SNS COLLEGE OF TECHNOLOGY

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COIMBATORE-641 035, TAMIL NADU

DEPARTMENT OF FOOD TECHNOLOGY

19FTE402- MEAT, FISH AND POULTRY PROCESS TECHNOLOGY

Unit 2- Fish Processing

Topic 4 – Spoilage of Fish

Fish is one of the most consumed seafood and it is a highly perishable food product. Fish and fish products are widely consumed as it is a good nutrition source due to their high protein content, unsaturated fatty acids, especially omega-3 fatty acids. The biological and chemical nature of fish leads to its deterioration after it is caught. The spoilage process (Rigor mortis) will start within 12 h.The deterioration occurs very quickly due to the metabolic activity of microorganisms, endogenous enzymatic activity (autolysis), and the chemical oxidation of lipids.

Contamination source of fish:

- Environmental factors.
- Equipment used such as catch boxes, bins, holds, dressing surfaces, decks, and cutlery handles.
- Water used for washing fish and cleaning the equipment.
- Method of harvesting, season handling, and processing.

Spoilage of fish :

- Fish contain important nutritional and digestive proteins, essential amino acids, lipid-soluble vitamins, micronutrients, and highly unsaturated fatty acids.
- It contains water (75–85%) and has a high water activity (0.98–0.99) which makes it prone to microbial growth.
- There are three modes of fish spoilage: Oxidation, Enzymatic and Microbial spoilage.

1. Oxidative spoilage

- Lipid oxidation is a major cause of deterioration and spoilage of fish that contain high oil/fat content stored fat in their flesh.
- Oxidation typically involves the reaction of oxygen with the double bonds of fatty acids.
- In fish, lipid oxidation can occur enzymatically or non-enzymatically.

- Lipid oxidation promotes protein denaturation, modification of the protein, electrophoretic profiles, nutritional losses, and endogenous antioxidant systems losses.
- Lipid hydrolysis and oxidation cause "belly burst" in fish in which the enzymes and microorganisms of the digestive tract cause massive gas development.

2. Enzymatic spoilage

- After capture, biological and chemical changes take place in dead fish due to the action of various enzymes found in fish.
- The digestive enzymes cause extensive autolysis which results in fish muscle softening, rupture of the belly wall, and drain out of the blood.
- Several proteolytic enzymes are found in fish that contribute to degradation in fish muscle and fish products during storage and processing.
- Proteolysis is responsible for the degradation of proteins which leads to fish spoilage by microbial growth.
- The changes in fish caused due to the various enzymes found in fish are:

Enzymes	Substrate	Effect
Glycolytic enzymes	Glycogen	Lactic acid production resulting in pH drop
Nucleotide breakdown enzymes	ATP, ADP, AMP, IMP	Gradual production of Hypoxanthine
Cathepsins	Proteins, peptides	Softening of tissue
Chymotrypsin, trypsin, carboxypeptidases	Proteins, peptides	Belly-bursting
Calpain	Myofibrillar proteins	Softening of tissue
Collagenases	Connective tissue	Softening and gaping of tissue
TMAO demethylase	Trimethylamine oxide (TMAO)	Formaldehyde production ATP

3. Microbial growth

- Fish flesh is composed of protein, fats, carbohydrates, water, and amino acid compounds such as trimethylamine oxide (TMAO), urea, taurine, creatine, free amino acids, and trace glucose, etc.
- The internal tissue of fish is generally considered sterile. Bacteria are present on the slime layer of the skin, gill surfaces, and the intestine.

- The microbial growth in fish is the main cause of fish spoilage and produces amines, biogenic amines, organic acids, alcohols, aldehydes, and ketones with unpleasant and off- flavors.
- The high water activity, low acidity (pH > 6) of fish result in the fast growth of microorganisms that leads to undesirable changes in appearance, texture, flavor, and odor, reducing its quality.
- At room temperature, Bacillus, Clostridium, Escherichia, Micrococcus, Proteus, Sarcina, and Serratia may predominate.
- For unpreserved fish, spoilage is caused by Gram-negative, fermentative bacteria (such as Vibrionaceae), whereas psychrotolerant Gram-negative bacteria (such as Pseudomonas spp. and Shewanella spp.) tend to spoil chilled fish.
- The fish spoilage is also caused by psychrotrophic, aerobic, or facultative anaerobic Gram- negative bacteria such as Pseudomonas, Moraxella, Acinetobacter, Shewanella putrifaciens, Vibrio, Flavobacterium, Photobacterium, and Aeromonas Gram-positive bacteria such as Staphylococcus spp., Micrococcus, Bacillus, Clostridium, Corynebacterium, Brochothric thermosphacta, and Streptococcus are found in fish. Lactic acid bacteria (LAB) can predominate in fish storage under vacuum or CO2 storage.
- Some parasites can also be transmitted by fish, including tapeworm (Diphyllobothrium latum), nematodes (Anisakis simplex and Capillaria philippinensis), and trematodes (Opisthorchis and Paragonimus).
- Spoilage compounds are produced by microorganisms during the storage of fresh fish.

Spoilage bacteria	**Spoilage compounds produced**
Shewanella putrefaciens	TMA, H2S, CH3SH, (CH3)2S, Hypoxanthine, and acids
Pseudomonas spp., *Enterobacteriaceae*	CH3SH, (CH3)2S, ketones, esters, aldehydes, NH3, and hypoxanthine
Photobacterium phosphoreum	TMA and hypoxanthine
Vibrionaceae	TMA and H2S
Lactic acid bacteria	H2S, ketones, esters, aldehydes, NH3, and acids
Yeast, Anaerobic rods	Ketones, esters, aldehydes, NH3, and acids
Aerobic spoilers	NH3, acetic, butyric, and propionic acids