

Microbial spoilage of Meat

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Meat spoilage

- The shelf-life of meat and meat products is the **storage time until spoilage**.
- The **point of spoilage** may be defined by a **abnormal bacterial level, an unacceptable off-odour, off- flavor or appearance**.
- The shelf-life depends on the numbers and types of microorganisms mainly bacteria that are initially present and their subsequent growth.

- The initial mesophilic bacterial count on meat and cooked meat products is about 10^2 - 10^3 cfu /cm² or gram, consisting of a large variety of species (Mel *et al.*,1971)
- Only 10% of the bacteria initially present is estimated to grow at refrigerated temperatures and the fraction causing spoilage will be even lower.
- During storage, environmental factors such as temperature, gaseous atmosphere, pH and NaCl will select for certain bacteria and affect their growth rate and activity. (Gill and Molin, 1991)

Growth of bacteria – Environment factors

Temperature:

- The appropriate cold-storage temperature for meat is - 1.5°C while the minimum growth temperature of psychrotrophic bacteria is 3°C (Gill and Molin, 1991).
- Decreasing refrigeration temperatures decrease bacterial growth and affect the composition of the bacterial flora.

Packaging:

- The shelf-life of meat increases in the order:
Air < high oxygen-MA < vacuum < no oxygen-MA < 100% CO₂

Table 1
Expected shelf-life under refrigerated storage, and growth ability of bacterial groups and specific bacteria on meat and meat products

| Product | Storage | Expected shelf-life | Growth ^a | | | |
|-----------------|---------------------------------|---------------------|-------------------------|---------------------------|----------------------|-------------------------|
| | | | <i>Pseudomonas</i> spp. | <i>Enterobacteriaceae</i> | Lactic acid bacteria | <i>B. thermosphacta</i> |
| Meat, normal pH | Air | Days | +++ | ++ | ++ | ++/+++ |
| | High O ₂ -MA | Days | +++ | ++/+++ | ++/+++ | +++ |
| | Vacuum | Weeks-months | + | + / ++ | +++ | ++/+++ |
| | 100% CO ₂ | Months | + | + / ++ | +++ | + |
| Meat, high pH | Vacuum | Days | + | ++/+++ | +++ | ++/+++ |
| | 100% CO ₂ | Weeks-months | + | + / ++ | +++ | + |
| Meat products | Air | Days | + / ++ | + | ++ | +++ |
| | Vacuum | Weeks | + | + | +++ | ++/+++ |
| | CO ₂ +N ₂ | Weeks | + | + | +++ | + |

^a + + +, dominant part of the microflora; + +, intermediate part of the microflora; +, minor part of the microflora.

pH:

- Meat contains about 0.2% glucose and 0.4% amino acids. High pH meat and adipose tissue spoil more rapidly than normal pH meat since amino acids are rapidly damaged (Elisabeth Borch *et al.*, 1996)
- Some of the bacteria are able to grow well on vacuum-packaged high pH meat - *B. thermosphacta*, Enterobacteriaceae such as *H. alvei*, *S. liquefaciens* and *Enterobacter sp.*

Effects

- The main defects of meat are off-odour and off-flavour, discoloration and gas production.

Off-odour and Off-flavour:

- Off-odors such as sweet and fruity, putrid, sulphury and cheesy, characterize aerobically stored meat (Dainty and Mackey, 1992).
- *Pseudomonas spp.*, specifically *Ps. .fragi* produce ethyl esters coinciding with the early stages of spoilage.

- Sulphur containing compounds contribute to the putrid and sulphury odors. The responsible compounds are for example hydrogen sulphide formed by *Enterobacteriaceae* and dimethyl sulphide formed by *Pseudomonas spp.*
- Cheesy odors are associated with acetoin diacetyl and 3-methylbutanol formation, presumably by *Enterobacteriaceae*, *B. thermosphactu* and homofermentative *Lactobacillus spp.* (Borch and Molin, 1989).

Discoloration:

- The bacterial production of hydrogen sulphide converts the muscle pigment to green sulphmyoglobin. Hydrogen sulphide is produced from cysteine and is triggered by glucose limitation.
- *Lactobacillus sake* forms hydrogen sulphide when the glucose and oxygen availability is limited (Egan *et al.*, 1989).

Gas production:

- *Clostridium spp.* have been associated with the production of large amounts of gas (H_2 and CO_2), (Dainty et al., 1989b)

References

- Elisabeth Borch, Marie-Louise, Kant-Muermans, Ylva Blixt; **Bacterial spoilage of meat and cured meat products**, International Journal of Food Microbiology 33 (1996) 103-120.
- George-John E. Nychas , Panos N. Skandamis , Chrysoula C. Tassou ,Konstantinos P. Koutsoumanis ; **Meat spoilage during distribution**, Meat Science 78 (2008) 77–89.