

# Microbial spoilage of meat

## Contamination of meat

- The healthy inner flesh of the meat contains few or no micro-organisms although they have been found in lymph node and bone marrow.
- Upon, death of animal, invasion of tissue by contaminating microorganisms takes place.
- In meat, microorganisms come from external source or from meat animal itself.
- Factors that influence invasion of meat by contaminating microorganisms are:
  - The load of organism in intestine. The greater the load, the greater will be the invasion of meat tissue. Therefore, starvation of animal for 24hrs before slaughter has been recommended.
  - The physiological condition of the animal immediately before slaughter:
  - The method of killing or bleeding: The better and more sanitary bleeding method contributes less contamination.
  - The rate of cooling: The rapid cooling will reduce the rate of invasion of meat by contaminants.
- Microorganisms are spread in the meat through the blood and lymph vessel, connective tissue spaces and by grinding in ground meat.

## Microbial Spoilage of meat:

- Common type of microbial spoilage of meat can be classified on the basis of whether they occur under aerobic or anaerobic condition and whether they are caused by bacteria, yeast, or mold.

### 1. Spoilage of meat under aerobic conditions:

#### *i. Bacterial spoilage of meat:*

- **Surface spoilage:**
  - It is caused by *Pseudomonas*, *Acenatobacter*, *Streptococcus*, *Leuconostoc*, *Bacillus* and *Micrococcus*.
  - Temperature and available moisture influence type of microorganisms causing slime.
- **Change in color of meat:**
  - Red color of meat may be changed into green brown or grey due to production of oxidising agent, H<sub>2</sub>S, etc. by microorganisms. For example, *Lactobacillus* and *Leuconostoc* cause greening of sausage.
- **Change in fat:**
  - Fat of meat may become rancid due to lipase producing microorganisms such as *Pseudomonas* and *Achromobacter*.
- **Surface color due to pigmented bacteria:**
  - *Serratia marcescens* give red spots.
  - *Pseudomonas syncyanea* give blue color, *Chromobacterium lividum* gives greenish blue to brownish black color, *Flavobacterium* give yellow color.

- **Phosphorescence:**
  - It is caused by luminous bacteria e.g. *Photobacterium* growing on surface of meat.
- **Off odors and off taste:**
  - Undesirable odor and taste called taint are caused by many bacteria due to production of volatile acids such as formic acid, acetic acid, butyric acid etc.
  - Actinomycetes give musty or earthy flavor.

## **ii. Fungal spoilage of meat:**

- **Stickiness:**
  - Many molds grow on surface of meat and make it sticky to touch.
  - Whiskers: when meat is kept at temperature near freezing, mold grow slowly without sporulation on surface producing white cottony growth.
  - It may be caused by *Thamnidium*, *Mucor mucedo*, *Mucor racemosus* etc.
- **Black spot:** It is caused by *Cladosporium herbarum*.
- **White spot:** It is caused by *Sporotrichum carnis*.
- **Green spot:** It is caused by *Penicillium* species.
- **Change in fat:** Many molds produce lipase and cause hydrolytic rancidity of fat.
- **Off odor and off taste:**
  - Many molds give musty flavor to meat in the vicinity of their growth.
- **By yeast:**
  - Under aerobic condition, yeast grow on surface of meat causing sliminess, rancidity of fat, off odor and taste and discolorations like white, pink, brown spots.

## **2. Spoilage of meat under anaerobic conditions:**

- In anaerobic condition, anaerobic or facultative anaerobic bacteria spoil the meat.
- **Souring:**
  - It is caused by formic acid, acetic acid, butyric acid, propionic acid, higher fatty acids and other organic acids. E.g. lactic acid produced by bacteria.
  - Souring may also be caused by food's own enzyme.
- **Putrefaction:**
  - It refers to the anaerobic decomposition of protein with production of offensive smelling compounds such as H<sub>2</sub>S, mercaptans, indole, skatole etc.
  - It is usually caused by *Clostridium* species but species of *Pseudomonas proteus* and Alkaligenes may cause putrefaction.
- **Taint:**
  - It refers to any undesirable odor or taste.

### **Spoilage of different types of meat products:**

#### **Spoilage of fresh meat:**

- Fresh beef:
  - Change in hemoglobin and myoglobin so as to cause loss of bloom and production of reddish-brown methemoglobin and metmyoglobin.
  - White, green, yellow, greenish blue, black spots due to pigmented micro-organism's phosphorescence.

- Sliminess on the surface due to slime forming organism, stickiness due to mold, whiskers due to mold etc.
- Souring and putrefaction.
- Fresh pork sausage:
  - Souring is the most common type of spoilage of refrigerated sausage.
  - It may be caused mainly by *Lactobacillus* and *Leuconostoc*.
  - Enclosed sausage undergoes slime formation by mold on long term storage.
  - Colored spots also appear on surface due to pigmented organism.

#### **Spoilage of cured meat:**

- Curing salts make meat more susceptible to gram +ve bacteria and mold than to gram -ve bacteria.
- Sausage:
  - If moisture is available micrococcus and yeast form slime in the surface.
  - With less moisture, mold may give cottony growth and colored spots.
  - Microorganisms that produce peroxide cause greening of sausage.  
E.g. *Lactobacillus*, *Leuconostoc* and other catalase -ve bacteria.

#### **Spoilage of Refrigerator packaged meat:**

- Packaging film permitting good penetration of oxygen and CO<sub>2</sub> favor more aerobic bacteria such as *Pseudomonas*, *Acenatobacter* and *Moraxella*.
- They cause spoilage like off flavor slime and sometimes putrefaction.
- Film with poor gas penetration encourage lactic acid bacteria causing sourness and slime.
- Curing solution or pickles:
  - Spoilage of curing solution is usually putrefactive and is caused by *Vibrio*, *Alcoligens* and *Spirillum*.
- Souring can be caused by *Lactobacillus* and *Micrococcus*.
- Slime is formed by *Leuconostoc* and *Micrococcus*.

### **Preservation of meat from spoilage:**

#### **i. Asepsis:**

- Asepsis prevents external microorganisms from entering into the meat.
- Water spraying before slaughter is recommended to remove dirt and microorganisms from hair and hide and foot bath may be used to remove dirt from hoofs.
- Other method of asepsis includes sanitization of knife, used for killing and personal hygiene of food handler.
- Films may be used to keep out bacteria and other microorganisms.

#### **ii. Use of heat:**

- Canning is a specialized technique of preservation for meat.
- Canned meats are divided into two groups on the basis of heat treatment employed for canning:

- **Self-stable canned meat:**
  - The processing temperature is 98°C and the size of container is usually less than 1lb.
  - They are made sterile or at least commercially sterilized.
- **Non-self stable canned meat:**
  - The processing temperature is about 85°C and the size of container is upto 22 lb.
  - They kill only part of spoilage organisms and the meat must be kept frozen to prevent spoilage.

### iii. Use of low temperature:

- **Chilling:**
  - Chilling temperature vary from -1.4°C to 2.2°C with the lower temperature preferred.
  - Meat are chilled rapidly because there is opportunity for growth of mesophiles if cooled suddenly.
  - The time limit for chilling storage depends on meat. For.eg. 30 days for beef, 1-2 weeks for mutton.
- **Freezing:**
  - Freezing is increasingly effective as the temperature drops from -12.2°C towards -28.9°C.
  - Meats are frozen quickly in package.
  - Freezing process kills about half of the bacteria and their number decrease slowly during storage.

### iv. Preservation by radiation

### v. Preservation by chemical preservative:

- Chemical preservatives are added in meat as a component of wood smoke and curing solution.
- **Smoking:**
  - Smoking of food usually have two main purposes i.e. adding desired flavor and preservation.
  - Other desirable effect include improvement in color and flavor and tenderization of meat.
  - Commonly smoke is obtained by burning hard wood, and temperature of smoking generally vary from 48°C- 72°C.
  - Smoking period lasts from a few hours to several days.
  - Preservative action of smoking is due to three factors i.e. chemical preservatives, drying action and heating.
  - Wood smoke contains large number of volatile compounds with bacteriostatic and bactericidal activity.
  - Some of which are formaldehyde, phenol, cresol, aliphatic acids, ketones, aldehyde etc.
  - Composition of anti-microbials depends on type of wood used.

- Wood smoke also contains large number of volatile coloring and flavoring agent.
- **Curing:**
  - It is a common preservation method for meat.
  - Both solid cuts and ground meat are subjected to curing.
  - Curing agents permitted in meat are NaCl, sugar, sodium nitrate and vinegar, but only the first three are commonly used.
  - There are few methods of introducing curing agents in meat:
    - The dry cure in which the dry ingredients are rubbed into the meat.
    - The pickles cure in which meat is immersed in the solution of curing agent.
    - The injection cure in which concentrated solution of agent is injected into the meat by needle.
  - The direct addition method in which curing agents are added directly in the finely ground meat.
  - The curing temperature (especially with pickle cure) usually is about 2.2°C – 3.8°C and the time of curing vary with the meat and the method used.
    - Function of ingredients used in curing are:
      - **NaCl:** It lowers  $A_w$  and gives flavor.
      - **Sugar:** It lowers  $A_w$  and gives flavor.
      - **Vinegar:** It is preservative.
      - **Sodium nitrite:** It is a coloring agent. It decomposes into nitric oxide that reacts with myoglobin of meat to form nitroso-myoglobin that gives red color to the meat. Sodium nitrate is used as a source of sodium nitrite, but it is not a real coloring agent.

**v. Spices and other condiments:**

- Spices used in meat are not in concentration high enough to be preservative but they help other preservative methods.

**vi. Antibiotics:**

- Antibiotic most commonly recommended in meat are chloramphenicol, oxytetracycline, chlortetracycline, nisin etc.
- Antibiotics may be applied in meat by various ways.
- It may be fed to the animal for long period.
- It may be fed in high dose for a short period before slaughter.
- It may be injected into flesh.
- It may be applied or mixed directly to the meat