

BIOTECHNOLOGICAL TOOLS IN FISH HEALTH MANAGEMENT

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Summary

Aquaculture industry is suffering serious losses due to diseases. Viral, bacterial and parasitic diseases are major problems in the industry. Disease management strategies targeted only at the pathogen is not successful in aquatic systems. Some of the approaches suggested include rapid detection and avoidance of the pathogen, biocontrol of the pathogen, immunoprophylaxis through vaccines and immunostimulants and bioremediation of the environment. Biotechnological approaches show promise to improve the health of cultured fish and shellfish and improve aquaculture production, while safeguarding the environment.

1. Microbial Disease Problems in Aquaculture

Aquaculture is one of the fastest growing food production sectors in the world. According to the Food and Agriculture Organisation (FAO) estimates, 29 percent of the world's food fish come from aquaculture. Freshwater aquaculture contributes 15.1 million tons to fish production, while marine and brackishwater aquaculture contribute 9.7 million tons and 1.6 million tons respectively. Developing countries in Asia account for 80 percent of aquaculture production and this industry contributes significantly to the economic growth of the producing countries. However, the aquaculture industry is facing serious problems due to diseases and today, disease is considered to be the major limiting factor for the growth of this industry. According to the estimates of the World Bank, the annual loss due to diseases in shrimp aquaculture alone is around US\$ 3000 million.

A number of viruses, bacteria, fungi and parasites are known to cause diseases in fish and shellfish. Tables 1-4 list some of the important bacterial and viral pathogens of cultured fish and shellfish. Some of these pathogens are causing serious problems in aquaculture due to the acute mortalities caused by them. For example, during the last five years, the shrimp culture in Asia suffered serious losses due to the disease caused by the viral agent, whitespot syndrome virus (wssv). The shrimp aquaculture in South America has been affected by taura syndrome virus. Bacterial diseases such as furunculosis and vibriosis have caused severe mortalities in finfish culture systems. In this context, one of the major challenges to the aquaculturists has been the management of health of cultured fish.

Disease/Pathogen	Host range	Geographical Distribution
Channel catfish virus disease, Channel catfish virus(CCV)	channel catfish	United States
Infectious pancreatic necrosis, Infectious Pancreatic Necrosis Virus(IPNV)	salmonids in fresh water	United States, Canada, Chile, Japan, Taiwan, Korea, Europe
Infectious hematopoietic necrosis, Infectious hematopoietic necrosis virus (IHNV)	salmonids in freshwater	North America, Japan, Taiwan Italy, France, Germany
Viral hemorrhagic septicaemia, Viral hemorrhagic septicaemic virus(VHSV, EGTVED disease)	salmonids in freshwater, grayling, whitefishes, and northern pike	Europe
Sturgeon wasting disease, (Adenovirus like)	white sturgeon	Sacramento river, California, USA
Eel birnaviruses Eel virus European, Branchionephritis, eel virus kidney disease	Japanese eel	Japan, Taiwan
Pike fry rhabdovirus disease(hydrocephalus, red disease of pike, grass carp rhabdovirus)	northern pike, brown trout, grass carp, white bream, gudgeon, tench	Europe
Herpesvirus salmonis	salmon and trouts	USA

disease		
Epizootic epitheliotropic disease (EED) (herpes - virus like)	lake trout, lake trout x brook trout	Great lakes, USA
<i>Oncorhynchus masu</i> virus(OMV herpesviruses)	masu, coho, chum, kokanee, rainbow trout, salmon	Japan
Salmon leukemia virus(SLV retrovirus)	chinook salmon sea cultured	British, Columbia, Canada
Golden shiner virus(reovirus)	golden shiner	USA
Spring viremia of carp(SVC, <i>Rhabdovirus carpio</i> infection,swim bladder inflammation, SBI)	common, bighead, crucian and grass carp	Great Britain, Russia, Europe Middle East
Grass carp reovirus disease(hemorrhagic viral disease of carp)	grasscarp, black carp, chebachek	China
Carp pox(<i>herpesvirus cyprini</i> disease, carp epithelioma)	common carp, crucian carp, barbel, bream, golden ide, rudd, smelt, garp x gold fish; aquarium fish	Europe, Asia, Russia, Great lakes, USA, Israel
Epizootic hematopoietic necrosis (perch iridovirus, Nillahcootie redfin virus)	redfin perch; native Australian fishes	Australia
Vacuolating encephalopathy(Picornalike virus)	Australian sea bass	Malaysia, Singapore, Tahiti, Australia, Indonesia, Philippines
Tiger puffer virus(white mouth disease)	tiger puffer	Japan
MHLLE-associated virus	semicirculatus angelfish	Uncertain

Turbot epithelial cell Gigantism (herpesvirus scophthalmic infection)	turbot	Scotland
Japanese flounder rhabdovirus disease (Rhabdovirus olivaceus, hirame rhabdovirus)	Japanese flounder, ayu, black sea bream, red sea bream, black rock fish, red spotted grouper, spotbelly greenling, sunrise sculpin yellowfish goby.	Japan
Epidermal hyperplasia/necrosis	Japanese flounder	Japan
Epidermal necrosis	Fox jacopver	Japan
Epithelial necrosis	Schlegeli black seabream	Japan
Viral nervous necrosis(picorna-like virus)	Japanese parrotfish, red-spotted grouper, striped jack	Japan
EUS virus	Striped snake head	Japan
(rhabdoviruses)	swamp eel	South East Asia

Table 1: Viral pathogens/diseases of cultured fish

Pathogen/disease	Host range	Geographical distribution
Enterobacteriaceae members		
<i>Citrobacteria freundii</i>	salmonids, sunfish, carp	Europe, India, USA
<i>Edwardsiella ictaluri</i> (enteric septicaemia of catfish)	channel catfish	USA
<i>Edwardsiella tarda</i> (edwardsiellosis, redpest)	various freshwater fish species	Japan, USA
<i>Proteus rettgeri</i>	silver carp	Israel

<i>Serratia liquefaciens</i> (septicaemia)	Atlantic salmon, turbot	France, Scotland
<i>Serratia plymuthica</i>	Rainbow trout	Scotland, Spain
<i>Yersinia ruckeri</i> (enteric redmouth, ERM)	salmonids	Australia, Europe, North America
Gram negative gliding bacteria		
<i>Flavobacterium branchiophilum</i> (gill disease)	salmonids	Europe, Korea, Japan, USA
<i>Flavobacterium columnare</i> (columnaris disease)	many fresh water species	world wide
<i>Flavobacterium psychrophilum</i> (cold water disease)	salmonids	Australia, Europe, USA
<i>Flexibacter maritimus</i> (salt water columnaris, gill disease)	many marine fish species	Europe, Japan
Vibrionaceae		
<i>Vibrio alginolyticus</i>	many marine fish	Worldwide
<i>V.anguillarum</i>		
<i>V.fischeri</i>		
<i>V.harveyi</i>		
<i>V.logei</i>		
<i>V.ordalii</i>		
<i>V.pelagicus</i>		
<i>V.splendidus</i>		
<i>V.vulnificus</i>		
(Vibriosis, saltwater furunculosis, skin, lesions, intestinal		

necrosis, septicaemia)		
<i>V. salmonicida</i> (cold water vibriosis, Hitra disease)	Atlantic salmon	Canada, Norway, Scotland
Pasterurellaceae		
Pasteurella piscicida (pasteurellosis, pseudotuberculosis)	cultured marine fish	Japan
Pseudomonadaceae		
<i>P. anguilliseptica</i> (Sekiten-byo, red spot)	Rainbow trout, marine fish species and particularly eels	Finland, France, Japan, Spain, Scotland
<i>Pseudomonas fluorescens</i> (septicaemia)	many fish species	Worldwide
<i>Pseudomonas putida</i> (haemorrhagic ascites)	Ayu	Japan
Anaerobic gram positive rods		
<i>Clostridium botulinum</i> type E(botulism)	salmonids	Denmark, England, USA
<i>Eubacterium tarantellus</i>	striped mullet	USA
(neurological disorders, eubacterial meningitis)	<i>(mugil cephalus)</i>	
Aerobic gram positive rods and cocci		
<i>Bacillus</i> sp.	various freshwater species	Nigeria
(Septicaemia)	salmonids	
Coruneform bacteria(corynebacteriosis)	salmonids	England
<i>Mycobacterium</i> spp. (Mycobacteriosis)	most fish species	Worldwide

<i>Nocardia</i> sp. (nocardiosis)	most fish species	Worldwide
<i>Renibacterium salmoninarum</i> (bacterial kidney disease, BKD)	salmonids	Europe, Japan, North and South America
<i>Stapylococcus</i> sp Eye disease	silver carp	India
<i>Streptococcus iniae</i> Streptococcosis	many freshwater fish species	Australia, Europe, Israel, Japan, Saudi Arabia, South Africa, USA, UK
Aeromonadaceae members		
<i>Aeromonas caviae</i>	Altantic salmon	Turkey
<i>A. hydrophila</i>	many cultured freshwater	Worldwide
<i>A. sorbi a</i> (motile aeromonas septicaemia)	species	

Table 2: Bacterial pathogens/diseases of cultured fish

Disease/Pathogen	Host range	Geographical distribution
Baculovirus penaei (BP)	<i>Penaeus vannamei</i> and Widespread in cultured and Wild shrimps of Americas	USA, Peru, Mexico
Monodon baculovirus (MBV)	<i>P. aztecus</i> , <i>P. monodon</i> , <i>P. merguensis</i> , <i>P. vannamei</i>	China, Taiwan, South East Asia, Australia, S.Africa, Israel
Midgut gland necrosis baculovirus (MNBV)	<i>P. japonicus</i>	Japan, Korea, The Philippines
Infectious hypodermal hematopoietic necrosis virus (IHHNV)	<i>P. stylirostris</i> , <i>P. vannamei</i> , <i>P. monodon</i> , <i>P. chinensis</i>	Taiwan, Singapore, Malaysia, Australia, The Philippines, Peru, Equador, Central America
Hepatopancreatic	<i>P. merguensis</i> ,	Korea, China, Taiwan,

parvo-like virus (HPV)	<i>P.monodon P. indicus, P.semisulcatus P.esculentus, P.chinensis</i>	South East Asia, Isreal, Kuwait
Reo virus or Reo-like virus	<i>P. monodon & P.japonicus</i>	Hawaii, France, Malaysia
Lymphoid organ parovo-like virus	<i>Metapenaeus</i> sp	USA, Asia, Australia
Yellow head virus	<i>P. monodon</i>	South East Asia
White spot syndrome virus(WSSV)	Many penaeid species	Worldwide
Taura syndrome virus (TSV)	Many penaeid species	Equador, China

Table 3: Viral pathogens/diseases of cultured penaeid shrimps

Disease/Pathogen	Host range	Geographical distribution
Chitinolytic bacteria		
(Shell disease, brownspot disease, blackspot disease, burned spot disease, rust disease)	many cultured marine species	Worldwide
<i>Aeromonas</i> sp		
<i>Flavobacterium</i> sp		
<i>Pseudomonas</i> sp		
<i>Spirillum</i> sp		
<i>Vibrio</i> sp		
<i>Alkaligenes</i> sp	<i>P. monodon</i>	Worldwide
<i>Alteromonas</i> sp.	<i>P. indicus</i>	Worldwide
Filamentous bacteria	All penaeid species	Worldwide
<i>Flexibacter</i> sp		

<i>Leucotrux</i> sp.		
<i>Cytophaga</i> sp.		
<i>Flavobacterium</i> sp.		
<i>Moraxella</i> sp.	<i>P.monodon</i> , <i>P. indicus</i> ,	
<i>Mycobacterium</i> sp.	<i>P. vannamei</i> ,	
<i>Pseudomonas</i> sp.	<i>P. monodon</i> , <i>P. indicus</i> , <i>P. setiferus</i>	
Rickettsial infections	<i>P. monodon</i> , <i>P.vannamei</i> ,	Hawai, Singapore, Malaysia
Texas necrotizing hepatopancreatitis (TNHP)	<i>P.merguiensis</i> , <i>P.marginatus</i>	Indonesia, Texas
<i>Vibrio</i> sp.		
Vibriosis, Penaeid bacterial		
Septicaemia, luminescent		
Vibriosis, redleg disease)		
<i>V.alginolyticus</i>	<i>P. monodon</i>	Worldwide
<i>V.anguillarum</i>	<i>P.monodon</i> , <i>P.orientalis</i>	
<i>V.campbelli</i>	<i>P.indicus</i>	
<i>V.cholerae</i> (non-O1)	<i>P.monodon</i>	
<i>V.damsela</i>	<i>P.monodon</i>	
<i>V.fischeri</i>	<i>P.monodon</i>	
<i>V.fluvialis</i>	<i>P.monodon</i>	
<i>V.harveyi</i>	<i>P.monodon</i>	
<i>V.nereis</i>	<i>P.monodon</i>	
<i>V.parahaemolyticus</i>	<i>P.monodon</i>	
<i>V.splendidus</i>	<i>P.monodon</i>	

<i>V.tubiasihii</i>	<i>P.monodon</i>	
<i>V.vulnificus</i>	<i>P.monodon</i>	

Table 4: Bacterial pathogens/diseases of cultured penaeid shrimps

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Biographical Sketch

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