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Course Code : BC001VAC

Unit – III
FISH AND MEAT

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QUALITY ASSESMENT OF FISH

INTRODUCTION OF FISH SPOILAGE

- Fresh fish spoilage can be very rapid after it is caught. The spoilage process (Rigor mortis) will start within 12 h of their catch in the high ambient temperatures of the tropics
- Rigor mortis is the process through which fish loses its flexibility due to stiffening of fish mussels after few hour of its death .
- Most fish species degrade as a result of digestive enzymes and lipases, microbial spoilage from surface bacteria and oxidation .
- During fish spoilage, there is a breakdown of various components and the formation of new compounds.

- These new compounds are responsible for the changes in odour, flavor and texture of the fish meat.
- Compositional changes during fish spoilage result

in lipid oxidation and protein degradation as well as the loss of other valuable molecules.

- In order to develop optimum preservation techniques for these value added products in active forms, understanding of the mechanism responsible for their degradation is essential.
- This review will focus on basic mechanisms of fish spoilage, preservation of fish with low temperature storage and comprehensive analysis of chemical preservation methods.

SPOILAGE OF FISH AND ITS TYPES

- **Fish spoilage results from three basic mechanisms**
  - **Enzymatic autolysis**
  - **Oxidation**
  - **Microbial growth**

Autolytic enzymatic spoilage:

1. Autolytic enzymatic Shortly after capture, chemical and biological changes take place in dead fish due to enzymatic breakdown of major fish molecules (FAO, 2005).
2. Hansen et al. (1996) stated that autolytic enzymes reduced textural quality during early stages of deterioration but did not produce the characteristic spoilage off-odors and off-flavors.
3. This indicates that autolytic degradation can limit shelf-life and product quality even with relatively low levels of spoilage organisms.
4. The autolytic changes that occur in chilled/frozen fish are summarized in Table 2 (FAO, 2005). Most of the impact is on textural quality along with the production of hypoxanthine and formaldehyde.
5. The digestive enzymes cause extensive autolysis which results in meat softening, rupture of the belly wall and drain out of the blood water which contains both protein and oil (FAO, 1986).

6. A number of proteolytic enzymes are found in muscle and viscera of the fish after catch.

7. These enzymes contribute to post mortem degradation in fish muscle and fish products during storage and processing.

8. There is a sensorial or product associated alteration that can be contributed by proteolytic enzymes (Engvang and Nielsen, 2001).

9. During improper storage of whole fish, proteolysis is responsible for degradation of proteins and is followed by a process of solubilization (Lin and Park, 1996).

12. Martinez and Gildberg (1988) reported that the rate of degradation by proteolytic enzymes was reduced when the fish was kept at 0°C and a pH of 5.

10. On the other hand, peptides and free amino acids can be produced as a result of autolysis of fish muscle proteins, which lead towards the spoilage of fish meat as an outcome of microbial growth and production of biogenic amines (Fraser and Sumar, 1998).

11. Belly bursting is caused by leakage of proteolytic enzymes from pyloric caeca and intestine to the ventral muscle. The proteases have optimal pH in the alkaline to neutral range.

Oxidative spoilage:

1. Lipid oxidation is a major cause of deterioration and spoilage for the pelagic fish species such as mackerel and herring with high oil/fat content stored fat in their flesh (Fraser and Sumar, 1998).
2. Lipid oxidation involves a three stage free radical mechanism: initiation, propagation and termination (Frankel, 1985; Khayat and Schwall, 1983).
3. Initiation involves the formation of lipid free radicals through catalysts such as heat, metal ions and irradiation.
4. These free radicals which react with oxygen to form peroxyl radicals. During propagation, the peroxyl radicals reacting with other lipid molecules to form hydroperoxides and a new free radical (Fraser and Sumar, 1998; Hultin, 1994).

5. Termination occurs when a build up of these free radicals interact to form non radical products.
6. Oxidation typically involves the reaction of oxygen with the double bonds of fatty acids. Therefore, fish lipids which consist of polyunsaturated fatty acids are highly susceptible to oxidation.
7. Molecular oxygen needs to be activated in order to allow oxidation to occur. Transition metals are primary activators of molecular oxygen (Hultin, 1994). In fish, lipid oxidation can occur enzymatically or non-enzymatically.
8. The enzymatic hydrolysis of fats by lipases is termed lipolysis (fat deterioration). During.

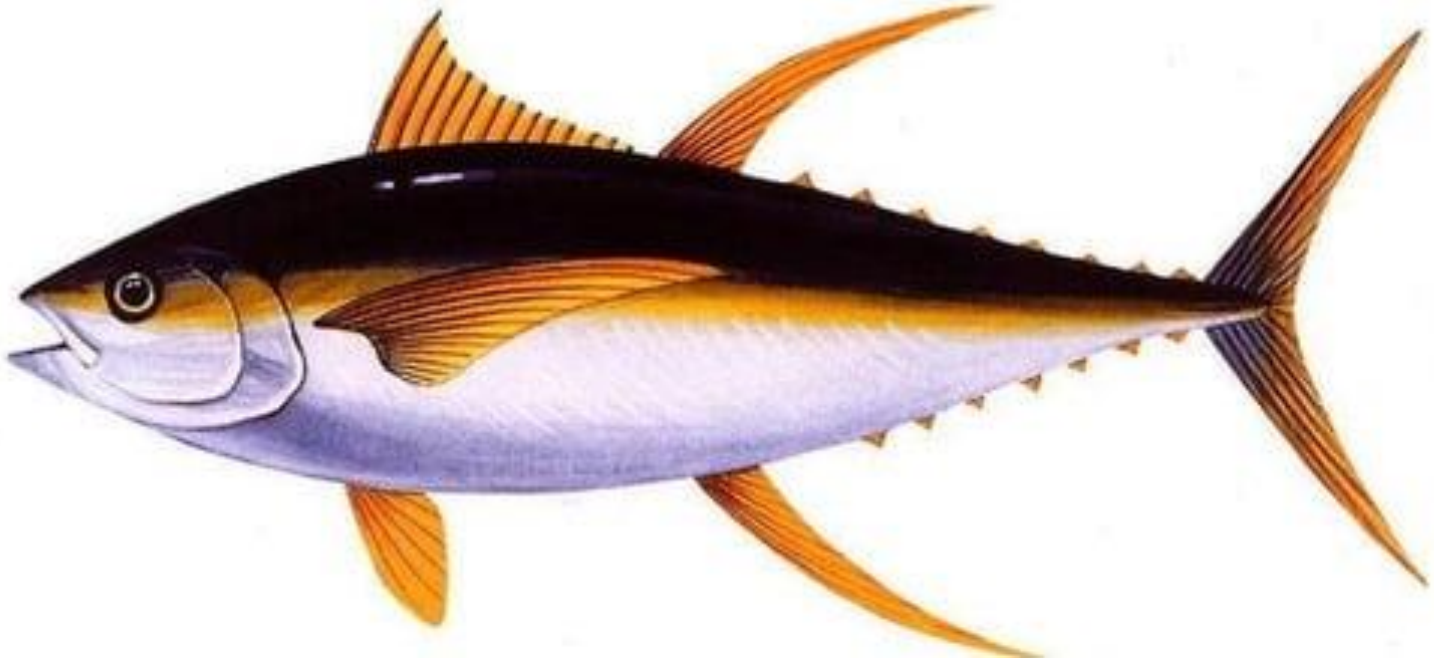
Microbial spoilage:

I. Microbial spoilage: Composition of the microflora on newly caught fish depends on the microbial contents of the water in which the fish live.

II. Fish microflora includes bacterial species such as Pseudomonas, Alcaligenes, Vibrio, Serratia and Micrococcus (Gram and Huss, 2000) Microbial growth and metabolism is a major cause of fish spoilage which produce amines, biogenic amines such as putrescine, histamine and cadaverine, organic acids, sulphides, alcohols, aldehydes and ketones with unpleasant and unacceptable off-flavors (Dalgaard et al., 2006; Emborg et al., 2005; Gram and Dalgaard, 2002).

III. For unpreserved fish, spoilage is a result of Gram-negative, fermentative bacteria (such as Vibrionaceae), whereas psychrotolerant Gram-negative bacteria (such as Pseudomonas spp. and Shewanella spp.) tend to spoil

Utilization of Fish wastes



Introduction

- About 70% of the fish is processed before final sale.
- Processing of fish involves stunning, grading, slime removal, de-heading, washing, scaling, gutting, cutting of fish, meat bone separation and steaks and filet.
- During these steps significant amount of waste (20-80% depending upon the level of processing and type of fish) is generated.
- In addition, a significant amount of the total catch from fish farming is discarded each year. Also, fish processing operation require **large volumes of potable** water which results in significant amounts of waste water .

- The majority of fish wastes are **disposed of in the ocean**.
- The aerobic bacteria present in the water **breakdown** the organic matter in the presence of oxygen leading to a considerable **reduction** of oxygen in water.
- There are also overloads of nitrogen, phosphorous and ammonia, which lead to **pH** variation, increased turbidity of the water and as a result of the decomposition of algae.
- the reduction in water oxygen content **creates an anaerobic condition** that leads to the release of foul gases such as hydrogen sulfide and ammonia, organic acids and greenhouse gases such as carbon dioxide and methane .

Fish Processing

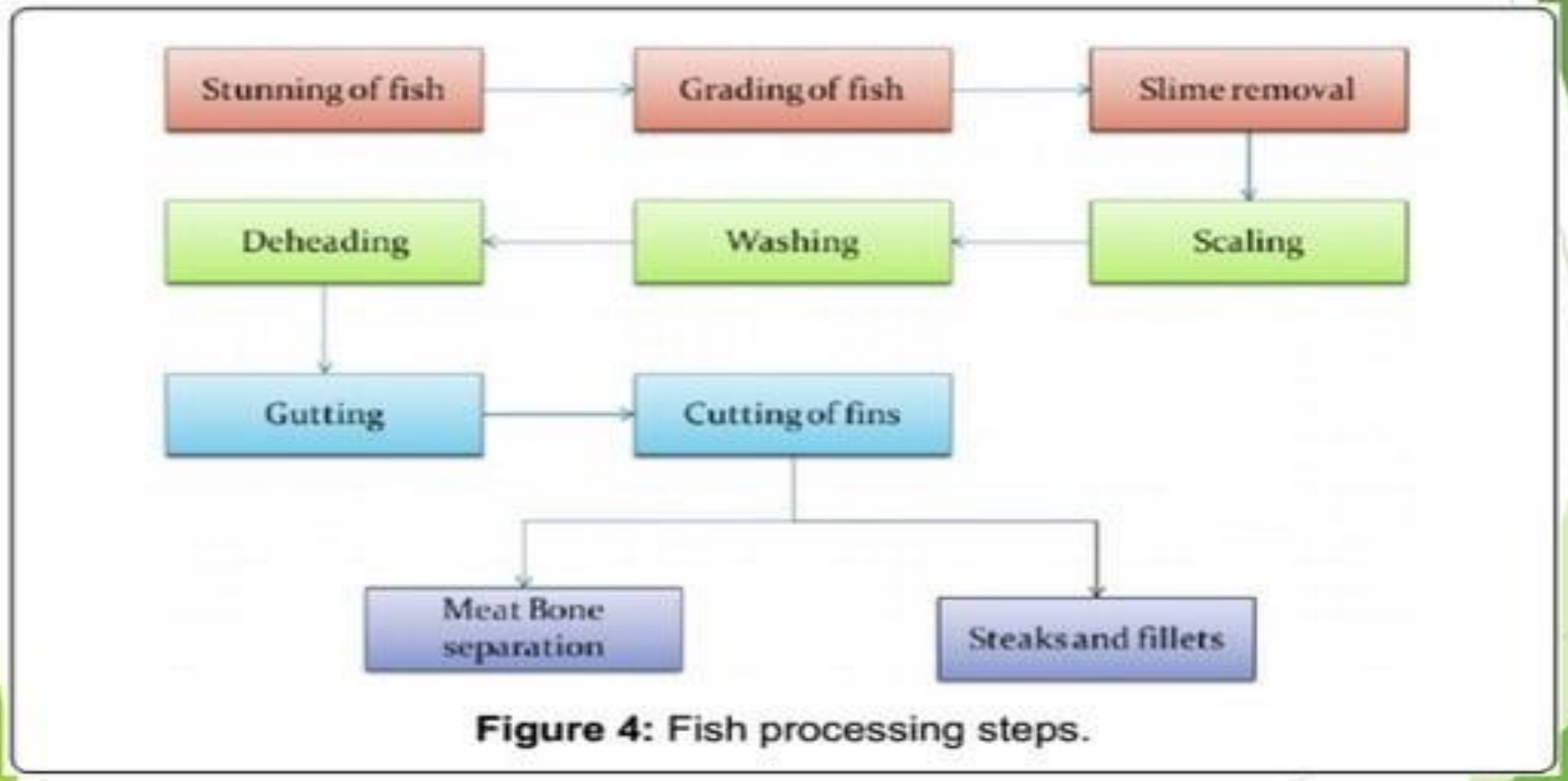


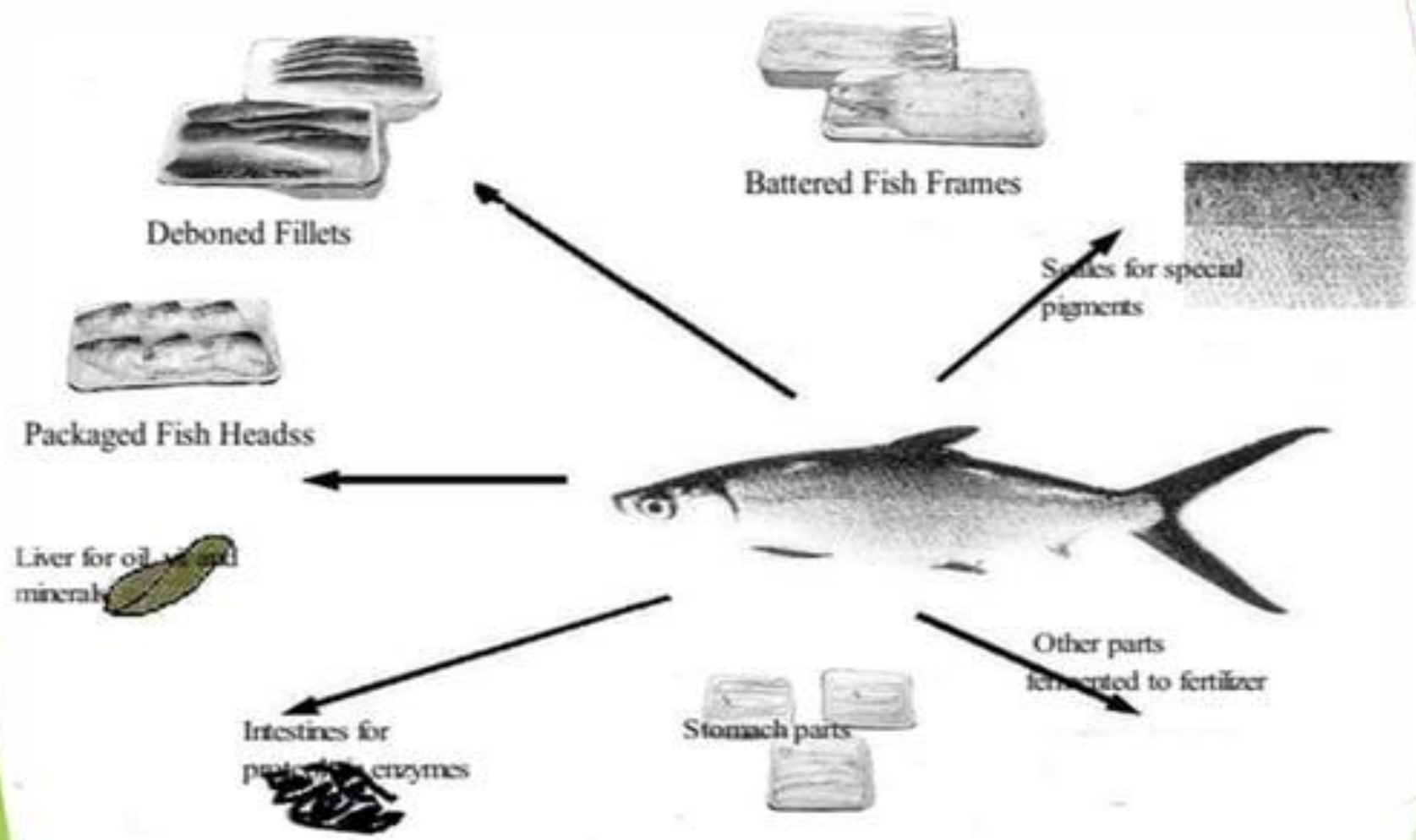
Figure 4: Fish processing steps.

Composition of Fish Waste

- the composition of the fish varies according to the type of species, **sex, age, nutritional status**, time of year and health. Most of the fish contains **15-30% protein, 0-25% fat and 50-80% moisture**
- For example:
  - Mackerel had the highest fat content (11.7%) and cod had the lowest (0.1%).
  - Salmon had the highest protein content (23.5%) and flunder had the lowest (14%).

  the moisture content of the fie fishes varied between 69 and 84.6% but the **ash content of all species was similar**.

- Solid fish waste consists of **head, tails, skin, gut, fish and frames.**
- These by products of the fish processing industry can be a great source of **value added products** such as proteins and amino acids, collagen and gelatin, oil and enzymes.
- These wastes contain proteins (58%), ether extract or fat (19%) and minerals.
- Also, mono-saturated acids, palmitic acid and oleic acid are abundant in fish waste (22%).


Deboned Fillets
Battered Fish Frames
Packaged Fish Headss
Other parts
Stomach parts

Utilization of Fish Protein

- Fish protein contains many **bio-active peptides that are easily absorbed** and can be used for various metabolic activities.
- They can be used as a functional ingredient in many food items as they have properties such as **water holding capacity, oil absorption, gelling activity, foaming capacity and emulsifiation property.**
- Kristinsson and Rasco reported that fish protein hydrolysate can be used as a **milk replacer** with high protein Efficiency ratio (PER) value and in a cost effective manner than dried skimmed milk.

- Due to its rich amino acid composition, fish protein can be as **supplementing cereal proteins and can be used in bakery products, soups and infant formulas**.
- It is also reported that fish proteins can serve as **nitrogen source for the growth of micro organisms** for the production of extracellular lipases .
- the fish protein hydrolysates also possess various bio-activities such as **antioxidative, antithrombic and antihypertensive** properties

Fish protein concentrate (FPC)


KIRKLAND
MAXIMUM STRENGTH
ENTERIC COATED
Fish Oil
1700 mg Concentrated Fish Oil
with 680 mg Omega-3 Fatty Acids
per serving
Dietary Supplement
200 SOFTGELS

For bio-diesel production

- bio-diesel is comprised of **monoalkyl esters** of vegetable oils, animal fats or **fish oils** which can be synthesized from **edible, non-edible and waste oils**
- It is a **non-toxic**, **biodegradable** and **renewable** energy source.
- bio-diesel can be produced **chemically or enzymatically**.
- **Chemically**, using alkali (NaOH) as catalyst due to high conversion ratio of triglycerols (TAG) to methyl esters (bio-diesel) and low reaction times (4-10 h).
- There are several **disadvantages** using chemical catalysts including high reaction temperature, soap formation, waste generation and contamination of glycerol with alkali catalysts.

FERMENTED MEAT PRODUCT

CONTENT:

- Fermentation
- Types of Fermentation
- Types of fermented food
- Fermented meat products
- Processing of fermented meat
- Meat Processing equipment
- Types of fermented meats
- Benefits

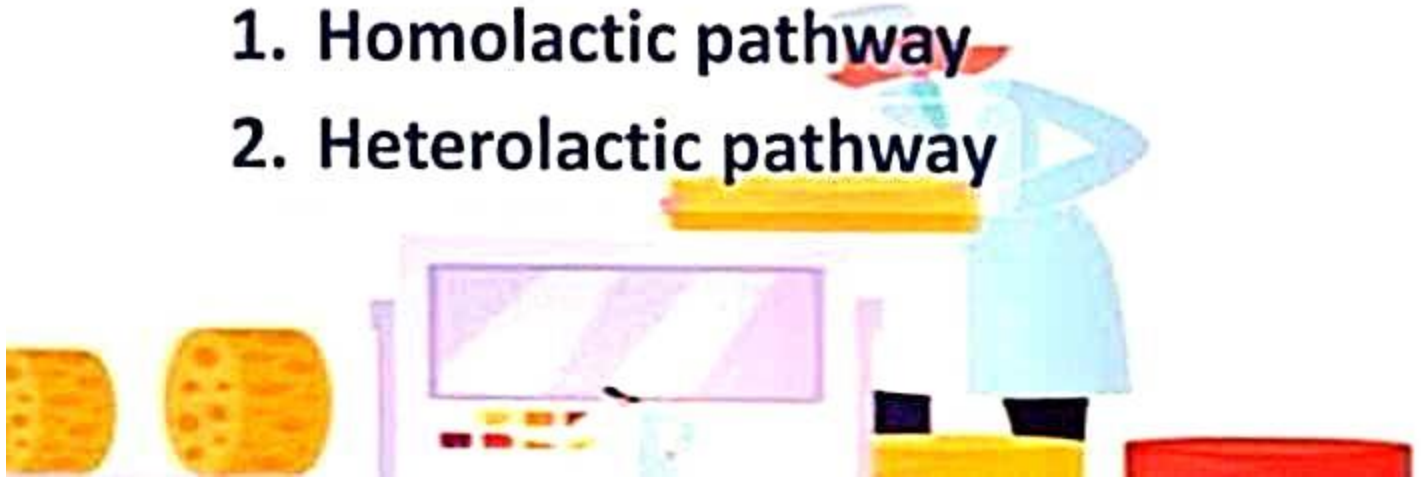
WHAT IS FERMENTATION

- Fermentation is derived from Latin verb fevereto boil .
- Fermentation has different meaning to biochemistry and industrial microbiologists.
- Also employed in preservation to create lactic acid in sour food such as pickles ,kimchi,and yogurt.
- Fermentation is a metabolic process in which an organism converts a carbohydrate such as starch or sugar into an alcohol or an acid for e.g. Yeasts perform Fermentation to obtain energy by converting sugar into alcohol .
- The science of Fermentation is known as zymology.

Types of Fermentation

- Alcoholic Fermentation
- Lactic acid Fermentation

1. Homolactic pathway
2. Heterolactic pathway



TYPES OF FERMENTED FOOD

1. **Meat analogues & substitutes:**
   Sausage,Salami, Meat, Dry meat, Pickled
2. **Acid fermented vegetables & Fruits :**
   Sauerkraut, Kimchi, Olives, Cucumbers, pickles
3. **Acid fermented legumes:**
   Soy Sauce, Tempe, Miso
4. **Cereal Products**
   Idli, Dhosa, Dhokla
5. **Alcoholic foods and Beverages:**
   Wine, Beer, Tea, coffee,Cocoa
6. **Dairy products:**
   Yogurt, Dohi, Cheese
7. **Fish products:**
   Dry Fish, Fish Pickle, Fish Sauce, Fish sausage
8. **Starch Crop Products**
   Nan, Ragi, Nata, Papadam
9. **Miscellaneous products**
   Vinegar,Pickled mushroom

Fermented meat products

- Sausages are one of the oldest form of foods consumed by humans.

- The manufacture of sausages began over two thousand years ago, and it is still a growing industry. While some of its basic practices are almost as old as civilization.

- In olden days people did not have refrigeration to preserve their meat and so making sausage was a way of overcoming this problem

PROCESSING OF FERMENTED MEAT

- The processing of fermented meat involves a series of steps.they are
- Pre – Fermentation steps
- Fermentation process
- Post – Fermentation steps
- And enhance the flavor , texture ,and nutritional value of the meat.

Pre- Fermentation steps:

- Selection and preparation of raw meat (grinding,chopping or slicing)
- Mixing with ingredient (salt ,sugar,spices,starter cultures)
- Creation of optimal environment (temperature,humidity,ph)

FERMENTATION PROCESS:

primary Fermentation (1-7days):microorganisms (e.g.,lactic acid bacteria ,yeast) break down protein,fats and carbohydrates.

Secondary Fermentation (7-30days): further breakdown and development of flavor compounds.

POST – FERMENTATION STEP

- Drying (air –drying ,smoking or freeze –drying)
- Aging (maturation) to develop flavor and texture
- Slicing and packaging
- Storage (refrigeration or freezing)

MEAT PROCESSING EQUIPMENT

Meat Grinders

Meat Slicer

Electric Saws

Meat Mixers

Meat Curing

Meatball Machines

TYPES OF FERMENTED MEATS:

- Salami
- Prosciutto
- Dry fish
- Ham
- Pepperoni
- Chorizo
- Mortadella
- Fermented sausages
- E.g.,korean chorizo,Chinese lap cheong.

FERMENTED FOOD BENEFITS

FROZEN MEAT & MEAT STORAGE

INTRODUCTION

Meat is an animal flesh that is eaten as food:

- Meat is mainly composed of water, protein, and fat.
- It is edible raw, but is normally eaten after being cooked and processed in a variety of ways.
- Meat is important in economy and culture.

FROZEN MEAT

- Frozen meat refers to meat that has been preserved by lowering its temperature to below 32 degree F typically at around 0 degree F or lower.
- Freezing halts the growth of bacteria and preserves the meat's freshness, texture, and flavor.
- Common types of frozen meat include beef, pork, poultry, and fish, which can be stored for extended periods compared to fresh meat.

BENEFITS OF FROZEN MEAT

- Extended shelf life: Allows for longer storage without spoilage.
- Convenience: Enables bulk buying and meal prep.
- Reduced waste: Helps in managing portions and minimizing spoilage.

PROCESSING

1. Receiving and Inspection

- **Quality Check**: Inspect the frozen meat for any signs of freezer burn, discoloration, or off-odors.
- **Temperature Verification**: Ensure that the meat has been stored at the appropriate freezing temperatures (-18°C or 0°F or lower).

2. Thawing

- **Refrigerator Method**: Thaw meat in the fridge to maintain a safe temperature.
- **Cold Water Method**: Submerge in cold water, changing the water every 30 minutes.
- **Microwave Method**: Use the defrost setting, but cook immediately afterward.

3. Preparation

- **Trimming**: Remove excess fat, gristle, or sinew as needed.
- **Cutting**: Portion meat into desired sizes (steaks, chops, etc.).
- **Marinating or Seasoning**: Enhance flavor if desired.

4. Cooking

- Ensure thorough cooking to safe internal temperatures (e.g., 75°C or 165°F for poultry).
- Use appropriate cooking methods (grilling, baking, sautéing).

5. Storage

- **Refrigeration**: If not cooked, store thawed meat in the refrigerator and consume within a few days.
- **Re-freezing**: If meat has been thawed safely in the fridge, it can be refrozen, although quality may decline.

6. Safety Considerations

- Always practice good hygiene (wash hands, sanitize surfaces).
- Avoid cross-contamination with other foods.

7. Labeling and Tracking

- Keep records of batch numbers, expiration dates, and thawing dates to maintain inventory and ensure food safety.

MEAT STORAGE

- Meat storage refers to the methods and practices used to preserve meat and ensure its safety, quality, and freshness over time.

1. Temperature Control

- **Refrigeration**: Store meat at temperatures below 4°C (39°F). Fresh meat should be consumed within a few days.
- **Freezing**: Store meat at -18°C (0°F) or lower for longer-term preservation. Proper packaging helps prevent freezer burn.

2. Packaging

- **Vacuum Sealing**: Removes air to reduce spoilage and freezer burn.
- **Wrapping**: Use plastic wrap, butcher paper, or freezer bags to protect meat from air and moisture.
- **Labeling**: Include dates and contents to keep track of freshness.

3. Storage Duration

- **Fresh Meat**: Typically lasts 1-3 days in the refrigerator.
- **Frozen Meat**: Can last several months (e.g., beef up to a year, poultry 6-12 months).

4. Hygiene Practices

- **Cleanliness**: Wash hands, utensils, and surfaces before and after handling meat to prevent cross-contamination.
- **Separation**: Store meat separately from ready-to-eat foods to avoid contamination.

5. Thawing

- Thaw meat in the refrigerator, in cold water, or using a microwave, never at room temperature to minimize bacterial growth.

6. Avoiding Spoilage

- Regularly check for signs of spoilage, such as off-odors, discoloration, or sliminess. Discard any meat that appears spoiled.
- By following these guidelines, you can effectively store meat to maintain its quality and safety.

BY-PRODUCTS FROM MEAT INDUSTRIES AND THEIR UTILIZATION

Introduction

- Meat industries generate significant quantities of by-products during the slaughtering and processing of animals.

- By-products are categorized as **edible** (fit for human consumption) and **inedible** (used for non-food applications).

- Proper utilization is crucial for economic, environmental, and sustainability purposes.

Major By-products

- **Edible By-products**
- **Inedible By-products**

Edible By-products

- **Liver, heart, kidney, and tongue**: High in nutrients; used in processed foods like pâtés and sausages.
- **Blood**: Rich in proteins; utilized in blood sausages, binders, and stabilizers in food products.
- **Intestines**: Processed into natural sausage casings.
- **Fats**: Rendered into edible lard or tallow used in cooking and baking.

Inedible By-products

- **Hides and skins**: Processed into leather and gelatin.
- **Bones**: Converted into bone meal (fertilizers) and gelatin.
- **Hair and wool**: Used in brushes, textiles, and fertilizers.
- **Hooves and horns**: Utilized for adhesives, gelatin, and craft materials.
- **Blood**: Processed into blood meal for animal feed or fertilizers.

Utilization of By-products

- **Animal Feed**
  - By-products like bone meal, blood meal, and feather meal are used as protein sources in livestock and poultry feed.
- **Fertilizers**
  - Rendering of bones, blood, and offal into organic fertilizers rich in nitrogen and phosphorus.
- **Pharmaceutical Industry**
  - Production of heparin (anticoagulant) from pig intestines.
  - Enzymes such as trypsin and pepsin extracted for medicinal purposes.

Cosmetic and Personal Care

- Tallow and gelatin used in soaps, lotions, and shampoos.

Bioenergy

- Rendering inedible fats into biodiesel or biogas for renewable energy sources.

Environmental Benefits

- Reduces waste and pollution from meat processing plants.
- Enhances sustainability by converting waste into valuable products.
- Reduces greenhouse gas emissions from waste disposal.

Challenges in Utilization

- High processing costs for certain by-products.
- Stringent regulations for food-grade and pharmaceutical applications.
- Technological barriers in fully utilizing all by-products.

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