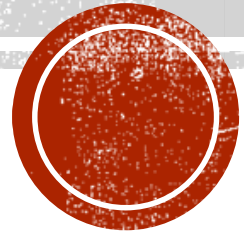
FREEZİNG AND FROZEN STORAGE



11. Week

Freezing

Fish is largely water, normally 60-80 percent depending on the species and the freezing process converts most of this water into ice. Freezing requires the removal of heat and fish from which heat is removed falls in temperature. During the first stage of cooling the temperature falls fairly rapidly to just below 0°C, the freezing point of water. As more heat requires to be extracted during the second stage, in order to turn the bulk of the water to ice, the temperature changes by a few degrees and this stage is known as the period of thermal arrest.

The factors associated with freezing and frozen storage. These are;

- The initial quality of fish and freshness,
- rigor mortis,
- Freezing rate, storage temperature,
- Storage time

As the water in fish freezes out as pure crystals of ice, the remaining unfrozen water contains an ever increasing concentration of salts and other compounds which are naturally present in fish flesh.

Freezing methods

- Slow freezing
- Quick freezing
- double freezing

Slow freezing, however, does result in an inferior quality product and this is now thought to be due mainly to denaturation of the protein. As the water is frozen out as püre ice crystals, the higher concentration of compounds in the unfrozen portion will result in an increase in the rate of denaturation.

Since the temperature just below 0°C is the critical zone for spoilage by protein denaturation, quick freezing recommended that all the fish should be reduced from a temperature of 0°C to -5°C in 2h or less. The fish should then be further reduced in temperature so that its average temperature at the end of the freezing process is equivalent to the recommended storage temperature of -30 °C.

Slow freezing resulted in the formation of large ice crystals which damaged the walls of the cells. This would then result in a considerable loss of fluid when the fish was thawed. The smaller ice crystals formed, when fish is frozen quickly were thought to do little damage to the cell walls and as a result little fluid was lost on thawing.

Difference in size of crystal probably accounts for some of the differences between slow and quick freezing. The walls of fish muscle are sufficiently elastic to accommodate the larger ice crystals without excessive damage. Also, most of the water in fish muscle is bound to the protein in the form of a gel and little fluid would be lost even if damage of the above nature did ocur.

Freezing and frozen storage of fish can give a storage life of more than one year, if properly carried out. It has enabled fishing vessels to remain at sea for long periods and allowed the stockpiling of fish during periods of good fishing and high catching rates as well as widened the market for fish products of high quality.

The mechanism by which frozen fish deteriorates is somewhat different from that causing spoilage of chilled fish. Provided the temperature is low enough below -10 °C and bacterial action will be stopped by the freezing process. Chemical, biochemical and physical processes leading to irreversible changes will still ocur, but at a very slow rate.

The spoilage of fish due to protein denaturation, fat changes and dehydration can all be slowed down by reducing the storage temperature. Fish recommends that frozen fish products should be stored at temperatures appropriate for the species, type of product and intended time of storage. The International Institute of Refrigeration recommends a storage temperature of -18 °C for lean fish such as cod and haddock and -24 °C for fatty species such as herring and mackerel.

Factors limiting the storage life;

- ✓ Protein changes
- ✓ Fat changes
- ✓ Colour changes
- ✓ Dehydration changes

Glazing

The application of a layer of ice to the surface of a frozen product by spraying, brushing on water or by dipping, is widely used to protect the product from the effects of dehydration and oxidation during cold storage. The ice layer sublimes rather than the fish below and it also excludes air from the surface of the fish and thereby reduces the rate of oxidation.

The amount of glaze applied depends on those factors;

- *Glazing time*
- *Fish temperature*
- *Water temperature*
- *Product size*
- *Product shape*