Evensen and Lorenzen, 1997; Cutuli et al., 2015; Xu DH et al, 2007 Kotob et al., 2016)

Histopathology is one of the important tools for verification and diagnosing in fish diseases. Generally, gross observations are enough for correct diagnosis, but some time extra information is necessary to determine the perfect reason for clinical aliment. (Reimschuessel, 1999). As the susceptibility of fish to different pathogens could be changed during mixed infections causing the appearance of sudden outbreaks in fish, effect of infection has still received limited inspection in fish and available data on this subject is still scarce. In this review, we focus on the individual and co-infections by homologous or heterologous pathogens and represent a reviewed summary about the knowledge regarding infections in fish.

Conclusions: Members of many bacterial taxa are associate with fish body for one or many times. However, may not all these taxa be considered as fish pathogens. They may be contaminants of medium in which fish present or they may be innocent saprophytes. The interactions can be either collaborative or sympathetic, might be result in the upgrading and inhibition of one or more pathogens along with bacteria, increasing or decreasing the severity of the disease. So that there may be great confusion about the precise meaning of disease. Such interactions can have an important impact on the growth and development of the fish species and should be important during the course of treatment and vaccination. It is evident that more research is needed in the future to improve knowledge concerning to the interactions of pathogens with fish and how they interact with the immune response of the fish. This will enrich our knowledge of understanding of the disease process and pathogenesis and will be useful for disease management in the field of fishery.

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