4. Quality and certification in fish value chain: Production to export

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Fish and Fishery product occupy a preeminent position in global food basket. It contributes immensely to the overall food and nutritional security in a global scale. As per the recent estimate by FAO, global fish production is estimated at 179 million tonnes in 2018 (equivalent to USD 401 billion), of which 82 million tonnes (46% of total), valued at USD 250 billion, came from aquaculture production. The per capita consumption is estimated to be 20.5 kg indicating increased acceptance of fish in human diet. Another overwhelming feature is that fish and fishery products remain as one of the most traded food commodities in the world. The value of global fish exports has increased from USD 7.8 billion to peak at USD 164 billion with an annual growth rate of 8% per annum. The most notable feature is that 38 percent of total fisheries and aquaculture production enters to international trade. Nearly 75% of the volume of seafood in international trade is imported by developed nations and 50% of that is exported by developing nations. Hence, food safety issues concerned with fish and fishery products are no more local or restricted to a particular geographical location, but has acquired global dimension. Preserving the quality and ensuring safety in value chain are keys in sustaining the envisaged goals of this food sector.

Quality of Fish: Sustaining perishable logistics

Fish and other aquatic invertebrates are considered to be a highly perishable commodity. Deaccelerating this perishability is the biggest challenge in cold chain logistics of fisheries sector for transport of fresh commodities to hinterlands as well as for intercontinental transport.

Factors affecting Quality of Fish and Fish Products

- Harvesting method
- Post-mortem changes
- Intrinsic characteristics
- Shape, Size, Fat content, Skin characteristics
- Post-harvest handling practices
- Temperature abuse
- Physical damage
- Preservation Approaches
- Dietary composition (Aquaculture Fish)

Assuring Quality: Multi-tasking endeavour

Quality is defined as sum of all properties and attributes of a food item that are acceptable to the customer.

The determinants of fish quality are: absence of fraud and adulteration; expected organoleptic and nutritional characteristics; sensory properties; safety; freshness; appealing appearance as well as added value such as source attribution (ecologically sustainable harvesting, environmental conditions, bycatch) and information about production areas (designation of origin: aquaculture vs wild capture).

Quality Control is defined as maintenance of quality at a level that satisfies the customer and that is economical to the producer or seller. Process specification, product specification, inspection and process control are components of a quality control system.

QUALITY FACTORS	
Freshness	Number in pack
Species	Bacterial count
Size of fish; weight of portion or contents	Salt content
Condition, texture	Smoke flavour
Blemishes: blood, dirt, bruises, parasites	Additives, colouring materials
Skin, bone, belly membrane	Colour, gloss
Odour, flavour	Freezing and cold storage conditions
Temperature, amount of ice	Glaze
Packaging	Voids, ice lumps
Amount of minced fish	Shape and size
Adhesion of batter and crumb	Amount of batter
Batter and crumb ingredients	Fish content
Arrangement of fill	Degree of fill; drained weight
Composition	Heat processing

Quality Assurance is defined as all those planned and systematic actions necessary to provide adequate confidence that a product or service will satisfy given requirements for quality. Quality assurance has components like process checklists, process standards, process documentation and Project audit. Generally, 7 QC/QA tools are used in demonstrating

integration of quality assurance in fish processing industry: check list, fishbone diagram, histogram, pareto chart, control chart, scatter diagram and stratification chart.

Fresh vs Spoiled confusion

Loss of freshness in fish after harvest is a continuous process. Once the quality is deteriorated, it is not possible to re-instate the original freshness characteristic of the species. Therefore, spoilage is an irreversible process; once the spoilage sets in acceptability goes for a downward trend. There is a simultaneous role of autolytic, chemical and microbial processes, which are responsible for post-mortem spoilage of fish.

The compelling reasons for spoilage of fish can be listed as follows:

- Fish is unique as a substrate for microbial growth
- Poikilotherm nature of fish
    - Selects bacteria that can thrive in a wide range of temperatures
- High post mortem pH in the flesh (typically greater than 6.0)
    - Allows growth of pH sensitive organism like *Shewanella*
- Presence of non-protein-nitrogen (NPN) in large quantities
    - low-molecular-weight water-soluble nitrogen contains compounds, particularly free amino acids and nucleotides gives a good substrate
- Presence of trimethylamine oxide (TMAO)
    - Leads to production of TMA, the typical off flavor compound
- High content of unsaturated fatty acids
    - Rapid oxidation leading to off-flavour

Options and Opportunities for managing Fish Quality

Post-harvest management of quality of fish and other aquatic products is a primary challenge for the policy makers and regulators across the globe. However, there are certain commonalities which can be applied across the globe.

- Hygienic design of fishing vessels: Fishing vessels which are in operation need to be hygienically designed and approved with adequate facilities for preserving the catch on-board. Countries need to develop schemes for certification based on “Good Fishing Vessel Practices” to encourage fishing boat owners to adopt this concept. Salient features of this novel approach can include scheduled cleaning and disinfection of surfaces, storage containers; pest control measures; temperature control of fish holds and harvested catch and record keeping.
- Implementation of GAqPs: In recent years “Good Aquaculture Practices” are increasingly being adopted by aquaculture farmers to ensure quality and safety of aquaculture produce as well as preventing transmission of trans-boundary diseases. Many certification schemes operated by both government and non-governmental organizations are available for certification.
- Provision of potable water and ice in primary production centres: Absence of potable ice and water in fishing harbours and fish markets has been a major bottleneck in ensuring safety of fish in post-harvest condition. Use of tube ice, flake Ice or slurry Ice

that have lower melting rate can be popularised in fishing sector. Also the ice plants and water supply units need to be certified for compliance with WHO norms of drinking water quality.

- Hygienic design of fishing harbours, jetties: FAO has published a detailed account of Fishing Harbour Planning, Construction and Management (FAO Fisheries and Aquaculture Technical Paper 539) that stresses the importance of integrating the concept of hygiene and sanitation in fishing harbour design.
- Hygienic design of fish markets: Fish markets need a huge upgradation to cater to the consumer safety norms of the sector. Most of the biological pathogens and contaminants get access to the marketed fish because of unhygienic setting of fish markets. India has formulated a standard "*IS 14520 : 2018 Fish industry - Operational cleanliness and layout of market – Guidelines*" for designing hygienic fish markets.
- Good Transportation Practices in cold chain logistics: For high mobility and temperature sensitive products like fish, it is imperative that countries must adopt "Good Transportation Practices" in cold chain logistics management. For safe transportation of temperature-sensitive freight from beginning to end, it is necessary to secure the right expertise, pre- determine capacity requirements, confirm product temperature, inspect condition of equipment, check for proper container airflow and establish standard operating procedures.

Standards: Trade-off between safety and commerce

Food safety standards can be classified as regulatory, voluntary, Government/Statutory, private, domestic, international or benchmarked depending upon its scope and range of application. Most of these standards have evolved based upon sanitary and phyto-sanitary (SPS) requirements, economic interest, risk analysis or as precautionary approach. The precautionary approach mostly relies on perception i.e. equivalent level of protection, appropriate level of protection (ALOP) or as low as reasonably achievable (ALARA).

Some of the major food safety concerns linked to fish and fishery products are:

- presence of Ciguatera toxin in reef dwelling finfish
- histamine fish poisoning
- norovirus and *Vibrio parahaemolyticus* in raw shellfish
- Salmonella in shrimp products
- *Clostridium botulinum* in processed products
- high level of environmental pollutants
    - mercury, cadmium, lead
    - polychlorinated biphenyls and pesticides
- antimicrobial residues in aquaculture products

Apart from the above-mentioned concerns which are mostly global, there are regional issues like use of adulterants like formaldehyde to retard decomposition process, ammonia to mask spoilage, use of un-approved additives (preservatives), and high level of pesticides in dry fish and presence of emerging pathogens in fisheries environs. The major fish importing blocks like European Union, USA, Japan, Russia and China have an array of import requirements for fish

and fish products. The ground of import rejections/refusals from various importing countries include presence of heavy metals (Pb, Cd, Hg), antibiotic Residues, foodborne pathogens, Histamine, biotoxins, Unapproved additives and loss of organoleptic quality.

Hazard Analysis and Critical Control Point (HACCP) is the most coveted quality assurance approach being used across the globe. The recent changes brought about by Codex Alimentarius Commission brings into focus the concept of food culture in managing fish quality. The revised seven principles of HACCP are as follows:

1. List all potential hazards that are likely to occur and associated with each step, conduct a hazard analysis to identify the significant hazards, and consider any measures to control identified hazards
2. Determine the Critical Control Points
3. Establish validated critical limits for each CCP
4. Establish a Monitoring System for Each CCP
5. Establish corrective actions
6. Validation of the HACCP Plan and Verification Procedures
7. Establish Documentation and Record Keeping

Certification: Guided schemes for enhanced acceptance

ISO has published series of standards for food safety management, prerequisite programmes and traceability which are being increasingly adopted by fish processing industries to gain international acceptance of their products. The ISO series of standards with specific application to fisheries sector are as follows:

- ISO 22000:2018 FOOD SAFETY MANAGEMENT SYSTEMS-Requirements for any organization in the food chain
- ISO/TS 22002-1:2009 PREREQUISITE PROGRAMMES ON FOOD SAFETY — PART 1: FOOD MANUFACTURING
- ISO/TS 22002-2:2013 PREREQUISITE PROGRAMMES ON FOOD SAFETY — PART 2: CATERING
- ISO/TS 22002-3:2011 PREREQUISITE PROGRAMMES ON FOOD SAFETY — PART 3: FARMING
- ISO/TS 22002-4:2013 PREREQUISITE PROGRAMMES ON FOOD SAFETY — PART 4: FOOD PACKAGING MANUFACTURING
- ISO/TS 22002-5:2019 PREREQUISITE PROGRAMMES ON FOOD SAFETY — PART 5: TRANSPORT AND STORAGE
- ISO/TS 22002-6:2016 PREREQUISITE PROGRAMMES ON FOOD SAFETY — PART 6: FEED AND ANIMAL FOOD PRODUCTION
- ISO 12875:2011-Traceability of finfish products—specifications on the information to be recorded in capture finfish distribution chains
- ISO 12877:2011-Traceability of finfish products—specifications on the information to be recorded in farmed finfish distribution chains
- ISO 18538:2015-Traceability of molluscan products—specifications on the information to be recorded in farmed molluscan distribution chains

- ISO 18539:2015-Traceability of molluscan products—specifications on the information to be recorded in captured molluscan distribution chains
- ISO 16741:2015-Traceability of crustacean products -- Specifications on the information to be recorded in farmed crustacean distribution chains
- ISO 18537:2015-Traceability of crustacean products -- Specifications on the information to be recorded in captured crustacean distribution chains

Many private food safety standards are also in operation across the globe which have bearing upon the international trade of fish and fish products although they do not have any government regulatory sanction. Some of the most popular private food safety standards are as follows:

- BRC (British Retail Consortium) Global Standard
- FSSC 22000 (Food Safety System Certification)
- Global Aquaculture Alliance BAP, issue 2 (GAA Seafood Processing Standard)
- IFS (International Featured Standards)
- SQF (Safe Quality Food) 2000 Level 2
- Synergy 22000
- Marine Stewardship Council

Way ahead: plugging loopholes

Fisheries and aquaculture have been the sunrise sector for many developing nations across the world. In view of the increasing global perception on quality and safety of fish and fish products, there has been a paradigm shift in management of quality across the value chain. The basic issue of hygiene maintenance at primary production centres needs to be a thrust area for all governmental agencies across the globe. Certification schemes of good aquaculture practices need to regionalised and made commodity-specific for wider acceptance among stakeholders. For empowering consumers, smart and intelligent packaging systems and development of IoT enabled food testing kits must be given a priority by the academic and research organizations.