Fish processing

George M. Pigott & R. Paul Singh

The word *fish* is commonly used to describe all forms of edible finfish, mollusks (e.g., clams and oysters), and crustaceans (e.g., crabs and lobsters) that inhabit an aquatic environment.

Handling Of Harvested Fish

The retention of nutritional properties and product quality of fish is dependent on proper handling of the **catch** after it has been harvested from its aquatic environment.

CHILLING

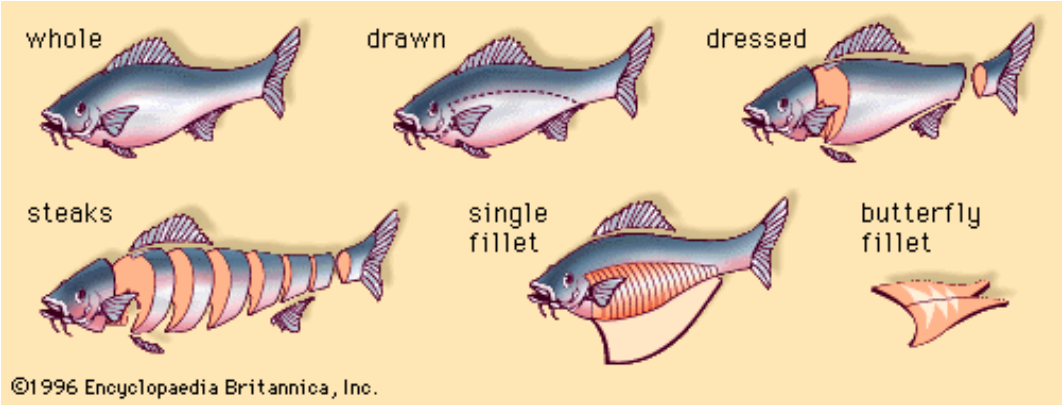
Harvested fish must be immediately stored in a low-temperature environment such as ice or refrigerated seawater. This chilling process slows the growth of microorganisms that live in fish and inhibits the activity of enzymes. Because fish have a lower body temperature, softer texture, and less connective tissue than land animals, they are much more susceptible to microbial contamination and structural degradation. If immediate chilling is not possible, then the fish must generally be sold and eaten on the day of the harvest.

Ice cooling and holding normally requires a one-to-one or one-to-two weight ratio of ice to fish, depending on the specific geographic location and the time it takes to transport the fish to the processing plant. Refrigerated seawater cooling and holding causes less bruising and other structural damage to the fish carcasses than ice cooling. However, fish cooled in refrigerated seawater absorbs salt from the water. For this reason fish that is destined for sale on the fresh or frozen market may be held in refrigerated seawater for only a limited amount of time. The addition of salt during canning or smoking processes is adjusted in order to compensate for any absorbed salt.

PREPROCESSING

Preprocessing of fish prepares the raw material for final processing. It is often performed on shipboard or in a shore-based plant and includes such operations as inspection, washing, sorting, grading, and butchering of the harvested fish.

The butchering of fish involves the removal of nonedible portions such as the viscera, head, tail, and fins. Depending on the butchering process, as much as 30 to 70 percent of the fish may be discarded as waste or reduced to cheap animal feed. The lower figure applies when the fish is canned or sold as “whole.” The higher figure applies when the fish is filleted or made into other pure meat products; in these cases the skeleton is discarded with as much as 50 percent of the edible flesh attached.



Final Processing Of Fish

The four basic procedures used in the final processing of fish products are heating, freezing, controlling water activity (by drying or adding chemicals), and irradiating. All these procedures increase the shelf life of the fish by inhibiting the mechanisms that promote spoilage and degradation. Each of these procedures also has an effect on the nutritional properties of the final product.

Canning

The canning process is a sterilization technique that kills microorganisms already present on the fish, prevents further microbial contamination, and inactivates degradative enzymes. In this process fish are hermetically sealed in containers and then heated to high temperatures for a given amount of time. Canned fish can be stored for several years. However, sterilization does not kill all microorganisms, and bacterial growth and gas production may occur if the products are stored at very high temperatures.

Freezing

Of the many processing methods used to preserve fish, only freezing can maintain the flavour and quality of fresh fish. Freezing greatly reduces or halts the biochemical reactions in fish flesh. For instance, in the absence of free water, enzymes cannot react to soften and degrade the flesh. The three steps for freezing fish include immediate cooling and holding, rapid freezing, and cold storage. If fish is frozen improperly, structural integrity may be compromised because of enzymatic degradation, texture changes, and dehydration.

Immediate cooling

The rapid cooling and holding of fish at temperatures between 2 and –2 °C (36 and 28 °F) takes place immediately after the fish have been harvested.

Rapid freezing

The key to freezing is rapid reduction of the temperature to between –2 and –7 °C (28 and 20 °F). This temperature range represents the zone of maximum ice crystal formation in the cells of the flesh. If water in the cells freezes quickly, then the ice crystals will remain small and cause minimal damage to the cells. However, slow freezing results in the formation of large ice crystals and the rupturing of the cell membranes. When slow-frozen flesh is thawed, the ruptured cells release water (called drip) and many compounds that provide certain flavour characteristics of fish, resulting in a dry, tasteless product. Fish that passes through the zone of maximum ice crystal formation in less than one hour will generally have minimum drip loss upon thawing.

Cold storage

Once fish is frozen, it must be stored at a constant temperature of –23 °C (–10 °F) or below in order to maintain a long shelf life and ensure quality. A large portion of fresh fish is water (e.g., oysters are more than 80 percent water). Because the water in fish contains many dissolved substances, it does not uniformly freeze at the freezing point of pure water. Instead, the free water in fish freezes over a wide range, beginning at approximately –2 °C (28 °F). The amount of remaining free water decreases until the product reaches a temperature of approximately –40 °C (–40 °F). Fish held below that temperature and packaged so as not to allow water loss through sublimation can be stored for an indefinite period. Unfortunately, there are relatively few commercial freezers capable of storing fish at -40° because of the tremendous variation in energy costs. Fish are therefore normally stored at –18 to –29 °C (0 to –20 °F), resulting in a variable shelf life ranging from a few weeks to almost one year.

Controlling water activity

Reducing the water activity of fish inhibits the growth of microorganisms and slows the chemical reactions that may be detrimental to the quality of the fish product. The control of water activity in fish is accomplished by drying, adding chemicals, or a combination of both methods.

Drying

The principal methods of drying, or dehydrating, fish are by forced-air drying, vacuum drying, or vacuum freeze-drying. Each of these methods involves adding heat to aid in the removal of water from the fish product. During the initial stages of drying, known as the constant-rate period, water is evaporated from the surface of the product and the temperature of the product remains constant. In the final stages of drying, known as the falling-rate period, the temperature of the product increases, causing water to move from the interior to the surface for evaporation.

Curing

Curing reduces water activity through the addition of chemicals, such as salt, sugars, or acids. There are two main types of salt-curing used in the fish industry: dry salting and pickle-curing. In dry salting the butchered fish is split along the backbone and buried in salt (called a wet stack). Brine is drained off until the water content of the flesh is reduced to approximately 50 percent (the typical water content of fresh fish is 75 to 80 percent) and the salt content approaches 25 percent. In heavy or hard-cure salting, an additional step is taken in which warm air is forced over the surface of the fish until the water content is reduced to about 20 percent and the salt content is increased to approximately 30 percent. Most dry-salted fish products are consumed in warm, humid countries or in areas that have few means of holding products in refrigeration or cold storage.

Smoking

Traditionally, smoking was a combination of drying and adding chemicals from the smoke to the fish, thus preserving and adding flavour to the final product. However, much of the fish smoked today is exposed to smoke just long enough to provide the desired flavour with little, if any, drying.

The smoking process consists of soaking butchered fish in a 70 to 80 percent brine solution for a few hours to overnight, resulting in a 2 to 3 percent salt content in the fish. The fish are then partially dried on racks. As the brine on the surface dries, dissolved proteins produce a glossy appearance, which is one of the commercial criteria for quality. Smoking is carried out in kilns or forced-air smokehouses that expose the fish to smoke from smoldering wood or sawdust. In cold-smoking the temperature does not exceed 29 °C (85 °F), and the fish is not cooked during the process. Hot-smoking is more common and is designed to cook the fish as well as to smoke it.