Chapter 4

Quality Issues in Live/Fresh/Chilled/Frozen Fish and Fish Products

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Fish and fishery products constitute an important component of human diet. Contribution of fish and other aquatic products in the average animal protein consumed worldwide is around 15%. Fish and other seafood items in daily diet is a smart choice for health conscious consumers. There are proven health benefits of consumption of aquatic products that out-weigh risks. Some of them are high content of omega-3 long-chain (>C20) polyunsaturated fatty acids that are found as high as 2-3% in tropical fishes. Documented proven health benefits of omega-3 fatty acids include aiding infant development, reduction of childhood asthma, lowering risk of breast cancer, protection against coronary heart disease and acute coronary syndrome, reduction of age-related macular degeneration, slow progression of Alzheimer's disease, reduction of depression and alleviation of symptoms of rheumatoid arthritis. Compared to marine fishes, freshwater fishes are characterized by elevated levels of omega-6 PUFA, especially linoleic (18:2) and arachidonic acids (22:4). Although PUFA content of freshwater fishes are lower than their marine counterparts, the levels are substantial to impart nutritional value. Apart from that fish is a valuable source of minerals such as calcium, phosphorus, iron, copper and selenium which are essentially required for human nutrition. Compared to other animal proteins, fish proteins are highly digestible with a balanced source of essential amino acids. Further, cholesterol levels in fish are also quite low (24-85 mg/100g) making it more amenable to present generation of health conscious consumers. Although fishes are not known to be good source of vitamins, levels of niacin, B12 and B6 are comparable to other protein rich foods. Some freshwater fishes like Salmon and Trout are known be good source of Vitamin D.

In aquacultured fish, the nutritional parameters are heavily influenced by the feeding regime as well as culture conditions. It also offers scope of artificially enriching cultured species with PUFA or similar nutrients.

Ensuring Quality in live/fresh/chilled/frozen fishes

The major reasons behind low processing of freshwater fish are lack of quality control measures at the production site and absence of cold chain network. Main quality concerns in live, fresh, chilled and frozen fishes are as follows:

Pesticide residues: As most of the waterbodies such as reservoirs and village ponds used for fish culture are multi-purpose in nature, there is a definite possibility of contamination with pesticides from anthropogenic sources. Riverine and lacustrine environments receive pesticide load from discharge of sewerage and industrial wastewaters. Pesticides also come from agricultural runoff and seepage through ground water contamination. After getting released into the environment, they are transformed into a range of different products based upon their susceptibility to biotic and abiotic degradation. These compounds are mobile, more persistent, and often more toxic to non-target organisms than the precursor parental pesticides. The organochlorine pesticides which are mostly detected in freshwater fishes are DDT, DDE, DDD, HCB, HCHs, CHLs, Aldrin, Dieldrin and Endrin.

Various herbicides, weedicides and insecticides are also used in aquaculture farms as a part of farming practices, especially during pond preparation. Presence of higher levels of DDT, HCH, Aldrin, Dieldrin, Endosulfan, Chloropyrifos and malathion in some aquatic water bodies has been reported. Lower residues of DDT and HCH in tropical fishes compared to temperate countries are ascribed to rapid volatilization of these organochlorine pesticides in tropical environments.

Presence of other persistent organic pollutants (POPs): As natural water bodies like rivers and lakes bear the onslaught of industrial dishrags, presence of persistent organic pollutants in fish tissue has raised concern. Important among them are dioxin and dioxin like compounds (PCDD/PCDF and PCBs), brominated flame retardants (BFRs), polychlorinated naphthalenes (PCNs) and polyaromatic hydrocarbons (PAHs). Incomplete combustion during waste incineration is the main reason behind loading of PCDD and PCDFs into the environment. The most toxic compound is 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) is a group 1 carcinogen which if present in food can cause severe reproductive and developmental problems, apart from the cancer.

Extra-label use of chemicals and drugs in aquaculture: As aquaculture has become a commercial venture, chemicals and drugs are increasingly used to boost production. It has also brought into focus which the extra-label use of drugs i.e drugs meant for human medicine are increasingly used in treating fish diseases. As fish is a food commodity, the residue of the drugs passes on to the consumers and pose serious health hazard. Use of pharmacologically active

substances like antibiotics, hormones, steroids, and anti-parasitic agents are reported in aquaculture practices.

Use of unapproved additives for preservation: In order to gain commercial advantage and extra shelf life, sometimes many un-approved/prohibited substances are used in freshwater fish preservation. Although health implications for many of these substances are poorly studied, use of these additives either not listed as GRAS or unspecified, bring challenges for domestic trade and regulatory agencies.

Adulteration with ammonia and formaldehyde: In order to give a false façade of freshness, freshwater fishes are often adulterated with varying concentration of ammonia. Higher ammonia content is not only hazardous to fish handlers, it also downgrades the organoleptic attributes to a large extent. Similarly, formaldehyde is used to mask spoilage in some parts of India. Presence of formaldehyde poses a serious health hazard for the consumer.

Presence of human pathogenic bacteria: As most of fish farms are situated close to human habitation and large waterbodies face the problem of dumping of un-treated domestic waste, presence of human pathogenic bacteria are often noticed in freshwater ecosystems. Presence of *Vibrio cholerae* and *Salmonella* has been reported in aquaculture ponds. Unhygienic handling at the farm site or onboard fishing boat and subsequent handling during auction or resale results in unhindered proliferation of pathogenic bacteria like *Staphylococcus aureus*, *Salmonella*, *Shigella* and *Escherichia coli*.

Off flavours: Many cultured freshwater fishes and prawns face the problem of muddy, earthy and mouldy off flavours. Geosmin and 2-methylisoborneol are two primary compounds responsible for musty or earthy flavours which are secondary metabolites produced by various actinomycetes and cyanobacteria. Geosmin is rapidly absorbed through gills and temperature plays an important role in rate of absorption and depuration from fish body.

Ushering quality in fresh/chilled and frozen fish

The term quality has no standard definition; it is used as a qualifier in describing some product or service. ISO defines quality as "*degree to which a set of inherent characteristics that fulfills requirements*". American Society of Quality (ASQ) defines quality as "*the totality of characteristics of a product or service that bear on its ability to satisfy stated and implied needs*". The different dimensions of quality include performance, features, reliability, conformance, durability, serviceability, aesthetics and perception. Although all these dimensions are not applicable for fishery products, pursuit of quality at every stage of value chain has been a priority requirement for all stakeholders.

The term 'quality control' and 'quality assurance' is used interchangeably without understanding the basic difference between the two. According to ISO (ISO 8402 – Terminology), quality assurance (QA) 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*. Hence, QA is a strategic management function that establishes policies, adapts programs to meet established goals, and provides confidence that these measures are being effectively applied. Quality Control (QC), on the other hand, is defined as *the operational techniques and activities that are used to fulfill requirements for quality* (ISO 8402 — Terminology), i.e., a tactical function that carries out the programs established by the QA.

Quality assurance approach got its inception with the advent of HACCP (Hazard Analysis and Critical Control Point) concept, which was based on preventing rather than correcting the occurrence of defects and hazards or the presence of foreign substances during product manufacture. Further changes have taken place in QA with the development of the concepts and applications of Total Quality Management (TQM). Total Quality Management (TQM) is a theory of management based on the principles of quality assurance. As defined by British Standard (BS7850-1), *TQM is a management philosophy and company practices that aim to harness the human and material resources of an organization in the most effective way to achieve the objectives of the organization*. The nine common TQM practices adopted for food manufacturing are cross-functional product design, process management, supplier quality management, customer involvement, information and feedback, committed leadership, strategic planning, cross functional training and employee involvement.

Function of quality assurance programme in freshwater fish processing can be as follows:

1. Development and implementation of a good hygiene and sanitation programme
2. Implementation of food safety QA prgramme
3. Internal audit of all QA programmes

Quality assurance systems are intended to provide confidence to a food company's management, its customers and to government regulatory agencies that the company is capable of meeting the food quality and food safety requirements.

Measures to retain quality

The international standards ISO 9001:2000 and ISO 9004:2000 have been formally used by food processing industries worldwide as a quality management standard. The ISO standard on food safety management system (ISO 22000:2018) was later on developed to

specifically cater to food industry. This standard is developed with the key elements of interactive communication, system management, pre-requisite programmes and HACCP principles. In India fish processing industries are gradually adopting this standard to strengthen international acceptance of Indian fishery products. Apart from ISO 22000:2018, many private food safety standards are being adopted. All these standards are formulated keeping intact the principles of HACCP (Hazard analysis and critical control point). Hence any domestic or international food safety standard can be very well implemented if HACCP principles are well understood.

Hazard Analysis and Critical Control Point (HACCP)

Hazard Analysis and Critical Control Point (HACCP) evolved as a quality assurance approach in late 1950's has been embraced as a food safety management tool throughout the world. Compared to traditional end product testing based food safety programmes, HACCP is a dynamic, preventive system of food control with a prior anticipated risk-response approach.

HACCP is a preventive system to control significant identified hazards. It also functions by designing food safety into a product and controlling the process by which the product is produced. However, it should be noted that HACCP does not rely on end product testing or lot acceptance criteria. HACCP is a core component in all national and international food safety standards such as IS 15000, ISO 22000:2005, USFDA Seafood HACCP regulation (CFR 123, Title 21), Dutch HACCP, BRC Gloabal Standard for Food, SQF 2000, IFS, etc.

HACCP is a system that identifies, evaluates, and controls hazards that are significant for food safety. As described by Codex Alimentarius Commission (CAC/RCP 1-1969; Rev. 4 - 2003) HACCP can be implemented by 12 logical steps that include five preliminary steps and seven principles.

Step 1.	Assemble HACCP team	Preliminary Steps
Step 2.	Describe product	
Step 3.	Identify intended use	
Step 4.	Construct flow diagram	
Step 5.	On-site confirmation of flow diagram	
Step 6.	Conduct hazard analysis	HACCP Principle I
Step 7.	Determine Critical Control Points (CCP)	HACCP Principle II
Step 8.	Establish critical limits for each CCP	HACCP Principle III
Step 9.	Establish a monitoring system for each CCP	HACCP Principle IV
Step 10.	Establish corrective actions	HACCP Principle V
Step 11.	Establish verification procedures	HACCP Principle VI
Step 12.	Establish Documentation and Record Keeping	HACCP Principle VII

Conclusion

Fish and fishery products have an edge over other animal products in terms of plethora of health benefits. But it's an arduous task to maintain quality starting from subsistence farming to commercial processing activity. Incorporation of modern food safety management tools coupled with emphasis on basic hygiene and sanitation measures throughout the food chain is the only solution. Then only we can claim fish as not only nutritious, but also safe.