

Processing, Quality and Elemental Safety of Fish

Subjects: Food Science & Technology

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Fish is a food widely produced, marketed and consumed throughout the world. It is a basic component of human nutrition due to its chemical and nutritional composition, but at the same time it is highly perishable and susceptible to contamination throughout the entire food chain, compromising its quality and safety. Fishing and aquaculture products, being perishable, require adequate processing and conservation to maintain their quality and safety as much as possible until their acquisition and final consumption. Over the years, different preservation methods have been developed and used to extend the useful life of fishery products with minimal impact on their nutritional and organoleptic properties, favoring quality and safety that allow the availability of food and protection of public health.

Keywords: foodborne diseases ; spoilage ; biological hazards ; preservation

1. Introduction

Fish is any animal intended for human consumption extracted from aquatic environments and is used as a generic term that can cover different organisms such as fish, crustaceans, and mollusks, among others ^[1]. Fish is a basic component of the human diet, considered to have high nutritional value due to its proportion of proteins with biological value and digestibility, vitamins, minerals, and lipids ^{[1][2][3]}.

Foods, including fish, are subjected to different processing and preservation conditions for marketing and consumption, which are focused on promoting their availability and improving their sensory, nutritional, and safety properties. Aquatic foods are one of the most commercialized food products worldwide, representing a source of food, economic income, and employment. In their live, fresh, or refrigerated states, and excluding algae, they are the forms with the highest proportion intended for direct human consumption, followed by their frozen, prepared, preserved, and cured states ^[4].

Food safety is the guarantee that food products will not cause harm to the consumer when they are prepared and/or consumed according to their intended use ^[5]. Food and fish can be contaminated by physical, chemical, radiological, and biological agents in the absence of hygienic conditions, during processing and preparation processes, becoming a source of diseases which are a major health problem in the world, most frequently in developing countries ^{[6][7]}.

2. The Fish Generalities

Fish are aquatic vertebrates capable of using the oxygen present in water for respiration through their gills. They have fins and a bone structure made up of a vertebral column from the head to the caudal fin constituted by vertebrae that extend to the sides, forming the ribs or spines ^{[8][9]}.

The chemical composition and nutritional value of the muscle (edible part) of fish is a function of various factors such as species, age, sex, season, migratory behavior, sexual maturation, feeding, sexual changes related to spawning, region of capture, culture, and capture method, among others ^{[10][11]}. The main components of fish muscle are water and proteins (high biological value and digestibility), which constitute the main component of the muscular and edible part of the fish ^{[8][11][12]}. Lipids (polyunsaturated ω -3 and ω -6) impact the nutritional value; bioactive, functional, and sensory properties; and stability during the preservation of these products ^{[2][8][11][13]}. On the other hand, among the minority constituents are carbohydrates (glycogen); vitamins of the B complex and in the case of fatty species, vitamins A and D; as well as various minerals such as sodium, calcium, phosphorus, iron, copper, and iodine ^{[8][11]}. It should be noted that a minor constituent group in fish are non-protein nitrogenous compounds such as ammonia, trimethylamine oxide, methylamine, dimethylamine, creatine, amino acids, nucleotides, purine bases, and urea, which significantly influence the quality and spoilage of fish ^[11].

3. Fish Production

Through fishing and aquaculture activities humans have access to aquatic foods, so their contribution to global food security and nutrition is vital and continues to grow. The Food and Agriculture Organization (FAO)'s estimates indicate that during 2020, capture fishing and aquaculture recorded a worldwide production of 177.8 million tons, of which 157.4 million tons were destined for human consumption, with an apparent per capita consumption of 20.2 kg, and where the main producing countries were from Asia and America, among which China, India, Indonesia, Vietnam, and Peru stand out, contributing to 58% of the world's fishing and aquaculture production of aquatic animals ^[4]. From this estimate, the live,

fresh, or refrigerated modality represents the highest proportion of fishery and aquaculture production and is regularly the preferred and highest cost form for direct human consumption; after that are products subjected to different processing and preservation conditions such as products that are frozen, prepared, canned, and cured; later come indirect uses in the forms of fishmeal and oils for the formulation of animal feed mainly [4][14].

4. Food and Fish Safety

Food safety is defined as the guarantee that food will not cause harm to the consumer when prepared and/or consumed [5][15]. The safety of food can be compromised at any stage of the food chain due to contamination by biological, chemical, and/or physical agents, generating a risk of illness for the consumer [15]. Foodborne diseases are considered an important public health problem due to their impact on millions of people around the world [1,5,16], their negative socioeconomic impact due to the decrease in productivity, their impact on trade in food products, and their imposition of a substantial burden on health systems due to expenses for hospitalizations and medications [5][16].

Fish and fish products are foods that are very susceptible to spoilage and contamination by various physical, biological, and chemical hazards at any point in the food chain [1][4][17][18], so the application of appropriate handling, hygiene, and preservation practices and conditions from capture or harvest to the consumer's table becomes essential [1][4][7][17]. Otherwise, these may become products that are not suitable for consumption and may pose a health risk as their safety is compromised due to contamination, growth of microorganisms, chemical and/or autolytic changes [4]. Fish and products have been associated with outbreaks of diseases due to consumption, where frequently the causal agents are of biological origin (bacteria, viruses, and parasites) and chemical origin (biotoxins and biogenic amines) [18][19][20][21][22].

5. Control and Prevention of Diseases Transmitted by Fish Consumption

The quality of fishing and aquaculture products is largely determined by their degree of freshness, where intrinsic characteristics, such as high water content, proteins, low proportion of connective tissue, and the qualitative and quantitative profile of microorganisms present, will determine the occurrence of the set of changes that contribute to its devaluation, rejection, and health risk [1].

Fish is a food that is frequently implicated as a cause of disease and among its contributing factors in different phases in the food chain are absent or inadequate hygiene conditions and practices in handling and processing; the use of contaminated raw materials; inadequate quality controls (time/temperature) in transformation processes, production, warehouse and dispensing services; absence or failures in standardized cleaning and disinfection programs; Good practices in primary production and manufacturing; poor equipment design; high humidity conditions; inadequate or absent zoning and hygienic barriers (these allow the spread of contamination from contaminated to clean areas); and poor ventilation design in processing areas [5][19][20][23][24][25].

6. Fish Processing and Preservation

Food processing involves any method that preserves fresh or raw foods and transforms them into food products for consumption, involving various actions considered as minimal processes such as washing, peeling, cutting, grinding, pasteurization, cooking, sterilization, refrigeration, freezing, drying, fermentation, and packaging, among many others. Thus, a food product can be processed in different ways, either at home or at the industrial level [26][27][28].

In foods of aquatic origin, there are a variety of processing and preservation technologies that contribute to extending their shelf life and guaranteeing their safety so that they can be distributed and marketed in areas far from where they are produced. Food preservation methods are classified as modern (refrigeration, freezing, canning, vacuum packaging, and modified atmospheres) and traditional (salting, smoking, cooking, drying, and pickling), the latter being of basic and common use in fish, and which can be applied individually or jointly [29].

Preservation methods are generally based on the modification of biological activity's optimal conditions (enzymes and microorganisms) such as lowering the temperature (refrigeration, chilling, or icing and freezing), heat application (canning, cooking, and smoking), reduction in available water (drying, salting, and smoking), pH modification (pickling), change in storage conditions, and absence or presence of oxygen or other gases (vacuum packaging or modified atmosphere) [4][9][30][31][32].

7. Conclusions

Fish is a basic food in the human diet due to its high nutritional value, with its main contribution being proteins, lipids, vitamins, and minerals. Fish is among the most produced and commercialized foods around the world, in presentations ranging from a whole raw state to products derived from the application of various processing and preservation methods.

Fish preservation technologies are varied, being used individually or together, and increase the shelf life and safety of products but affect nutritional, sensory, and freshness properties; however, more research remains to be conducted on the development and implementation of technologies that allow the freshness and nutritional qualities of the food to be

respected, that avoid or reduce to a minimum or safe levels the different hazards and factors associated with spoilage and health risk alongside consequent economic accessibility, and promote a reduction in process time and energy consumption in their implementation.

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