Seafood Chilling, Refrigeration and Freezing
Seafood Chilling, Refrigeration and Freezing
Science and Technology

Nalan Gökoğlu and Pınar Yerlikaya
Fisheries Faculty, Akdeniz University, Antalya, Turkey

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Fish and other seafood are the major sources of nutritious protein and micronutrients. They form part of a healthy diet due to their content of high-quality protein with essential amino acids, minerals and vitamins. However, their flesh is perishable feature and causes spoilage. Therefore, preservation of seafood is an important issue. The preservation methods lowering the temperature protect the original properties of these products. The first application on board a vessel is chilling or freezing. These preservation methods are used comprehensively for fish and fish products. Books on chilling, refrigeration and freezing are generally available for all foods, but there is a limited number of books specializing on fish.

In this book, besides general knowledge on chilling, refrigeration and freezing, seafood-specific applications are given. I hope that this book will be useful for researchers, students and industrialists.

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Drawings: Dr. Yasar Ozvarol.

Nalan Gökoğlu
and Pınar Yerlikaya
CHAPTER 1

Introduction

1.1 Spoilage of seafood

Fish can be easily spoiled after death. The decomposition of fish flesh occurs mainly due to various chemical, microbial and enzymatic actions. Microorganisms are found on the skin, gill surfaces and in the intestines of live fish. In live fish, these microorganisms do not affect on fish quality due to the normal body defences of fish. However, microorganisms attack fish tissues after death. While numerous microorganisms can cause spoilage of fish, the main ones are bacteria. The bacterial flora of fish is affected by several factors, including season and environment. The bacterial microflora of fish is related to the microbial population of the water in which it lived. Psychrophilic and mesophilic microorganisms are responsible for the fish spoilage. Microorganisms enter the body of fish through gills, blood vessels, skin and abdominal wall. Moreover, bacteria may enter through injured tissues. Bacteria cause undesirable flavour and taste changes in the flesh of fish. Besides flavour and taste, bacteria are responsible for the changes in appearance and physical properties of fish. Deteriorative changes in fish are due to decomposition of non-protein nitrogen compounds. Proteins are degraded into peptides, amino acids, ammonia and some other low-molecular weight
nitrogen compounds. The deteriorative changes occurring in fish result in the gradual accumulation of certain compounds in the flesh. Enzymes remain active after the death of the fish and are particularly involved in flavour changes that take place during the first few days of storage. Autolysis is the breakdown of proteins, lipids and carbohydrates by enzymes. The initial quality loss in fish occurs by these autolytic changes. All of the factors affecting the quality of fish, such as bacteria and enzymes, may bring about sensory changes, which are unacceptable for the consumer.

1.2 Preservation of seafood

Since fresh fish spoil easily, they need to be processed and preserved. Preservation provides a long shelf-life for fish and fish products. Preservation can be defined as the storage of excess fish when they are abundantly caught or produced so they can be consumed as if fresh in times when food is scarce or when transported to long distances. Preservation affects food in two ways: (1) it keeps the original freshness and properties of fish; (2) it changes the original properties of the food and creates new product. The main purpose of both of these is to prevent spoilage, especially by microorganisms. Several preservation methods have been developed, some of them providing a longer shelf-life than others. The choice of a preservation method depends on the product, properties of the product, availability of energy, the storage facilities, and the costs of the method. It is sometimes necessary to combine methods.

Fish spoils very quickly in high ambient temperatures, because chemical, physical and microbiological actions accelerate in high temperatures. Therefore, the temperature should be reduced immediately after harvest. In this regard, preservation begins in fishing vessels for fish and fishery products. The first preventative step to keep the quality of fish is taken onboard. Chilling, refrigeration and freezing are generally used onboard as preservation methods; these methods are also common in inshore applications. The fish are transported to land under cold conditions, and stored in cold storage until processing or marketing in the plant. Products remain fresh under refrigeration for a few days; they can be stored much longer when frozen. Low temperatures must be maintained accurately and continuously.
1.2.1 Chilling
Chilling is to reduce fish temperature to 0°C. The main aim of chilling is to prevent physical, chemical and microbiological activities occurring under normal conditions by reducing the temperature. Chilling cannot completely stop spoilage of fish but retards it. Effective chilling depends on some factors, including initial microbial load, chemical composition, temperature, relative humidity, and air velocity. The lower the temperature means the longer the shelf life. Mesophilic and thermophilic microorganisms are retarded at chilling temperature. Different chilling methods are used for fish and fishery products. The most common and effective method is chilling with ice. In this method the fish is completely surrounded by ice because the cooling capacity of ice is very good. Melting ice removes heat from the fish and so cools it. Moreover, chilled or refrigerated sea water (RSW) is used for chilling of fish. This method is common in onboard applications.

1.2.2 Refrigeration
Refrigeration is also a method of lowering the temperature of the product. In this method mechanical cooling is used. Air is cooled by a refrigerator and cold air is passed over the surface of a fish to rapidly cool it. Air takes the moisture from the surface of the product, and therefore surface of the fish becomes dry. For this reason, refrigeration is more suitable for iced fish. After icing of fish in boxes or containers, they are stored under refrigeration and effective cooling is achieved in this way. On the other hand, frozen products should be stored in cold conditions until use. Different refrigeration systems and refrigerants are used for fish and fishery products. Refrigeration equipment can be installed in fishing vessels. Thus, fish quality keep just after catching. RSW is a good chilling method on board, and refrigerated equipment installed in the vessel produces RSW.

1.2.3 Freezing
Preservation of fish and fishery products for longer periods can be achieved by freezing. Freezing is the process of removing heat to lower product temperature to −18°C or below. It has the advantage of minimizing microbial and enzymatic activity. Microbial and enzymatic activities are limited by lowering temperature and water activity. Many