27. Microbiological aspects of fish and fishery products

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Introduction

Fisheries contributes to the global nutritional and food security immensely. According to the estimate of 2018, the live weight of fish produced from captured fisheries and aquaculture activities has crossed 178.5 million tonnes. Captured fisheries and aquaculture contributed to 54% and 46% of its productions. Out of the 178.5 million tonnes produced, 156.4 million tonnes are used for human consumptions for over 7.6 billion population across the globe with per capita consumption of over 20.5 kg per year. Among which 37.6% are in traded for exports for value 164.1 USD (FAO, 2020).

The most important exporting countries across the world are EU, China, Norway, Vietnam, Chile, India, Thailand, United States, Canada, Ecuador, and Russia. EU and China take shares around 56 billion USD and other countries 58 billion USD in terms of values of export. Major countries importing seafood are USA, Japan, China, Spain, Vietnam, France, Italy, Germany, Sweden and South Korea. The countries China, Vietnam, United States, are involved in both import and export.

Definition:

Seafood are edible aquatic animals which excludes mammals covering freshwater and sea for food purpose. Aquatic food or *blue foods* are food originating from animals, plants, and microorganisms of water bodies.

Microbes and Microbiology

Living organisms that multiply frequently and spread rapidly and very tiny in nature that cannot be seen in naked eye are microorganisms or microbes. Majority of the organisms are existing as beneficial flora in each and every niche and contributing to the basic biogeochemical cycle of the life. However, some of the microbes do exists as pathogenic to either human or animals including the fish/shellfish. Examples are Bacteria (e.g., *Staphylococcus aureus*, Streptococcus pneumoniae), viruses (e.g., Measles, Mumps), fungi (e.g., *Candida albicans*,), parasites (Coccidia etc) which are pathogenic to human.

In general, to exception of commercially sterile and other pro, pre and synbiotics food products, food have the proximity of getting contaminated to various microbes during entire production and processing chain. The raw food in general has the highest culturable bacterial concentrations, followed by minimally and fully processed foods. Minimally or fully processed food including ready-to-eat food contamination depends on the level of sanitary hygiene followed during the processing and preservation steps.

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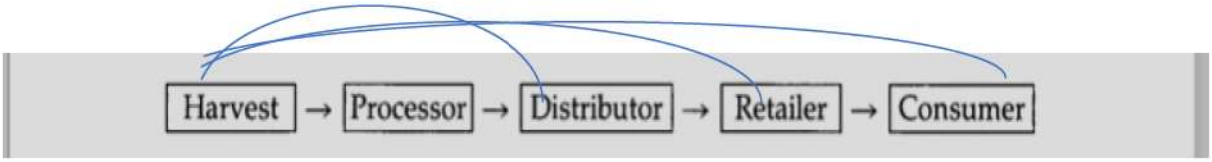

Fig.1. Steps contributes to the entry of microbes in the seafood chain

The food with acceptable microbiological quality range may also serve as the sink for the development of antibiotic resistances through bacteria, bacteriophages, bacterial DNA and mobile genetic elements, some of which may include AMR genes. Hence, the food chain ecosystem may be conducive niches for gene transfer, selection and persistence of AMR bacteria and this route cannot be generally disregarded. In the typical seafood production chain, the fish which are harvested has many distributions step viz., harvest to consumer, harvest to processor, harvest to retailers, harvest to distributors and retailers (Fig.1.). The more the number of handling steps, the more the probability of microbes being contaminated into the food production chain.

In the seafood production chain, the food fish gets harvested either from aquaculture farms or from capture fisheries activities. The harvested food fish gets transported to retail market, hypermarket, or unorganized retail vendors. The harvested food fish may be taken to the fish processing factories within their state or to the neighbouring state and get processed for domestic or export purposes. The major contributing factors which results in the contamination of pathogens in to the seafood are water and ice. In order to break the chain of contamination of these microbial pathogens into the seafood production and distribution channel, the places mentioned in the figure.2 has to be implemented.

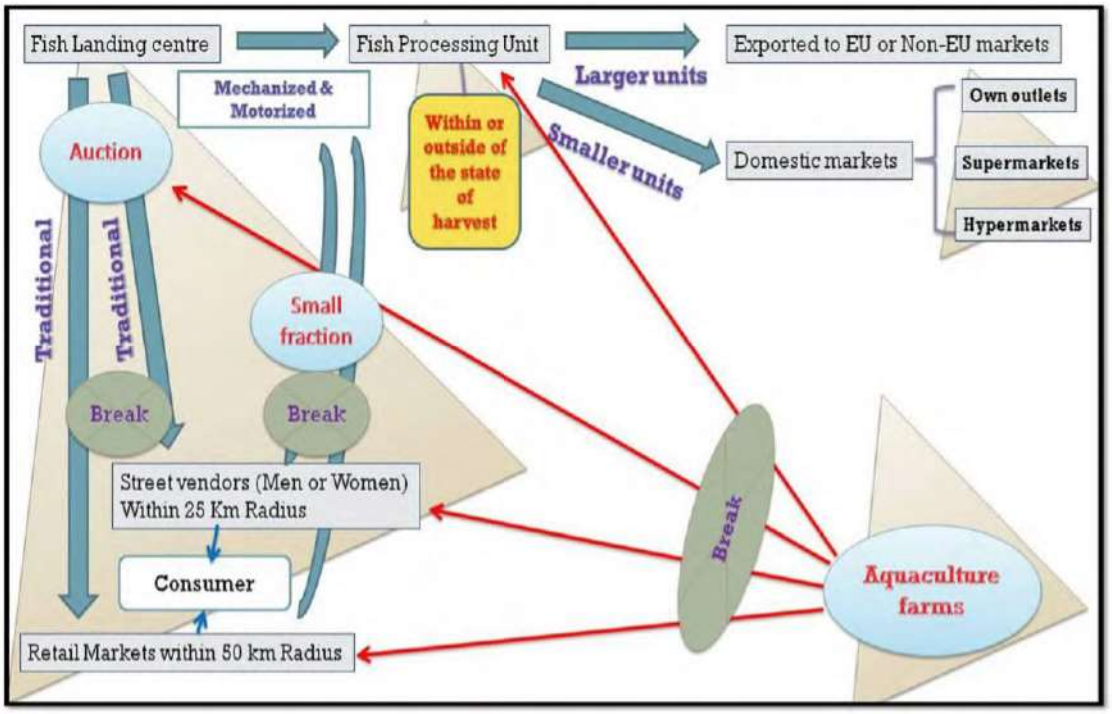

Fig. 2. Typical seafood production and distribution chain with major break point places for preventing contamination of microbial pathogens.

The seafood meant for human consumption either for domestic market or for exports has to be ascertained for predefined quality. In India, the seafood or fish/fishery products meant for domestic consumption is regulated by Food Safety and Standards Authority of India (FSSAI) and seafood meant for export purpose is handled by Export inspection council (EIC).

The end product (fish and fishery products) has to be examined for the absence of hazards. "Hazard in food is defined as anything that could contaminate food and cause illness or injury, or could otherwise violate established food safety program criteria if left uncontrolled". Hazard in the food is classified into three categories viz., physical, chemical and biological. A physical hazard is any foreign matter unintentionally introduced to food or a naturally occurring object which could cause illness or injury to the person consuming the food item. Natural and manufactured chemicals can cause people to become sick if they have contaminated food at the source or during processing. Chemical hazards can be divided into two categories: chemical agents and toxic metals. While physical and chemical hazards have potential to cause foodborne illness, the majority of foodborne illnesses result from biological hazards such as bacteria, viruses, and parasites (referred to collectively as pathogens). CDC has identified 31 different pathogens known to cause foodborne illness.

These hazardous microbes are classified once again as severe hazards, moderate hazardous with limited spread and moderately hazardous with extreme spread.

Examples of severe hazard are *Clostridium botulinum* types A, B, E, and F, *Shigella dysenteriae, Salmonella* Typhi, *Salmonella* Paratyphi A, B, Hepatitis A and E, *Brucella abortis; B. suis, Vibrio cholerae* 01, *Vibrio vulnificus, Taenia solium* and *Trichinella spiralis*.

Among these severe hazards, the *Clostridium botulinum* types A, B, E, and F, *Shigella dysenteriae, Salmonella* Typhi, *Salmonella* Paratyphi A, B, Hepatitis A and E, *Vibrio cholerae* 01, *Vibrio vulnificus* are relevant to seafood.

Examples of moderate hazards with extreme spread are *Listeria monocytogenes, Salmonella* spp., *Shigella* spp., Diarrheagenic *Escherichia coli, Streptococcus pyogenes,* Rotavirus, Norwalk virus group, *Entamoeba histolytica, Diphyllobothrium latum, Ascaris lumbricoides,* and *Cryptosporidium parvum*. Among these moderate hazards, *Listeria monocytogenes, Salmonella* spp., *Shigella* spp., Diarrheagenic *Escherichia coli, Diphyllobothrium latum* are very relevant to the seafood.

Examples of moderate hazards with limited spread are *Bacillus cereus, Campylobacter jejuni, Clostridium perfringens, Staphylococcus aureus, Vibrio cholerae, non-O 1, Vibrio parahaemolyticus, Yersinia enterocolitica, Giardia lamblia* and *Taenia saginata*. Among these, *Bacillus cereus, Campylobacter jejuni, Clostridium perfringens, Staphylococcus aureus, Vibrio cholerae, non-O 1, Vibrio parahaemolyticus,* and *Yersinia enterocolitica* are very relevant to the seafood industry.

For the seafood industry, the pathogens such as *Salmonella* sp. *Yersinia* spp., *C. Botulinum, S. aureus, L. monocytogenes,* ***Vibrio* spp. (*V. cholerae, V. vulnificus, and V. parahemolyticus*),** *Aeromonas* sp, *Campylobacter* sp and *Bacillus cereus* are very important. Few of the pathogens are emerging in nature and few are endemic to the seafood production system and others are reemerging in nature.

Examination of the biological hazards in the seafood

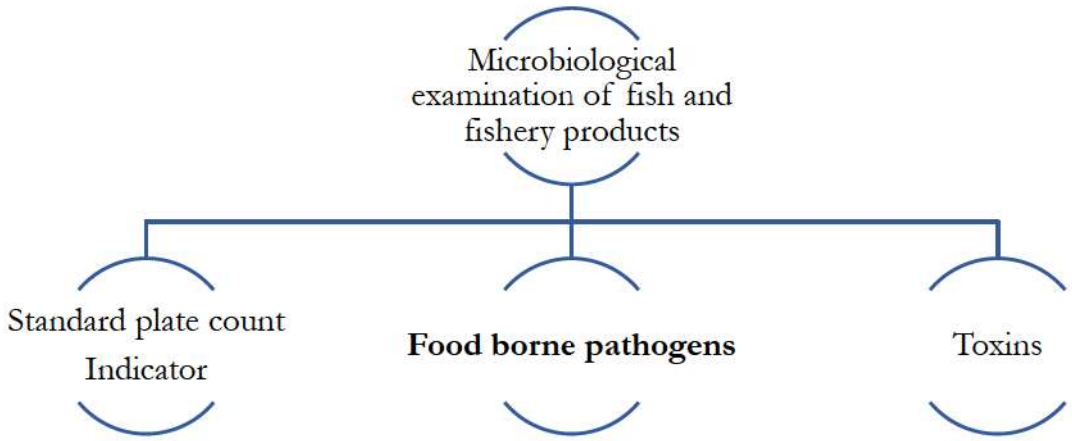

Fig. 3. Microbiological examination of seafood

Microbiological examination of seafood can be categorized into examination for indicator organisms, examination for the pathogens and or its toxins (Fig. 3).

Microbiological examination of seafood has few important steps (Fig. 4)

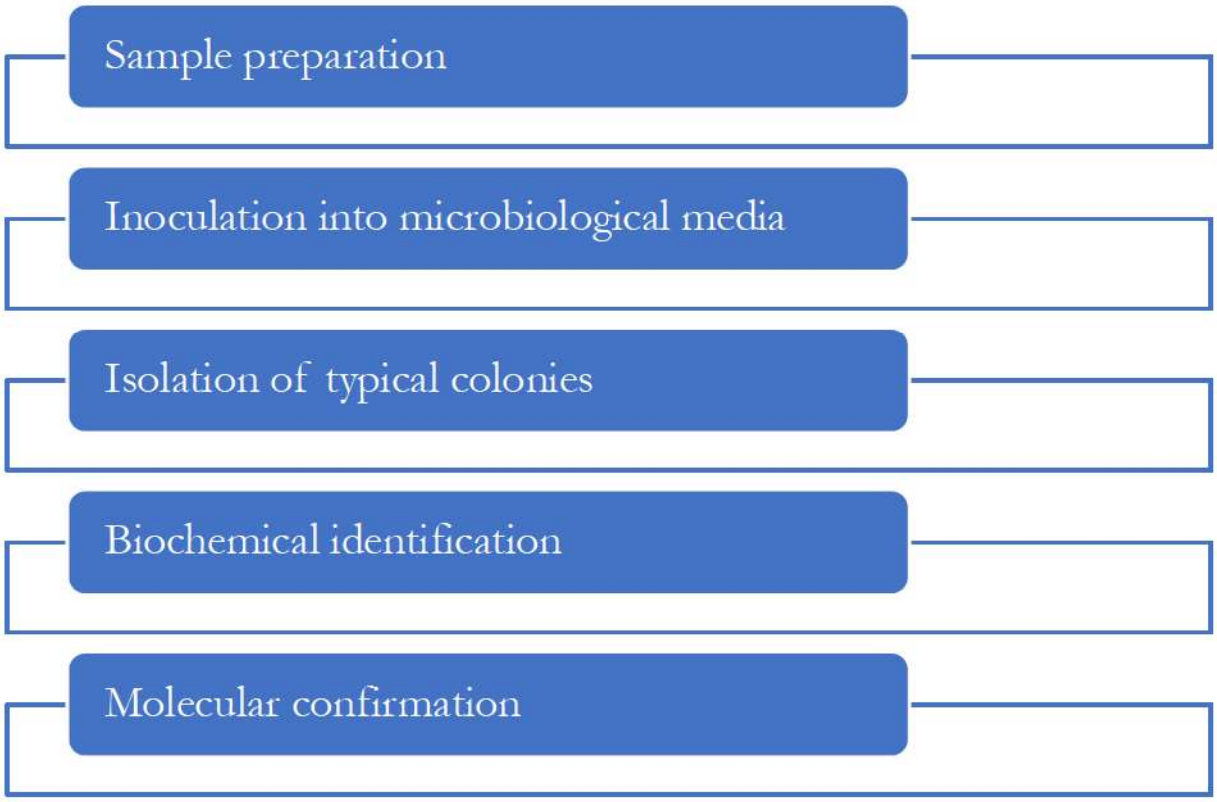

Fig. 4. Basic steps involved in the microbiological examination of seafood

For the microbiological examination of seafood, the laboratory should have these facilities. Sample receiving room, Sample processing room, Media preparation room, Media sterilization room, Inoculation room, Incubation room, Identification room, Decontamination and washing room.

Instrumentation required for setting up of microbiological testing facility for food includes Incubators / refrigerated / Co2/ BOD, Hot air oven, Autoclaves, Homogenizer / Stomacher / Mixer, Colony counter, Water bath, weighing balance, Thermal cycler including gradient, Gel electrophoresis system, Gel documentation system, Biosafety cabinet, Refrigerator centrifuges, Refrigerated shaker incubator and Microscope. A typical work flow in any standard microbiological laboratory is presented in Figure 5.

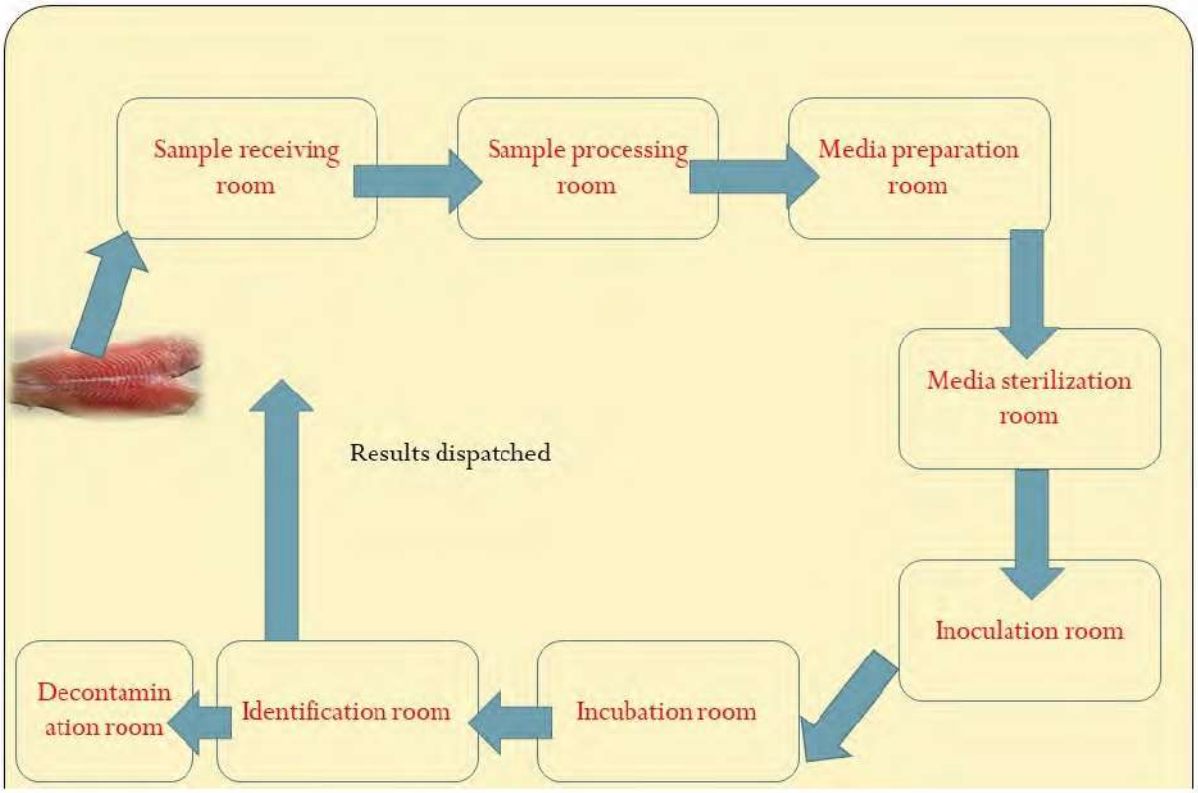

Fig. 5. Typical work flow and rooms involved in the microbiological testing.

For the microbiological examination of seafood (fish and fishery products) the laboratory should follow the exporting or importing countries guidelines viz., FSSAI – India, BAM – USA, ISO guidelines – EU countries and other based on the country's regulatory requirements.

To conclude, Fish and fishery products are most traded commodities across globe, For sustainability – Quality of food has to be maintained, Hazards – Biological hazards has to be controlled, Places where the biological hazard entry can be prevented should be defined in the seafood production system, Layout of microbiology laboratory and instrumentation involved in the testing varies based on the laboratory requirements, and the Guidelines sorting for each matrix testing is highly essential for the laboratory involved in the testing.

References for reading

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