Disease Free Fish for Better Processing: Importance of Fish Health in Value Addition

C E Bridgete Princey[1] and G. Anbu Kani Selvam[2]*

[1]Dept. of Fish Processing Technology, Tamil Nadu Dr. J. Jayalalithaa Fisheries University, Fisheries College and Research Institute, Thoothukudi, Tamil Nadu, India.
[2]Dept. of Fish Pathology and Health Management, Tamil Nadu Dr. J. Jayalalithaa Fisheries University, Fisheries College and Research Institute, Thoothukudi.

Corresponding Author
Anbu Kani Selvam. G
Email: imanbuganesan26@gmail.com

OPEN ACCESS

Keywords

Disease free fish, Fish pathology, Fish processing technology, Value addition, Seafood quality, Food safety, Biosecurity

How to cite this article:

Princey, C. E. B. and Selvam, G. A. K. 2026. Disease Free Fish for Better Processing: Importance of Fish Health in Value Addition. *Vigyan Varta* 7 (08): 14-21.

ABSTRACT

The production of disease-free fish is fundamental to ensuring the quality, safety, and value addition of seafood products. Fish health directly influences muscle quality, processing efficiency, shelf life, and consumer acceptance, making it an essential component of modern aquaculture and seafood processing. Infectious diseases and physiological stress can cause tissue damage, microbial contamination, biochemical deterioration, and quality defects that reduce the suitability of fish for processing into high-value products such as fillets, surimi, smoked fish, canned products, and ready-to-cook items. Furthermore, poor fish health contributes to increased post-harvest losses, economic losses, and food safety concerns throughout the seafood supply chain. Effective biosecurity measures, disease surveillance, hygienic harvesting, and Good Aquaculture Practices (GAP) help maintain fish quality before processing, while Hazard Analysis and Critical Control Point (HACCP) systems, proper sanitation, cold-chain management, and advanced preservation technologies ensure product safety and quality during processing. Integrating fish pathology with fish processing technology provides a comprehensive farm-to-fork approach that enhances seafood quality, minimizes losses, supports sustainable aquaculture, and improves the production of safe and value-added fish products. Promoting disease-free fish production therefore benefits

farmers, processors, consumers, and the seafood industry by improving profitability, food safety, and long-term sustainability.

INTRODUCTION:

Fish is one of the most nutritious and widely consumed animal protein sources in the world, providing high quality protein, essential amino acids, omega-3 fatty acids, vitamins, and minerals that contribute significantly to human health. The rapid expansion of aquaculture has played a crucial role in meeting the increasing global demand for fish and fishery products. However, producing high-quality seafood involves more than achieving higher production; it begins with maintaining the health of fish throughout the culture period. Disease-free fish form the foundation for safe processing, superior product quality, longer shelf life, and successful value addition (Paterson *et al*., 1997).

Fish health has become an essential component of modern seafood production because bacterial, viral, fungal, and parasitic diseases not only reduce production but also adversely affect the physical, chemical, microbiological, and sensory quality of fish. Diseased fish often exhibit muscle degradation, tissue damage, abnormal texture, discoloration, and microbial contamination, making them less suitable for processing into value-added products. These quality defects reduce consumer acceptance and significantly affect the economic returns of processors and farmers (Cortés-Sánchez *et al*., 2024).

The seafood industry depends heavily on high-quality raw materials to manufacture products such as fillets, ready-to-cook items, smoked fish, canned fish, surimi, fish sausages, and other value-added products. The quality of these processed products is directly influenced by the physiological condition of fish before harvest. Stress, disease, poor handling, and inadequate farming practices accelerate biochemical and microbiological changes that deteriorate muscle quality, resulting in reduced processing yield and shorter storage life. Therefore, maintaining fish health from the farm stage is equally as important as maintaining hygienic processing conditions (Peng *et al*., 2024).

Food safety has also emerged as a major concern in seafood processing. Fish are highly perishable because of their high moisture content, neutral pH, endogenous enzymes, and naturally occurring microorganisms. When diseased fish enter the processing chain, they may carry increased microbial loads and spoilage organisms, thereby increasing the risk of contamination during handling, storage, transportation, and processing. Implementing effective disease prevention strategies at the farm level, together with strict hygiene and Hazard Analysis and Critical Control Point (HACCP) systems during processing, is essential to produce safe seafood products and minimize foodborne hazards (Sheng & Wang, 2021; Lupin *et al*., 2010).

In addition to improving food safety, healthy fish also contribute to sustainability by reducing post-harvest losses throughout the seafood supply chain. Seafood is one of the most perishable food commodities, and significant losses occur during harvesting, transportation, processing, retail distribution, and consumer handling. Disease-related quality deterioration further increases these losses by reducing product acceptability and market value. Producing disease-free fish not only improves processing efficiency but also minimizes wastage, enhances resource utilization, and supports sustainable seafood production (Love *et al*., 2015).

Therefore, fish pathology and fish processing technology should not be viewed as separate disciplines but as complementary components of a single production system. Effective disease management during aquaculture, combined with proper processing technologies, ensures the production of safe, nutritious, high-quality, and value-added seafood products that benefit farmers, processors, consumers, and the aquaculture industry.

Why Fish Health Matters Before Processing

The quality of processed seafood is largely determined by the health status of fish before harvesting. Healthy fish possess firm muscle texture, normal biochemical composition, desirable colour, and low microbial load, making them ideal raw materials for various processing methods. In contrast, diseased or stressed fish experience physiological and metabolic alterations that negatively influence flesh quality long before processing begins. Consequently, the concept of producing high-quality seafood starts at the farm rather than in the processing plant (Paterson *et al*., 1997).

Fish are continuously exposed to numerous disease-causing agents, including bacteria, viruses, fungi, and parasites. These pathogens compromise tissue integrity, reduce growth performance, weaken immune responses, and increase physiological stress. During disease outbreaks, fish often exhibit reduced feeding, abnormal swimming behaviour, skin lesions, haemorrhages, fin erosion, and muscle degeneration. Such pathological changes lower carcass quality and decrease the suitability of fish for value-added processing (Cortés-Sánchez *et al*., 2024).

Moreover, chronic stress caused by overcrowding, poor water quality, transportation, and disease activates physiological stress responses that accelerate post-mortem biochemical changes in fish muscle. Elevated stress hormones rapidly deplete glycogen reserves, leading to faster rigor mortis, protein denaturation, increased lipid oxidation, and deterioration of texture, flavour, and water-holding capacity. These changes significantly reduce processing yield and consumer acceptability, emphasizing the importance of maintaining healthy fish before harvest (Peng *et al*., 2024).

Impact of Fish Diseases on Processing Quality

The quality of processed seafood is determined not only by processing technology but also by the physiological condition of fish before harvest. Disease outbreaks cause extensive pathological and biochemical changes in fish tissues, which directly affect the quality of raw materials used in seafood processing. Fish suffering from bacterial, viral, fungal, or parasitic infections often exhibit muscle degeneration, haemorrhages, skin ulcerations, excessive mucus secretion, and tissue necrosis. These abnormalities reduce the suitability of fish for producing high-quality value-added products and significantly lower their market value (Cortés-Sánchez *et al*., 2024).

One of the most significant consequences of poor fish health is the deterioration of muscle quality. Disease and physiological stress trigger rapid metabolic changes, including depletion of muscle glycogen, increased lactic acid production, protein denaturation, and accelerated lipid oxidation. These biochemical changes adversely affect important quality attributes such as texture, water-holding capacity, colour, flavour, and overall appearance of fish flesh. As a result, processed products prepared from diseased fish often have reduced consumer acceptability and shorter storage life (Peng *et al*., 2024).

Stress associated with disease also accelerates post-mortem deterioration. Poor handling, overcrowding, inadequate water quality, and infectious diseases stimulate stress responses that hasten rigor mortis and enzymatic degradation of muscle proteins. These processes lead to softer flesh, increased drip loss, reduced fillet yield, and poor processing performance. Such quality defects are particularly undesirable in products requiring firm texture, including fillets, smoked fish, frozen products, surimi, and ready-to-cook seafood (Peng *et al.*, 2024).

Fish processors rely on uniform raw materials to maintain consistent product quality. However, diseased fish frequently display visible defects such as haemorrhages, ulcerative lesions, fin erosion, abnormal pigmentation, and tissue damage. These defects reduce the aesthetic quality of seafood products and often result in trimming losses or complete rejection during processing. Consequently, processors experience reduced production efficiency and economic losses due to lower recovery of edible flesh (Paterson *et al.*, 1997).

Maintaining fish health throughout the production cycle therefore has direct economic benefits. Healthy fish produce firm muscle, higher fillet yield, better processing characteristics, improved shelf life, and superior sensory quality. These advantages ultimately enhance consumer confidence, increase product value, and improve profitability for both aquaculture producers and seafood processing industries (Paterson *et al.*, 1997; Cortés-Sánchez *et al.*, 2024).

Fish Diseases and Food Safety

Seafood is recognized as one of the most nutritious foods; however, it is also highly perishable because of its high moisture content, neutral pH, active endogenous enzymes, and naturally occurring microorganisms. The presence of diseased fish in the processing chain further increases the risk of microbial contamination and quality deterioration. Therefore, ensuring fish health before harvest is an essential step in producing safe seafood products (Sheng & Wang, 2021).

Diseased fish often carry elevated populations of spoilage microorganisms and opportunistic pathogens on the skin, gills, and gastrointestinal tract. During harvesting, dressing, filleting, and further processing, these microorganisms can spread to equipment, water, processing surfaces, and other fish through cross-contamination. If proper hygienic measures are not followed, microbial contamination can rapidly increase during storage and distribution, reducing shelf life and compromising product safety (Sheng & Wang, 2021).

Several factors influence seafood safety, including raw material quality, sanitation practices, storage temperature, packaging conditions, and transportation. Even fish that appear externally normal may undergo rapid spoilage if they have been subjected to disease or prolonged physiological stress before harvest. Such conditions accelerate microbial growth and enzymatic degradation, leading to undesirable odours, discoloration, texture changes, and quality loss during processing and marketing (Cortés-Sánchez *et al.*, 2024; Sheng & Wang, 2021).

To minimize these risks, seafood industries widely implement the **Hazard Analysis and Critical Control Point (HACCP)** system. HACCP is a preventive food safety management approach that identifies potential biological, chemical, and physical hazards throughout seafood processing and establishes critical control measures to prevent contamination. Effective implementation of HACCP improves product safety, enhances consumer confidence, reduces product rejection, and strengthens compliance with national and international seafood quality standards (Lupin *et al.*, 2010).

In addition to HACCP, Good Aquaculture Practices (GAP), Good Manufacturing Practices (GMP), proper sanitation, rapid chilling, maintenance of the cold chain, and regular microbial monitoring collectively contribute to producing safe seafood. Integrating disease prevention at the farm level with hygienic processing practices creates a comprehensive "farm-to-fork" strategy that ensures seafood reaching consumers is not only nutritious but also safe, wholesome, and of high quality (Sheng & Wang, 2021; Lupin *et al*., 2010).

Fish Health and Value Addition

Value addition has become one of the most effective approaches to increase the economic value of fish and fishery products. Products such as fillets, fish fingers, surimi, smoked fish, fish sausages, pickles, canned fish, and ready-to-cook products require high-quality raw materials to ensure desirable texture, flavour, appearance, and shelf life. The success of these products depends greatly on the health status of fish before harvest. Disease-free fish possess superior muscle quality, better nutritional composition, and lower microbial contamination, making them ideal for processing into premium value-added products (Paterson *et al*., 1997).

Conversely, fish affected by disease or severe physiological stress often exhibit poor flesh quality, excessive drip loss, soft muscle texture, abnormal pigmentation, and tissue damage. These defects reduce processing efficiency by lowering fillet recovery, increasing trimming losses, and affecting the overall appearance of processed products. Consequently, processors experience reduced product quality, shorter shelf life, and lower market acceptance, ultimately affecting profitability throughout the seafood value chain (Peng *et al*., 2024; Cortés-Sánchez *et al*., 2024).

The quality of raw materials also determines the success of modern preservation technologies such as vacuum packaging, modified atmosphere packaging, freezing, smoking, and canning. Healthy fish respond more effectively to these preservation methods because their muscle proteins remain structurally intact and microbial loads are comparatively lower. This improves product stability during storage and transportation while maintaining desirable sensory attributes such as colour, flavour, firmness, and freshness (Cortés-Sánchez *et al*., 2024).

Maintaining fish health also contributes significantly to reducing seafood losses throughout the production and processing chain. Disease outbreaks often result in increased mortality, rejection of poor-quality fish, trimming losses during processing, spoilage during storage, and wastage at retail and consumer levels. Love *et al*. (2015) estimated that approximately **40–47%** of the edible seafood supply is lost across different stages of the supply chain, highlighting the importance of minimizing losses through improved fish health, efficient processing, and proper handling practices. Producing disease-free fish therefore not only enhances product quality but also supports sustainable resource utilization and economic growth in the seafood industry.

Role of Biosecurity in Producing Disease-Free Fish

Disease prevention is considerably more effective and economical than disease treatment. Therefore, biosecurity has become a fundamental component of sustainable aquaculture. Biosecurity comprises a series of preventive measures designed to minimize the introduction, spread, and persistence of infectious pathogens within aquaculture systems. Effective biosecurity ensures that healthy fish enter the processing chain, thereby improving product quality and reducing economic losses (Paterson *et al*., 1997).

Good biosecurity practices include the use of certified disease-free seed, regular health monitoring, quarantine of newly introduced fish, maintenance of optimal water quality, proper nutrition, routine sanitation of culture facilities, and control of farm visitors and equipment movement. These measures reduce disease outbreaks and improve overall fish welfare, resulting in stronger immune responses, improved growth performance, and better-quality raw materials for seafood processing (Paterson *et al*., 1997).

In addition to farm-level management, post-harvest handling practices also play an important role in maintaining fish quality. Immediate icing after harvest, hygienic handling, rapid transportation under refrigerated conditions, and uninterrupted cold-chain management effectively slow microbial growth and biochemical deterioration. These practices preserve the freshness and nutritional quality of fish until processing, ensuring better-quality finished products (Cortés-Sánchez *et al*., 2024; Sheng & Wang, 2021).

Integrating farm biosecurity with hygienic processing practices creates a comprehensive quality assurance system. Healthy fish harvested under biosecure conditions require fewer corrective interventions during processing, resulting in improved processing efficiency, reduced wastage, enhanced food safety, and increased consumer confidence in seafood products (Lupin *et al*., 2010).

Modern Technologies Ensuring Fish Quality

Advances in fish pathology and seafood processing technology have greatly improved the ability to produce safe and high-quality fish products. Rapid disease diagnosis using molecular techniques, microbiological testing, and routine health surveillance enables early detection of pathogens before fish enter the processing chain. Early diagnosis reduces the risk of disease transmission, minimizes production losses, and ensures that only healthy fish are selected for processing (Paterson *et al*., 1997).

Modern seafood industries increasingly combine rapid chilling, vacuum packaging, modified atmosphere packaging (MAP), hygienic automation, and continuous cold-chain management to maintain product quality during storage and transportation. These technologies slow microbial growth, reduce oxidative deterioration, preserve sensory characteristics, and significantly extend shelf life. Their effectiveness is greatly enhanced when the raw material originates from healthy, disease-free fish (Cortés-Sánchez *et al*., 2024).

Food safety management systems such as HACCP continue to play a central role in modern seafood processing. By identifying critical control points and implementing preventive measures throughout processing, HACCP minimizes biological, chemical, and physical hazards while ensuring compliance with national and international food safety standards. In addition to improving consumer protection, HACCP reduces product rejection, improves processing efficiency, and supports export-quality seafood production (Lupin *et al*., 2010).

The future of seafood quality assurance lies in integrating disease surveillance, biosecurity, advanced processing technologies, and comprehensive quality management systems into a single **farm-to-fork** approach. Such integration not only protects fish health but also enhances processing efficiency, increases value addition, reduces seafood losses, and strengthens the long-term sustainability of the aquaculture industry (Love *et al*., 2015; Sheng & Wang, 2021).

Future Perspectives

The future of aquaculture depends not only on increasing fish production but also on ensuring that fish entering the processing chain are healthy, safe, and of superior quality. As consumer demand for high-quality seafood continues to grow, greater emphasis must be placed on preventive fish health management rather than relying solely on disease treatment. Early disease detection, effective biosecurity measures, responsible farming practices, and improved water quality management will continue to play vital roles in producing disease-free fish suitable for value addition (Paterson *et al*., 1997).

Recent advances in seafood processing technologies, including improved cold-chain systems, vacuum packaging, modified atmosphere packaging, and modern quality assurance programs, have significantly enhanced the safety and shelf life of fish products. However, the success of these technologies ultimately depends on the quality of the raw material. Healthy fish with minimal physiological stress and low microbial contamination respond better to preservation methods and produce processed products with improved texture, flavour, nutritional value, and storage stability (Cortés-Sánchez *et al*., 2024; Peng *et al*., 2024).

Food safety management systems such as Hazard Analysis and Critical Control Point (HACCP), together with Good Aquaculture Practices (GAP) and Good Manufacturing Practices (GMP), are expected to become even more important as seafood industries expand to meet global market demands. These integrated quality management systems reduce food safety hazards, improve consumer confidence, facilitate international trade, and promote sustainable seafood production (Lupin *et al*., 2010; Sheng & Wang, 2021).

Furthermore, minimizing seafood losses throughout the production and processing chain remains an important global priority. Improving fish health, reducing disease outbreaks, strengthening quality control, and adopting efficient processing technologies can substantially decrease post-harvest losses while increasing economic returns for farmers, processors, and exporters. Integrating fish pathology with fish processing technology therefore represents a holistic "farm-to-fork" strategy for achieving sustainable aquaculture and high-quality seafood production (Love *et al*., 2015).

CONCLUSION

Fish health is the cornerstone of successful seafood processing and value addition. Disease-free fish provide high-quality raw materials that enhance processing efficiency, improve product appearance, maintain desirable texture and flavour, extend shelf life, and ensure food safety. Conversely, disease outbreaks and physiological stress reduce muscle quality, increase microbial contamination, decrease processing yield, and result in significant economic losses throughout the seafood value chain (Peng *et al*., 2024; Cortés-Sánchez *et al*., 2024).

The integration of fish pathology with fish processing technology offers an effective approach to producing safe, nutritious, and value-added seafood products. Preventive health management through biosecurity, disease surveillance, responsible aquaculture practices, hygienic processing, cold-chain maintenance, and HACCP implementation ensures that fish retain their quality from production to consumption. This integrated approach not only benefits farmers and seafood processors but also enhances consumer confidence and supports the long-term sustainability of the aquaculture industry (Paterson *et al*., 1997; Lupin *et al*., 2010; Sheng & Wang, 2021).

Ultimately, producing disease-free fish should be recognized as the first and most important step in value addition. By combining effective fish health management with advanced processing technologies, the aquaculture sector can reduce post-harvest losses, improve seafood quality, strengthen export competitiveness, and contribute to a safer and more sustainable global food system (Love *et al*., 2015).

REFERENCES

Cortés-Sánchez, A. D. J., Diaz-Ramírez, M., Torres-Ochoa, E., Espinosa-Chaurand, L. D., Rayas-Amor, A. A., Cruz-Monterrosa, R. G., ... & Salgado-Cruz, M. D. L. P. (2024). Processing, quality and elemental safety of fish. *Applied Sciences*, *14*(7), 2903.

Love, D. C., Fry, J. P., Milli, M. C., & Neff, R. A. (2015). Wasted seafood in the United States: Quantifying loss from production to consumption and moving toward solutions. *Global Environmental Change*, *35*, 116-124.

Lupin, H. M., Parin, M. A., & Zugarramurdi, A. (2010). HACCP economics in fish processing plants. *Food Control*, *21*(8), 1143-1149.

Paterson, B., Goodrick, B., & Frost, S. (1997). Controlling the quality of aquacultured food products. *Trends in Food Science & Technology*, *8*(8), 253-257.

Peng, L., Zhang, L., Xiong, S., You, J., Liu, R., Xu, D., ... & Yin, T. (2024). A comprehensive review of the mechanisms on fish stress affecting muscle qualities: Nutrition, physical properties, and flavor. *Comprehensive Reviews in Food Science and Food Safety*, *23*(3), e13336.

Sheng, L., & Wang, L. (2021). The microbial safety of fish and fish products: Recent advances in understanding its significance, contamination sources, and control strategies. *Comprehensive Reviews in Food Science and Food Safety*, *20*(1), 738-786.