Food as a Substrate for Microrganisms

Core Course: Food and Industrial Microbiology
M.Sc., Microbiology
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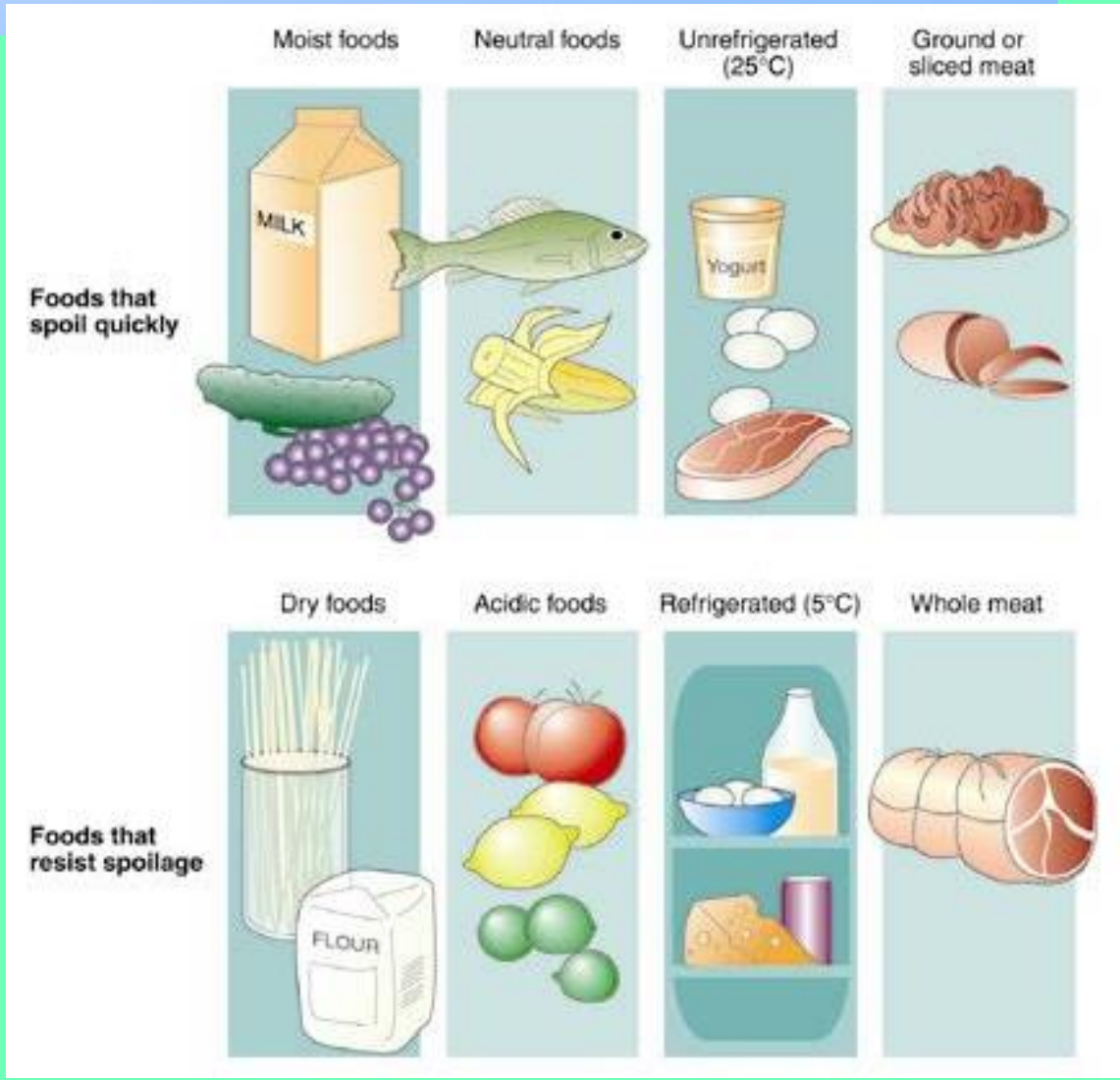
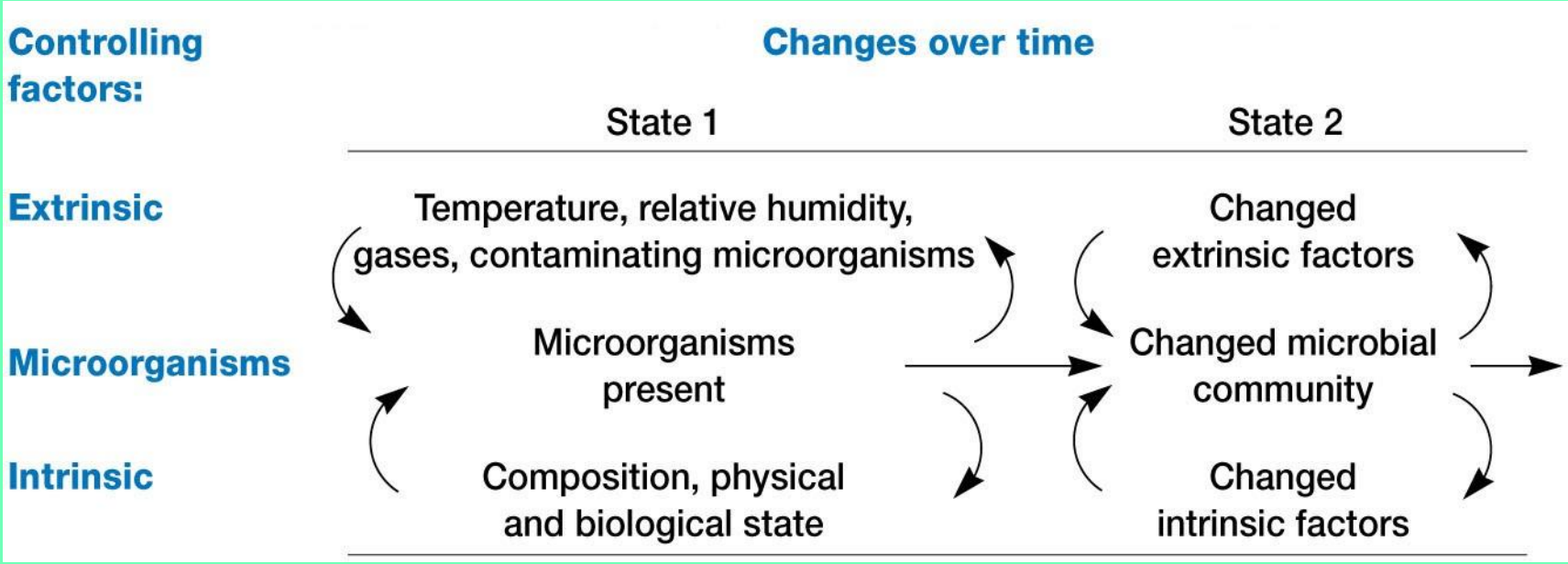
Conditions for Spoilage

- Water
- pH
- Physical structure
- Oxygen
- temperature



Microorganism Growth in Foods



Intrinsic Factors

- composition
- pH
- presence and availability of water
- oxidation-reduction potential
  - altered by cooking
- physical structure
- presence of antimicrobial substances

Composition and pH

Table 41.1 Differences in Spoilage Processes in Relation to Food Characteristics

Substrate	Food Example	Chemical Reactions or Processes[a]	Typical Products and Effects
Pectin	Fruits	Pectinolysis	Methanol, uronic acids (loss of fruit structure, soft rots)
Proteins	Meat	Proteolysis, deamination	Amino acids, peptides, amines, H_2S, ammonia, indole (bitterness, souring, bad odor, sliminess)
Carbohydrates	Starchy foods	Hydrolysis, fermentations	Organic acids, CO_2, mixed alcohols (souring, acidification)
Lipids	Butter	Hydrolysis, fatty acid degradation	Glycerol and mixed fatty acids (rancidity, bitterness)

[a]Other reactions also occur during the spoilage of these substrates.

- putrefaction
  - proteolysis and anaerobic breakdown of proteins, yielding foul-smelling amine compounds
- pH impacts make up of microbial community and therefore types of chemical reactions that occur when microbes grow in food

Water availability

- in general, lower water activity inhibits microbial growth
- water activity lowered by:
  - drying
  - addition of salt or sugar
- osmophilic microorganisms
  - prefer high osmotic pressure
- xerophilic microorganisms
  - prefer low water activity

Physical structure

- grinding and mixing increase surface area and distribute microbes
  - promotes microbial growth
- outer skin of vegetables and fruits slows microbial growth

Antimicrobial substances

- coumarins – fruits and vegetables
- lysozyme – cow’s milk and eggs
- aldehydic and phenolic compounds – herbs and spices
- allicin – garlic
- polyphenols – green and black teas

Extrinsic Factors

- temperature
  - lower temperatures retard microbial growth
- relative humidity
  - higher levels promote microbial growth
- atmosphere
  - oxygen promotes growth
  - modified atmosphere packaging (MAP)
    - use of shrink wrap and vacuum technologies to package food in controlled atmospheres

Microbial Growth and Food Spoilage

- food spoilage
  - results from growth of microbes in food
    - alters food visibly and in other ways, rendering it unsuitable for consumption
  - involves predictable succession of microbes
  - different foods undergo different types of spoilage processes
  - toxins are sometimes produced
    - algal toxins may contaminate shellfish and finfish

Food Spoilage

- Approximately 1/3rd of all food manufactured in world is lost to spoilage
- Microbial content of foods (microbial load): qualitative (which bugs) and quantitative (how many bugs)
- Shelf life
  - Non-perishable foods (pasta)
  - Semiperishable foods (bread)
  - Perishable foods (eggs)

General Principles

- Minimize contamination by:
  - Good management processes
  - Acceptable sanitary practices
  - Rapid movement of food through processing plant
  - Well-tested preservation procedures

Spoilage

- Meat
  - Cutting board contamination
  - Conveyor belts
  - Temperature
  - Failure to distribute quickly
  - Fecal bacteria from intestines
- Fish
  - Polluted waters
  - Transportation boxes

Spoilage

- Poultry and Eggs
  - Human contact
  - Penetration by bacteria
- Milk and Dairy Products
  - Lactobacillus and Streptococcus species that survive pasturization (sour milk)
- Breads
  - Spores and fungi that survive baking
- Grains
  - Fungi produce toxins

Food-Borne Diseases

- two primary types
  - food-borne infections
  - food intoxications

Preventing Foodborne Disease

- Food infections (microbes are transferred to consumer)
- Food poisoning (results from the toxin consumption)

Food-Borne Intoxications

- ingestion of toxins in foods in which microbes have grown
- include staphylococcal food poisoning, botulism, *Clostridium perfringens* food poisoning, and *Bacillus cereus* food poisoning

Mycotoxins

- Ergotism
  - toxic condition caused by growth of a fungus in grains
- Aflatoxins
  - carcinogens produced in fungus-infected grains and nut products
- Fumonisins
  - carcinogens produced in fungus-infected corn