Critical Issues in Food Safety - Marine Fisheries An Overview

NIRMALA THAMPURAN
Central Institute of Fisheries Technology (CIFT)
(*Indian Council of Agricultural Research)*

Cochin-682 029, India

About CIFT

The only National Centre in the country where research in all disciplines related to fishing and fish processing undertaken

Recipient of **Sardar Patel Outstanding ICAR Institution Award** twice in 2000 and 2006

Played a major role in enhancing seafood export of the country

Recognized as Referral Laboratory by ICAR in the field of Fisheries

NABL Accredited Laboratories

The EU and FDA have recognized CIFT as approved laboratory for quality assessment of seafood by importing countries

Indian Fisheries *at a glance…..*

- Global Position of 3rd in Fisheries and 2nd in Aquaculture
- A unique and healthy food for rich as well as poor
- Largest Industrial sector
- Highest earner of foreign exchange
- Great Scope for diversification and value addition
- Food safety issues and quality problems high
- Great Diversity in origin
- Traceability difficult

Fisheries Resources

Marine Sector	
Coastline	8129kms
Exclusive Economic Zone	2.02 million sq km
Continental shelf	0.506 million sq km
Brackish water Sector	1.24million ha
Freshwater Sector	
Rivers and canals	1,97,204 km
Estuaries	0.29 million ha
Ponds and Tanks	2.35 million ha
Reservoirs	3.15 million ha
Other water sources	1.3 million ha

Fish Production

Per capita fish availability(kg)	9.0
Total Fish Production 2005-06	6.57 million tons
Marine Sector	2.81 million tons
Inland other than Aquaculture	3.76 million tons
Aquaculture	0.143 million tons
Employment Generation	14 million
Export 2007-08	
Quantity	536955 tons
Value	7555 Crores
Major item exported	Frozen shrimp
Major country of export	European Union

Diversity in Fisheries

Marine
Brackish water
Freshwater

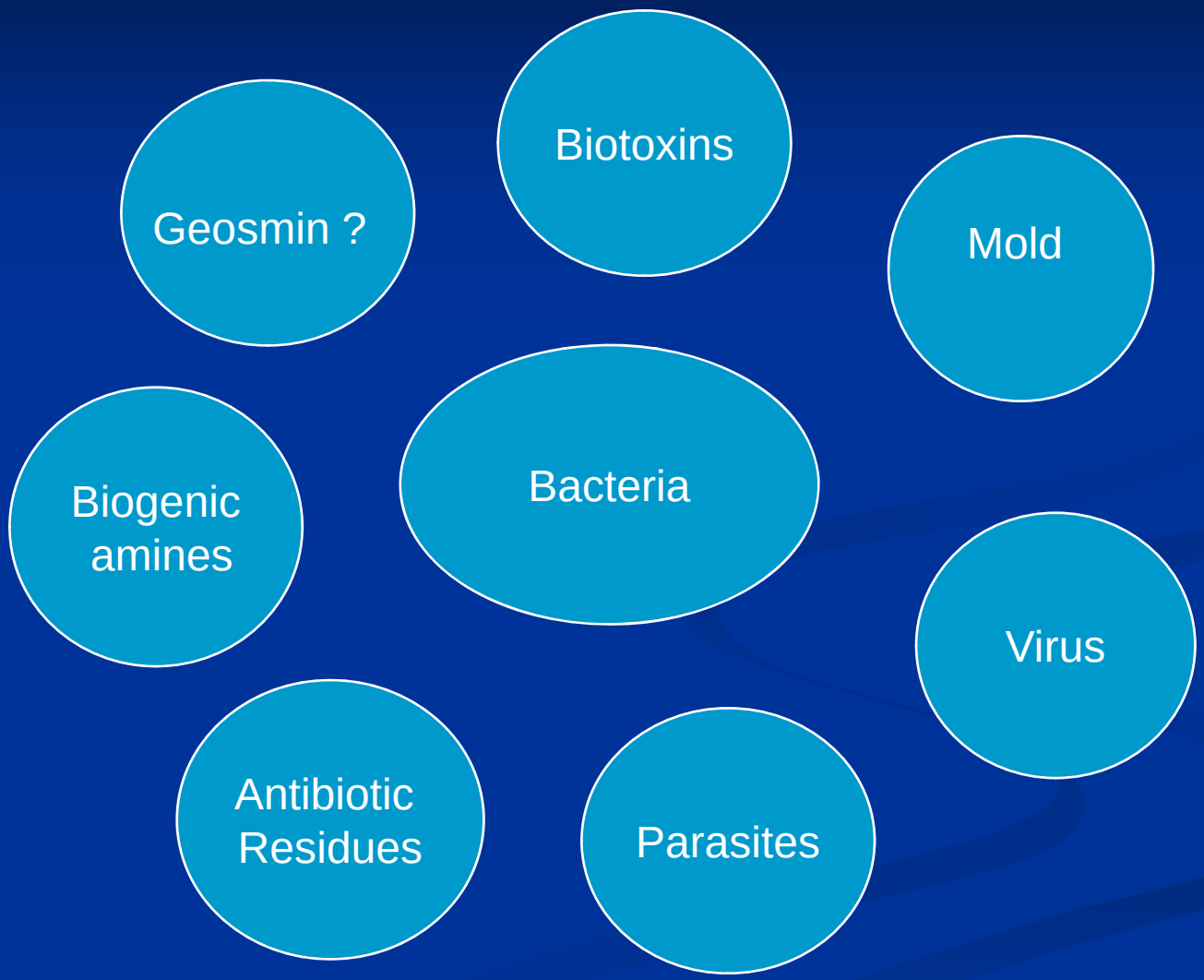
Culture

Capture

Major Categories

- Fish
- Crustacean shellfish
- Molluscan shellfish
- Fishery Products
  - Frozen
  - Dried
  - Smoked
  - Value added

Food Safety Issues in Fisheries



Biological Hazards in Fish & Fish Products

The biological hazards are broadly classed into **Two** categories

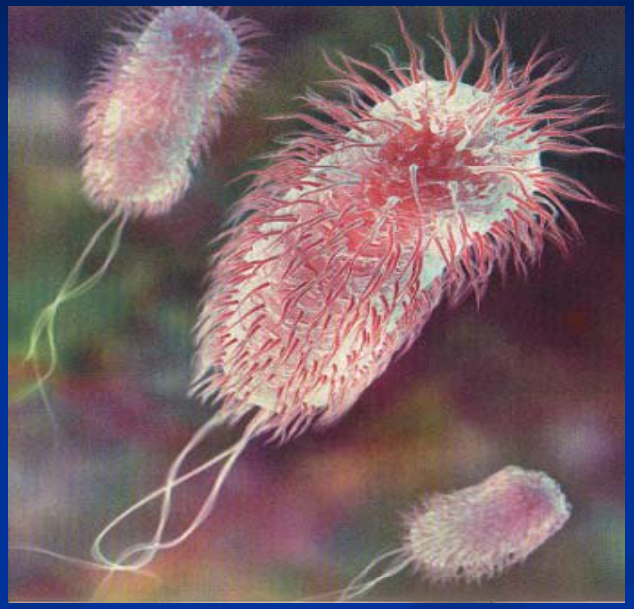
1. Challenges or threats specific to fish and fishery products that are related to the environment from where animals are captured.

   Control measures are difficult
   Long term strategies are required for elimination
   More basic research needed

2. The second group are of general nature common to all types of food which results from contamination, recontamination and survival of biological hazards leading to production of harmful metabolites eg. Toxins.

   can be effectively controlled by application of GMP, GHP, SSOP along with a well-designed HACCP

Microbial issues .. Bacteria



- **Bacteria related to quality**
  - Total Bacterial Count
  - Total coliforms and *E.coli*
  - *Staphylococcus aureus*
  - Fecal Streptococci
- **Pathogenic bacteria**
  1) **Conventional**
     - Salmonella, *Vibrio cholerae*, *V. parahaemolyticus*, *Listeria monocytogenes*
  2) **Emerging**
     - *E. coli* O157, *V. vulnificus*, Aeromonas, *Yesinia enterocolitica* ,*Campylobacter jejunii*

Pathogens

- *Vibrio cholerae* - Zero tolerant - o1and non o1 detected from marine and brackish and fresh water samples but o139 not detected. *Ctx* gene found in non o1
- *Vibrio parahaemolyticus* – Isolated from marine and brackish water samples. In shrimp up to 80 % samples positive. Kanagawa positives less than 14%
- *Vibrio vulnificus-* Incidence less than 16% -Isolated from marine samples-Gut is the prominent source

Pathogens contd. ….

- *Salmonella* – Zero tolerant - detected in brackish and fresh water samples, specially cultured varieties and processed samples – Emphasis on lac+ salmonella - PCR based Rapid detection protocol developed- Source tracking in progress- Most frequent isolates are S. Weltreveden and S. Rissen
- *Listeria monocytogenes-* Mainly associated with Raw seafood, Smoked / salted fish - So far not isolated from Cochin - Other related Listeria species isolated – PCR based multiplex developed

Emerging Pathogens

- Enteropathogenic *E.coli O157*

  An extensive survey in fish & fishery products conducted – Incidence negligible – PCR based detection standardized for different pathogenic types

- *Yersinia enterocolitica*

  Incidence very low- *Y. enterocolitica* biotype 1A isolated from fish samples –pathogenic potential absent

Pathogenic bacteria from the animal / human reservoir prevalent in fresh and processed fish / shellfish from tropical Indian waters.

Pathogenic bacteria	Fresh Fish		Processed Fish	
	Sample analysed	% positive	Sample analysed	% samples positive
Salmonella	Fish/shellfish Crustaceans	ND -17 17	Frozen fish/ shellfish	<1 -15
Shigella	Fish/shellfish	ND - 4	Frozen Iced/ dried fish/ shellfish	ND
Yersinia enterocolitica	Fish/shellfish	ND	Frozen / Dried fish/ shellfish/	ND
Escherichia coli 0157:H7	Fish/shellfish	30- 48 ND	Frozen fish/ prawn Squid/cuttle fish -	ND - 49 20 -
Staphylococcus aureus	Fish/shellfish	9	Frozen fish / shellfish Cooked Frozen crab Dried Fish Frozen squid/ cuttle fish	5-14 100 47 10- 23

Indigenous bacterial pathogens prevalent in fresh and processed fish/ shellfish from tropical Indian waters

Pathogenic bacteria	Fresh		Processed	
	Sample analysed	% positive	Sample analysed	% positive
Vibrio parahaemolyticus	Fish/shellfish Shrimp oysters	5- 35 83 10	Frozen fish Iced shellfish	4 --5 28-32
Vibrio cholerae O1 non-O1 O139	- Fish/shellfish	ND	Frozen fish	ND- <1 ND - 27
Vibrio vulnificus	Fish/shellfish oysters	5-18 43	Frozen fish/ shellfish Iced shellfish	4-7 7-26
Clostridium botulinum	Fish/shellfish	17-24	Frozen fish Cured fish	15 10
Aeromonas	Fish/shellfish	100	Frozen fish	66
Plesiomonas shigelloides	shellfish	present	-	-
Listeria monocytogenes	Fish/shellfish	ND- 17	Frozen fish	ND
Bacillus cereus	Fish/shellfish	19- 24	Frozen fish	0-11
Clostridium perfringens	Fish/shellfish	4 -65	Prawn -Frozen Canned	11 ND

2. Toxins

a) Bacterial Toxins

Clostridium botulinum

Staphylococcus aureus

Bacillus cereus

b) Fungi & their toxins- eg.Aflatoxin

c) Natural toxins

1. Scombroid fish poisoning
2. Algal Toxins – PSP,DSP

Bacterial Toxins

- *Clostridium botulinum*

  Predominant types in seafood from India -Type E,C and D - Type C detected in fish/ shellfish / sediments. Type D detected in cured products . Psychrotrophic type E isolated by PCR

- *Staphylococcus aureus*

  Incidence high in products subjected to more handling- Incidence more in value added products ,frozen shrimp and dried shrimp – Most of the isolates are enterotoxigenic – SEB most common followed by SEC and SEA and SED – Multiple enterotoxins produced – Toxin production inhibited at refrigeration temperature

- *Bacillus cereus*

  Frequently detected in fish/shellfish/dried fish-15% of the fresh fish from market carry this microorganism-10% of the frozen fish carry *B. cereus*- Toxigenic strains observed

Algal Toxins

- Mainly of marine origin (shellfish)
- Include PSP,NSP,AMP,DSP and CFP .PSP is the most severe form
- Studies conducted along the Coast in Arabian sea
- A very low Incidence of PSP producing organism reported
- Causative species of one toxic bloom identified as *Gymnodinium pulchellum*
- Mussel from the area had no detectable toxin
- Nontoxic algal blooms also occur frequently

Parasites

The bivalves examined during the 30-month study was free of parasites of sanitary significance.

On the other hand, organisms of phytosanitary significance such as ectocommensal ciliates and turbellarians showed prevalence in all the bivalves examined.

Ricketsia like organisms and *Stegorticha* sp. in *C. madrasensis* and nematodes and copepods in *V. cyprinoides* also showed considerable prevalence.

A very low infestation rate with *Trichodina* sp. (*V. cyprinoides*), Pinnotherus sp., gregarian spores (*P. viridis), Polydora ciliata* and trematode metacercaria (*C. madrasensis*) was recorded.

Presence of biogenic amines

- Important group of amines found in fish are histamine, putrescine, cadaverine, tyramine, spermine and spermidine
- Used as indicator of quality (fresh)
- Mainly due to bacterial action (*Enterobacteriaceae. Shewanella , Photobacterium*)
- Histamine the most important member
- A problem in selected species like mackerel, tuna herring etc.
- Incidence more in dried fish
- Causes histamine poisoning

Antibiotic residues

- Residues

  Screening started from 1999 – Actual problem started in 2001- Antibiotics Chloramphenicol, Sulpha group, tetracycline and nitrofuran derivatives – less than 5% samples positive – main issue with cultured shrimp

- Antibiotic resistance in pathogen observed in culture system- Multiple antibiotic resistant strains present in farm environs

- Bacterial inhibitors Any compound used as preservative can act – e.g. chlorine., tripoly phosphates

Capture Fisheries

- Mainly from marine sources , but also from inland
- Items are - Fish, Shellfish (mollusk and crustacean), are the main items - constitute about 60% of the production
- Marine items are exported and consequently most problems are of export origin, (rejection)

Critical biological issues in this area

- Improper handling i.e. TPC, E.coli, S. aureus
- Contamination - Salmonella, Pathogenic Vibrios
- Spoilage (Histamine)
- Biotoxins occasionally present

Culture Fisheries

- Fin fishes like carp, milkfish etc.
- Crustacean shellfishes - Shrimp ***Penaeus monodon*** and M***acrobrachium rosenbergii*** cultured in large scale
- Oyster
- Mussel
- Export oriented
- <u>Critical biological issues</u>
  - Poor quality ie.TPC,Coliforms,Ecoli, S. aureus
  - Presence of pathogens like Listeria , salmonella ,pathogenic vibrios
  - Presence of antibiotic residue a major problem in cultured shrimp
  - Viruses like Entero virus – in-depth study needed
  - Muddy flavor (Geosmin) - rare problem with cultured shrimp
  - Parasites – Occasional
  - Biotoxins – not detected

Detention of Fish and fishery products by EU - a typical study from Kerala

Cause of detention	1997	1998	1999	2000	2001	2002	2003
Salmonella	10	0	3	2	3	4	1
Vibrio cholerae O1 and non O1	3	1	0	1	1	2	2
Vibrio parahaemolyticus	1	1	0	0	2	1	1
S. aureus	0	0	0	1	0	0	0
Antibiotic residues	0	0	0	0	0	5	6
Bacterial Inhibitors	0	0	0	0	0	9	4
Others (TPC)	1	0	0	0	3	1	1
Total	15	2	3	4	9	22	15

Permitted limits of microorganisms

Type	Standard	TPC/g	*Ecoli*/ g	*S.aureus*/ g	*V.cholera* /25g	*V parahaem* /25g	Salmonella /25g
Fresh fish	EU IS	5,00,000* 1,00,000*	20 20	100 100	Absent	Absent	Absent
Fresh shrimp	EU IS	5,00,000* 5,00,000	20 20	100 100	Absent	Absent	Absent
Frozen fish/ Shrimp	EU IS	1,00,000 1,00,000*	20	100	Absent	Absent	Absent
Fishery products (Fish mince)	IS	1,00,000*	20	100	Absent	Absent	Absent
Dried fish	IS	10,000	20	100	Absent	Absent	Absent

*Subject to type of fish/shrimp

Strategies for overcoming These issues

- Risk Analysis
- The hazards associated with seafood is diverse and have been well-identified.
- The actual risk posed by these hazards of Indian origin are not fully studied.
- The epidemiology of disease to be studied and documented
- Outbreak data to be documented
- Consumption data to be documented
- State Level participation needed

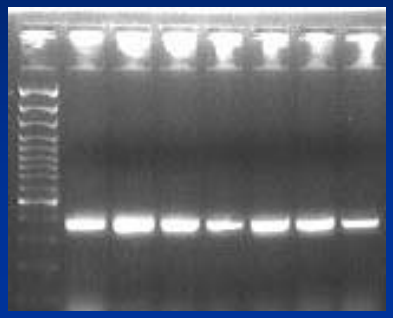
Methodology

- Despite great advances in microbiological testing, methodology still inadequate because food safety problems change with
- Changes in Life style and food habits
- Production practices
- Adaptive changes of pathogens
- Interference from related bacterial genera
- Use of conventional and molecular methods in food testing

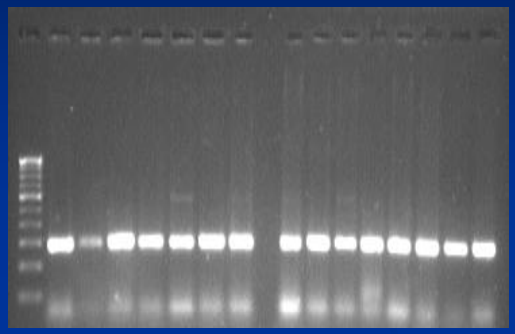
Rapid PCR Detection Methods for Seafood borne Pathogens developed by CIFT

PCR based rapid and sensitive assays has been developed for

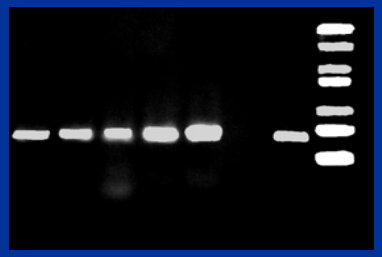
Vibrio cholerae,
Vibrio parahaemolyticus,
***Escherichia coli* 0157,**
Clostridium botulinum,
Salmonella,
Bacillus cereus,
Listeria monocytogenes
Yersinia enterocolitica



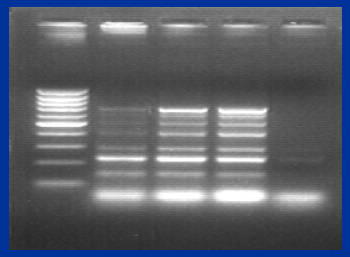
V. parahaemolyticus



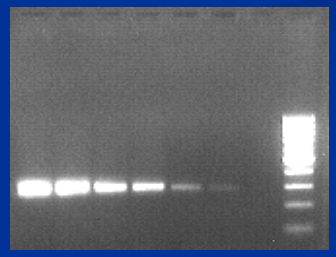
Vibrio cholerae



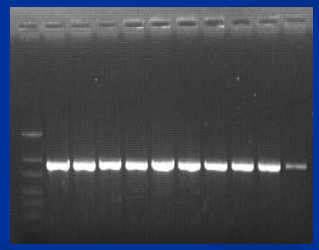
C .botulinum



E.Coli 0157H7



Salmonella



L. monocytogenes

Policies

Fisheries Policies need to be upgraded on areas related to

- Monitoring and enforcement measures related to hygiene
- Laboratory testing facilities
- Upgrading landing facility
- Harmonization of standards
- Better production and marketing strategies
- Should be linked to scientific evidences

Guidelines and Standards

- Need for a properly collated and effectively presented guidelines, to provide a strong basis for production and supply of seafood
- In areas relating to new processing technique and emerging issues, new guidelines should come into force eg. Bacterial toxins in MAP products
- Need for a concise, comprehensive single source for all FDA guidelines
- Harmonization of standards-should be transparent- scientifically based.
- Need for standards in domestic supply

Environment

- Fisheries related hazards whether chemical or biological in nature, change with time. This is because marine/ freshwater/ brackish water ecosystem, being an open area, most prone to natural or anthropogenic contamination and pollution, is constantly in change. Therefore
- Improvement in environment means safer fish
- Regulations to minimize biological contamination of environment should be strengthened
- Increased environmental monitoring should be initiated at State level with the help of federal agencies or even NGOs
- Public education on adverse impact of environmental threats to human health
- A database the environment with specific hazards and identification of dangerous zones – to be available to regulatory agencies ,industry and consumers
- Continued efforts has to be put up in the problem areas in coming years and a continuous monitoring is recommended.

Documentation of Data

Risk profiling is an important part of risk assessment. This necessitates data on the seafood related illness within the country.

A national surveillance system should be set up and documentation centers state-wise can generate data on the food-borne (seafood) disease outbreaks in the country to link type of pathogen with number of illness traceable to consumed food

Information on fish consumption preferences and pattern has to be collected continuously.

Legislation

- When new legislation is being considered for seafood and consumer, the following points can be considered
- Regulating vessel and dock (landing) facility in relation to human health
- Need for strong state role in inspection that will require federal support
- The need to facilitate closure of certain harvesting area on the basis of human health hazard
- Collation of current regulations in easily available form
- Need to train state and federal regulatory personal

Training & Awareness Programme

- A vigorous campaign at different levels for information dissemination and education is needed.

- Awareness Programme to fish vendors on good hygienic practices and sanitation should be intensified

Conclusion

- The real dimension of the food safety issues will be understood only after risk analysis .This necessitates realistic case studies with the pathogens (salmonella and vibrios) in selected foods
- We have adequate data on the prevalence and characterization of the pathogens . However there is a gap in data for risk assessment and control of risk.
- Net work centers should be set up with central and state participation for documentation and availability of the information
- Hygiene and sanitation Programme has been streamlined in post harvest processing side. But harvesting to preprocessing sectors need control and monitoring.hence awareness and education should be concentrated in this area.
- In certain areas ,though awareness is observed, there is lack of machinery to bring out the desired level of quality .. e*g.* availability of potable water or ice. Involvement and support from state should be strengthened in these areas.
- More thrust should be in the domestic supply
- The seafood produced in India is generally safe and of good quality. It is comparable in quality and safety to seafood in any other part of the world.

“Learn to respect fish as our food and we can improve the quality of the fish”

Thank You