Unit – I: Handling and Principles of Fish Preservation

1.1 Handling of Fresh Fish, Storage and Transport of Fresh Fish

Fish is among the most perishable of all food materials because of its high water content (approximately 70–80%), neutral pH, and the presence of easily digestible proteins and unsaturated fats. Immediately after capture, several biological and chemical changes begin in fish tissue, making proper handling and preservation essential to maintain freshness, quality, and nutritional value. The first and most critical step in fish preservation is proper handling from the moment of capture until processing or marketing.

Handling of fish begins right on the fishing vessel or landing centre. The fish should be handled hygienically, avoiding contamination from unclean surfaces, equipment, or human contact. Freshly caught fish should be washed thoroughly with clean seawater or potable water to remove slime, scales, blood, and surface microorganisms. Rough handling such as throwing or piling can damage the delicate flesh, causing bruising and breakage, which accelerates spoilage. Fish should always be shaded from direct sunlight and kept cool immediately after catching.

Storage of fresh fish plays a vital role in maintaining quality. Once captured, fish should be chilled as soon as possible to a temperature close to 0°C. Icing is the most common method used for short-term storage, especially in tropical regions. Crushed ice is preferred as it melts evenly and absorbs heat rapidly. The fish are arranged in layers alternating with layers of ice in insulated boxes, baskets, or containers. The general ratio of ice to fish is about 1:1 by weight. This method maintains fish freshness for one to two days, depending on the species and ambient conditions. For longer storage or during transportation, mechanical refrigeration is used. Refrigerated seawater systems and ice-slurry methods are advanced forms of cooling used on large fishing vessels.

Transportation of fresh fish requires maintaining low temperature throughout the journey. For short distances, insulated boxes with sufficient ice are adequate, but for longer distances, refrigerated trucks or vans are necessary. The packaging should be leak-proof and insulated to prevent temperature fluctuations. Transportation by air is also used for high-value fish species like tuna and salmon, where maintaining freshness is critical. In all cases, time, temperature, and hygiene are the key factors to prevent spoilage and ensure the fish reaches the consumer in good condition.

1.2 Post-Mortem Changes in Fish: Rigor Mortis and Spoilage

Once fish dies, several physiological and biochemical changes occur in its tissues, collectively known as post-mortem changes. These changes affect the texture, flavour, odour, and overall quality of the fish. The most important post-mortem phenomenon is rigor mortis, followed by autolysis and bacterial spoilage.

Rigor mortis is the stiffening of muscles that occurs after death. In the living state, muscle flexibility depends on adenosine triphosphate (ATP), which enables the muscle fibres actin and myosin to remain separate. After death, respiration stops, oxygen supply ceases, and ATP is no longer synthesized. As ATP levels decline, actin and myosin combine to form actomyosin, causing the muscles to stiffen. This phase is known as rigor mortis. The onset and duration of rigor mortis depend on species, size, temperature, and the physical condition of the fish. Generally, it begins a few hours after death and lasts for 6 to 24 hours. During rigor mortis, the fish remains firm and elastic. Once rigor passes, the fish becomes soft and flabby, and spoilage begins.

After rigor mortis, autolytic enzymes such as proteases, lipases, and cathepsins, which are naturally present in the fish tissues, start breaking down proteins and fats. This process leads to softening of the flesh, release of odorous compounds, and a decrease in pH. These changes make the tissue more susceptible to bacterial invasion. Microorganisms, especially psychrophilic bacteria like Pseudomonas and Shewanella, grow rapidly at warm temperatures and cause visible and olfactory signs of spoilage such as slime formation, discoloration, and foul odour.

1.3 Spoilage in Marine Fish and Freshwater Fish

Both marine and freshwater fishes undergo spoilage through similar biochemical and microbiological mechanisms, though the specific spoilage organisms differ due to habitat conditions. Marine fish contain trimethylamine oxide (TMAO), which is reduced by bacteria to trimethylamine (TMA), producing the typical “fishy” odour during spoilage. Spoilage bacteria commonly found in marine fish include Vibrio, Pseudomonas, Shewanella putrefaciens, and Photobacterium. These bacteria thrive in saline environments and are responsible for the characteristic off-odours, slime, and surface discoloration in marine fish.

In contrast, freshwater fish contain bacteria such as Aeromonas, Flavobacterium, Micrococcus, and Bacillus. These species are not halophilic but can rapidly multiply at moderate temperatures, leading to sour odour, soft texture, and surface slime. Spoilage in both types of fish can be categorized into three stages. The first stage involves autolysis and the release of amino acids and peptides; the second stage involves bacterial decomposition producing ammonia and amines; and the third stage includes oxidative rancidity, especially in fatty fishes, due to the breakdown of unsaturated lipids.

Temperature plays a decisive role in the spoilage rate. At ambient tropical temperatures, spoilage can occur within 12 hours, whereas at 0°C it may take 2 to 3 days. Hence, immediate icing or chilling after capture is vital for maintaining freshness. Delayed chilling or rough handling accelerates spoilage, leading to economic losses and food safetyrisks.

1.4 Principles of Fish Preservation

The basic principle of fish preservation is to inhibit or slow down the activity of spoilage agents such as microorganisms, enzymes, and chemical reactions. Preservation methods are based on physical, chemical, or biological principles, and they aim to extend the shelf life while retaining nutritional and sensory quality.

The first step in any preservation process is cleaning. Thorough washing removes mucus, blood, scales, and contaminants that harbour bacteria. Cleaning also improves the appearance and acceptability of the product. Lowering of temperature is one of the most effective preservation methods. Chilling, icing, and freezing reduce the metabolic and microbial activities that cause spoilage. Chilling maintains fish in a near-fresh state for short periods, while freezing at –18°C or lower can preserve fish for several months by halting microbial growth and enzyme activity.

Raising of temperature through cooking, boiling, smoking, or canning destroys microorganisms and enzymes completely. Canning, for instance, involves heating fish in airtight containers to temperatures of 115–121°C under pressure, ensuring long-term preservation. Denudation, which involves removal of the skin and scales, is sometimes used before preservation to reduce bacterial contamination and improve product quality.

Salting is an age-old technique that relies on osmotic pressure. Salt draws out moisture from the fish tissues, creating conditions unfavorable for bacterial survival. The method is economical and commonly used for coastal fish preservation. Chemical preservatives like sodium benzoate and formaldehyde (under controlled limits) may be used to inhibit microbial growth. Natural preservatives derived from plant extracts and organic acids are gaining popularity due to health and environmental concerns.

Gamma radiation is a modern preservation method that involves exposing fish to controlled doses of ionizing radiation. This process destroys spoilage microorganisms and parasites without significantly affecting the sensory properties or nutritional value of the fish.

In conclusion, fish preservation combines traditional wisdom and modern technology to prevent spoilage and ensure safe, high-quality fish for consumers. Efficient handling, proper storage, and the scientific application of preservation principles are crucial for sustaining the fisheries industry and reducing post-harvest losses.