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Microbial Spoilage of Foods

Factors affecting kinds, numbers, growth and survival of microorganisms in foods



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Parameters Affecting the Growth

- Factors affecting the growth of microorganisms are divided into two categories:
 - **Extrinsic** – properties of the environment (processing and storage) that exist outside the food product that affect both microorganisms and food. Included are:
 - Temperature of storage
 - Relative humidity of environment
 - Presence and concentration of gases
 - Presence and activities of other microorganisms



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Extrinsic Factors

- **Temperature of Storage** – lowest temperature at which they grow has been reported as -34 C and the highest is above 100 C. Divided into following categories:
 - Growth at below 7°C but optimum at 20 and 30 °C are referred to as **psychrotrophs** (*Pseudomonas*, *Lactobacillus*, *Enterococcus*)
 - Growth between 20 and 45 °C with optimum between 30 and 40 °C are referred to as **mesophiles** (*Salmonella*, *Escherichia coli*)
 - Growth at above 45 °C with optimum between 55 and 65 °C are referred to as **thermophiles** (*Bacillus*, *Clostridium*)



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Extrinsic Factors

- **Relative Humidity of the Environment :**
Important both from the standpoint of a_w within foods and growth of microorganisms at the surface
- Foods with low a_w when placed in high RH pick up moisture until equilibrium has been established
- Higher the temperature, lower is the RH and vice versa
- Foods spoiled by yeasts, molds should be stored under conditions of low RH



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Extrinsic Factors

- **Presence and concentration of gases in environment**
 - CO₂ is the single most atmospheric gas that is used to control microorganisms in foods
 - Ozone has antimicrobial properties and also used to extend shelf life of foods but cannot be used in high lipid foods because it causes rancidity
 - Categorized as GRAS by USA in 1997 and approved for use as food sanitizing agent



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Extrinsic Factors

- **Presence and Absence of other Microorganisms**
 - Few organisms produce substances that are either inhibitory or lethal to other microorganisms
 - Include antibiotics, bacteriocins, hydrogen peroxide, and organic acids
 - Bacteriocins – Compounds produced by one/group of microorganisms that inhibit or kill other microorganisms
 - Nisin produced by some strains of *Lactococcus lactis* has an inhibitory effect on *Clostridium butyricum*, and gram positive bacteria



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Intrinsic Factors

— **Intrinsic** – properties that exist as part of the food itself and these include:

- pH
- Water Activity (a_w)
- Oxidation – reduction potential
- Nutrient Content
- Antimicrobial constituents
- Biological Structures



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Intrinsic Factors

- pH
 - Most microorganisms grow best at pH value around 7.0 (6.6 – 7.5) with few growing below a pH of 4.0
 - Some (pathogenic bacteria) tend to be more fastidious (complex **nutritional** and cultural requirements for growth)
 - Most meats have a final pH of about 5.6 and above and this makes these products susceptible to molds, yeasts and bacteria
- Aw (moisture content)
 - Oldest methods of preserving food is by drying/desiccation (removal of moisture)
 - Water molecules are loosely oriented in pure liquid water and can easily rearrange



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Intrinsic Factors

- **Aw** contd....
 - Aw of pure water is 1.00 and addition of solute lowers the aw because water molecules orient themselves on the surface of the solute and the properties of the solution change dramatically
 - Microbial cells compete with solute molecules for free water molecules and some pathogenic bacteria require aw greater than 0.9 while *Staphylococcus aureus* can grow in as low as 0.86
- **Oxidation – Reduction Potential (O/R or EH):**
 - Aerobic organisms require more oxidized environments
 - Anaerobic organisms require reduced conditions
 - Microaerophilic organisms require special conditions



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Intrinsic Factors

- **Nutrient Content** – require water, source of energy, nitrogen, vitamins, minerals, and related growth factors
- **Antimicrobial Constituents** – stability of some foods against attack by microorganisms is due to presence of certain naturally occurring substances that have been shown to have antimicrobial activity (Nisin)
- **Biological Structures** – Natural covering of some food sources provide excellent protection against the entry and subsequent damage by spoilage organisms (hide, skin, and feathers of animals)