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Physical, chemical, microbiological and sensory changes during handling, chill storage and refrigerated storage of fishes

Introduction

- The chilling of fish is a process by which temperature of a fish is reduced close to but not below freezing point of water (0°C). It delays both biochemical and bacteriological process in fish and consequently prolongs the storage of fish and fish products. So long as the chill temperature is maintained, deteriorative changes in fish remain retarded. Quality of chilled products depend mainly on the initial quality of raw fish, method and duration of chilling and efficient storage. The main merit of the method is that it provides the maximum possibility of preserving the natural nutritional and functional properties of the fish. Fish may be chilled by ice or by a homogeneous coolant such as cold air or cold liquid (fresh water, brine or seawater). For chilling fish on board of a fishing vessel, ice, CSW, CFW, RSW or cold water is used.
- Chilling is an effective way of reducing spoilage if done quickly and handled carefully & hygienically. The objective is to cool fish as quickly as possible, to as low a temperature as possible, without freezing. Chilling cannot prevent spoilage, but the colder the fish the greater the reduction in bacterial and enzyme activity.
- Chilling leads to various changes according to the initial condition of the fish. Some of the general factors affecting the chilling process are as follows:

Factors affecting the changes during chilling process

- **i. Species (Marine/ freshwater)**
 - Marine fish are more prone to spoilage during chilling due to a high content of TMA which is converted into TMAO by the bacteria. In the case of freshwater fish there is an antimicrobial covering on the skin which is absent in marine fishes. Moreover marine shrimp are more quickly damaged due to high amino acid content leading to softening of the muscle.
- **ii. Size**
 - It is found that larger fish get spoiled slower than the smaller fishes. As smaller fishes are tendered in nature and their skin not that tough, they easily get bruised and hence accelerate spoilage.
- **iii. Method of capture and handling**
 - The quality of chilled fish largely depends on the method of capture and handling. How carefully and properly they are handled will be reflected during the storage life. If the fish is undergoing physical deformities from the beginning itself, then it will get damage sooner.
- **iv. Fat content**
 - Fatty fish start spoiling faster than the lean fish. Their abdomen will become soft and sometimes belly bursting occurs. Due to fat content their muscle are more soft and susceptible to digestive enzymes.
- **v. Type of ice**
 - If the edge of the ice is sharp and rough then physical damage may occur during chilling. It may puncture the skin and give way to microbes to enter into the flesh. So the storage life will be affected.

Physical changes:

- **i. Color:** While chilling there is a color change of the fish. They become discolored from natural color. The pigments may get oxidized or affected by some other factors.
- **ii. Texture:** The texture becomes harder due to stiffening of the muscle during rigor mortis process. This happens since the protein gets denatured and actin and myosin fail to slide leading no contraction and relaxation.
- **iii. Eyes, skin, scales:** Due to longer chilled storage the eyes structure become concave. The scales will get removed and the skin become bare which is undesirable and not economic.
- **iv. Weight loss:** Weight loss occurs due to leaching of amino acids (shrimp), WSP and vitamins from the fish body when the ice melts.

Biochemical changes:

- i. Moisture content: During iced storage moisture contents of both freshwater and marine water species showed a small but erratic, mostly increase fluctuation. With fillets of ghol whether wrapped or unwrapped, cultured Rohu and a few species of major carps, moisture content showed a minor increase at the beginning followed by a decrease.
- ii. TVB content: Least concern with Freshwater fish. Marine water fish show increase after 3 days or more. Used for the assessment of degree of freshness.
- iii. NPN content: Both Freshwater and Marine water show gradual decrease during ice storage. This shows deterioration of flavor.
- iv. Alpha amino nitrogen: AAN content of freshwater murrel and brackish water milkfish in unpacked condition showed a gradual decrease during the period of ice storage.
- v. Total nitrogen/ Protein: In the limited number of cases where data are available, total nitrogen / protein content in most of the cases decreased substantially during iced storage. This decrease may be mainly due to the loss of soluble protein components.

Biochemical changes:

- vi. Water soluble and sarcoplasmic protein content : Leach out when the ice is melting and hence decrease.
- vii. Salt-soluble protein content : Most of the species of tropical fish examined showed decrease in salt-soluble/ myofibrillar protein fraction at the end of ice storage period.
- viii. TMAO : As TMA is degraded into TMAO by the bacteria its quantity increases indicating spoilage condition.
- ix. FFA : Due to lipid oxidation the FFA increases after a longer period of ice storage.
- x. ATP degradation : While rigor mortis process ATP is degraded and hypoxanthine is formed which is bitter in taste. More amount of hypoxanthine indicates higher degree of spoilage.

Types of ice used for chilling:

- Block ice: widely used due to many reasons
- Crushed block ice
- Flake ice: most preferred and considered the best ice.
- Plate ice
- Tube ice

Chilled foods:

- **i. Controlled atmosphere storage**
 - Atmosphere differs from ambient air. Low oxygen and/or high Carbon dioxide
- **ii. Modified atmosphere storage**
 - Pack flushed with a pre-mixed gas. Differs from CA above in that no correction takes place in the storage period.
- **iii. Modified Atmosphere Packing**
 - The same as Modified Atmosphere Storage above.
 - Used extensively in the UK retail trade for extension of shelf-life, especially for the fish trade.

Summary:

- Keep fish cool - $< 4^{\circ}\text{C}$
- Use potable water for ice
- Maintain chill temperatures