Microbial Spoilage of Foods

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

• **Relative Humidity of the Environment**: Important both from the standpoint of aw within foods and growth of microorganisms at the surface

  • Foods with low aw 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
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
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
Intrinsic Factors

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

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