

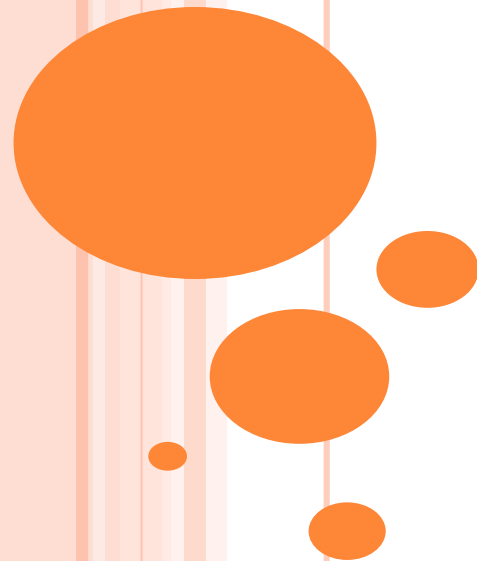
MEAT TECHNOLOGY

Meat spoilage and quality loss

-microbiological

-chemical

-physical



SHELF LIFE OF FRESH MEAT

- The time it takes for the meat to become no longer acceptable to the consumer.
- Based on unacceptable:
 - Color (browning of meat, greying of fat)
 - Flavor and aroma (rancid, acid, sulfur etc.)
 - Texture (loss of structure-soft)
 - Moisture and nutrient content (surface drying)



CHANGES IN SUITABILITY

- Microbiological
 - Spoilage due to bacterial growth
 - Mould growth
- Chemical
 - Oxidation
 - Autolysis (proteolysis)- breakdown of protein structure
 - Color changes
- Physical
 - drying

MICROBIAL SPOILAGE OF MEAT

Microbial contamination in the meat processing chain

- Carcass contamination during slaughtering
- External sources during bleeding, handling, skinning, cutting and further processing
- Intestinal tract of animals, exterior of animals (hide, hooves and hairs)
- Knives, cloths, air, and hands and clothing of workers.



MICROBIAL SPOILAGE

- Growth of microorganisms
- Enzyme production

GROWTH OF MICROORGANISM IN MEAT

- Meat is a ideal culture for many microbes because it is high in moisture, rich in nitrogenous compounds, traces of CHO, and plentifully supplied with minerals and vitamins.
- Also, meat pH is favorable for most microorganism.

MICROBIAL SPOILAGE-HOW DOES IT MANIFEST ITSELF?

- Visible growth
- Gas production
- Slime
- Off-flavours

Sequence of events in meat spoilage

Microorganisms have to get into the meat from a source or more



Meat environment should favour the growth of microbes



Meat need to be stored under the growth condition for a sufficient length of time

- To allow sufficient number necessary to cause spoilage or changes in meat.
- To allow the produced enzyme to spoil the food.

CHEMICAL CHANGES CAUSED BY MICROORGANISMS

- Degradation of carbohydrates
- Degradation of N- compounds
- Degradation of lipids

TYPES OF SPOILAGE OF MEATS

Spoilage under

- Aerobic conditions
- Anaerobic conditions

SPOILAGE UNDER AEROBIC CONDITIONS

Under aerobic conditions, bacteria may cause:

- Surface slime-which may be caused by species of
 - Pseudomonas
 - Acinetobacter
 - Moraxella,
 - Alcaligenes,
 - Streptococcus
 - Leuconostoc
 - Bacillus
- Micrococcus
- It is early indication of spoilage, often observed before expiry date.

SPOILAGE UNDER AEROBIC CONDITIONS

- Changes in color of meat- the red color of meat, called «bloom», may be changed shades of green, brown, grey as a result of the production of oxidizing compounds e.g. hydrogen peroxides, hydrogen sulfide.

Responsible microorganisms:

- *Lactobacillus*
- *Leuconostoc*
- Changes in fats- The oxidation of unsaturated fats may take place chemically in air and may be catalyzed by light and copper, e.g. oxidative rancidity

Responsible microorganisms:

- *Pseudomonas*
- *Acromobacters*
- Also yeast

SPOILAGE UNDER AEROBIC CONDITIONS

Various surface colors due to pigmented bacteria-

- *Serratia*
- *Pseudomonas syncyanea*
- *Micrococcus* or *Flavobacterium*
- *Chromobacterium lividum* and other bacteria

SPOILAGE UNDER AEROBIC CONDITIONS

Aerobic growth of moulds may causes:

- Stickiness-surface becomes sticky
- Whiskers- when meat is stored at temperatures near freezing, a limited amount of mycelial growth may take place without sporulation.
- Black spot- usually caused by *Cladosporium herbarum*
- White spot- mostly caused by *Sporotricum camis*

SPOILAGE UNDER AEROBIC CONDITIONS

Green patches- this occurs due to species:

- *Penicillium* such as *P.expansum*, *P.oxalicum*
- Decomposition of fats- many moulds have lipase and hence cause hydrolysis of fats.

SPOILAGE UNDER ANAEROBIC CONDITIONS

- Facultative and anaerobic bacteria can able to grow within the meat under anaerobic conditions and cause spoilage.

Following changes occurs in such conditions

- Souring
- Putrefaction
- Taint

Souring

It imparts sour taste to meat due to acids such as formic, propionic, acetic etc. meat's own enzymes are responsible for it.

Putrefaction

True putrefaction is the anaerobic decomposition of protein with the production foul smelling compound such as H₂S, indole, NH₃, amines due to species of *Clostridium*

Taint

Taints or undesirable odors and tastes that appear in meat

VARIOUS SPOILAGE FEATURES OF MEAT

- Off odor-off flavor
- Discoloration
- Gas production

OFF ODORS AND OFF FLAVORS

- Off odors such as sweet and fruity, putrid, sulphury and cheesy, are characterized in aerobically stored meat.

Species which are responsible:

- *Pseudomonas sp.*
 - *Pseudomonas fragi*
- Sulphur compounds may also contribute off flavor.

DISCOLORATION

- Bacterial production of hydrogen sulphide converts the muscle pigment to green **sulphomyoglobin**.
- Hydrogen sulphide is produced from cysteine and is triggered by glucose limitation *L.sakei* forms hydrogen sulphide.

GAS PRODUCTION

- *Clostridium spp.* have been associated with the production of large amount of gas in vacuum packed beef, accompanied by foul off odors.



- Gas production (CO_2) by **lactic acid bacteria** without extensive off odors may be associated with vacuum packaged beef and pork.

SPOILAGE UNDER AEROBIC CONDITIONS

- Off odors and off taste-»taints» or undesirable odors and tastes, that appear in a meat «souring» is the term applied to almost any defect that gives the sour odor that may be due to volatile acids. e.g. formic, butyric, propionic acids.
- «Cold storage flavor» or taint its nothing but stale flavor.
- *Actinomyces* may be responsible for musty or earthy flavor.

MEAT SPOILAGE

- is characterized by the appearance of off odors and slime, which are manifest when surface loads exceed 10^7 CFU/cm².
- The slime is due to the accumulation of bacterial cells.
- Spoilage bacteria utilize glucose, free amino acids or other simple nitrogenous compounds to attain population of about 10^8 CFU/cm², at which point the organoleptic quality of the meat will clearly reveal it is spoiled.

MEAT SPOILAGE

Ground Meats

- Same microorganisms as whole meats, but always have higher microbial loads. Why?
- greater surface area which gives microbes better access to the food and also traps air to favor the growth of gram-negative, aerobic bacteria like *Pseudomonas spp.*
- every handling or processing (storage utensils, cutting knives, grinders) step can contribute additional contamination to the final product.
- one heavily contaminated piece (e.g. a lymph node) can contaminate an entire lot when they are ground together.



MEAT SPOILAGE

Vacuum – packed meats

- not all O₂ is removed during packaging but residual is consumed by respiration of aerobic microorganisms and the tissue itself.
- results in increased CO₂ levels and thus get a longer shelf life.

The microflora shifts from predominantly Gram- aerobes to Gram+ anaerobes and microaerophilic lactic acid bacteria (LAB) (like *Lactobacillus*, *Carnobacterium* and *Leuconostoc*).



MEAT SPOILAGE

Vacuum-packed meats

- if nitrites have been added to the vacuum packaged meat (e.g. to inhibit *C. botulinum* in hams, bacon), LAB domination is even more pronounced.
- In general, vacuum packaged meats are considered very safe foods and free from most pathogenic species of bacteria.

Spoilage in vacuum packaged meats is manifest by:

- 1. **Slime** development due to overgrowth of microbe.
- 2. **Greening** caused by microbial production of H_2O_2 or H_2S .
- H_2O_2 production in meat has been associated with several types of lactic acid bacteria (primarily *Lactobacillus*)

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 - H_2O_2 production in meat has been associated with several types of lactic acid bacteria (primarily *Lactobacillus*)
3. Off odors which result from:
 1. the release of short chain fatty acids
 2. the production of volatile compounds like acetoin, diacetyl and H_2S (and many other compounds, depending on the dominant spoilage bacterium).

CHEMICAL REACTIONS

- Lipid oxidation
- Autoxidation of lipids and the production of free radicals are natural processes which affect fatty acids and lead to oxidative deterioration of meat and off-flavours development.
- After slaughtering of animals, the fatty acids in tissues undergo oxidation when the blood circulation stops and metabolic processes are blocked.
- Lipid oxidation is the reaction of oxygen with double bonds of fatty acids.

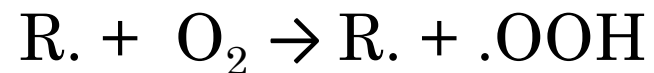
CHEMICAL

Lipid oxidation

- involves three stage free radical mechanisms:
- initiation,
- propagation and
- termination

Initiation: Heat, metal ions and irradiation act as catalyst and form lipid free radicals during the initiation tage.

Reaction of these free radicals with oxygen form peroxyl radicals as follows:



R. : radical, .OOH : peroxyl radical

CHEMICAL

Lipid oxidation

○ **Propagation:** During the propagation stage, the peroxy radicals react with other lipid molecules to form hydroperoxides and new free radicals as follows:

- $R\cdot + O_2 \rightarrow ROO\cdot$
- $RH + ROO\cdot \rightarrow ROOH + R\cdot$
- $ROOH \rightarrow RO\cdot + \cdot OH$

○ **Termination:** Termination occurs when these free radicals interact to form non-radical products as follows:

- $R\cdot + R\cdot \rightarrow R-R$
- $R\cdot + ROO\cdot \rightarrow ROOR$
- $ROO\cdot + ROO\cdot \rightarrow ROOR + O_2$

CHEMICAL

Autolytic enzymatic spoilage:

- Enzymatic actions are natural process in the muscle cells of the animals after they have been slaughtered and are the leading cause of meat deterioration.
- In the autolysis process, the complex compounds (carbohydrates, fats and protein) of the tissues are broken down into simpler ones resulting in softening and greenish discoloration of the meat.
- These autolysis changes include proteolysis and fat hydrolysis which are prerequisite for microbial decomposition.
- Excessive autolysis is termed “souring”.

PHYSICAL-DRYING

- Weight loss
- Drip loss or purge

Drip loss:

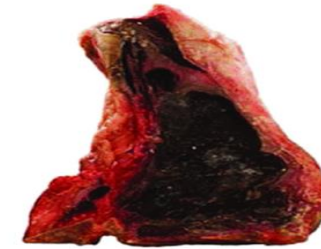
refers to the high protein fluid that is lost from fresh meat. This particular definition applies to that fluid that is lost from meat without any added mechanical force other than gravity.

0.1-1% is normal

Ranges from <0.5 to 10%



Three weeks aged
Weight lost -10%



Aged 30 days
Weight lost -15%



Aged 50 days
Weight lost -23%



Aged 120 days
Weight lost -35%



PRACTICAL STORAGE LIFE OF CHILLED MEAT



Product	Storage life
Carcass/quarters etc. in air (0°C to 2°C)	
Beef (stockinette)	3-4 weeks
Beef (poly wrapped)	12 days
Lamb and mutton	10-13 days
Offals	7 days
Primal cuts- vacuum packed (0°C)	
Beef	10-12 weeks
Lamb and mutton	6-10 weeks
beef and lamf offal	3-4 weeks
Minced beef	2-3 days