

Lecture 2

Food microbiology



Prepared by
Samira fattah
Assis. Lec.

College of health sciences-HMU

Introduction

- Food supply consists basically of plants and animals or product derived from them.
- it is understandable that our food supply can contain microorganism in interaction with food.
- These microorganisms use food supply as a source of nutrients for their own growth.





These will cause 2 possibilities:

- Either – Result in deterioration of food (“spoil”)



- OR These interactions between microorganisms and food give beneficial to human.



Example

- Two species of *Penicillium* fungus are named after cheeses.
- One of them is *P. roqueforti*, gives blue cheeses (like Roquefort).
- Cheesemakers add *P. roqueforti* to the milk, so it's present throughout the cheese.
- The blue mold grows and produce the beautiful blue veins that characterize these cheeses.



How microorganisms can cause deterioration of the food?

- When they utilize the nutrients of the food, it involved changes in the food compound like:
- synthesis a new compound that cause spoiling of the food.

or

- produced enzymatic changes and contributing off-flavours by mean of breakdown of product.

What are the importance of microorganisms in food?

Good (desirable)	Bad (undesirable)
Food bioprocessing	Foodborne disease
Food biopreservation	Food spoilage
Probiotics	

GOOD (DESIRABLE)

- Food bioprocessing

means: Foods produce by using **biological process**.

- In this process, food-grade microorganisms are used to produce different types of fermented food using raw materials from animal and plant sources (this process known as “starter culture”).
- Besides, microbial enzymes are also being used to produce food and food additives.

Starter culture

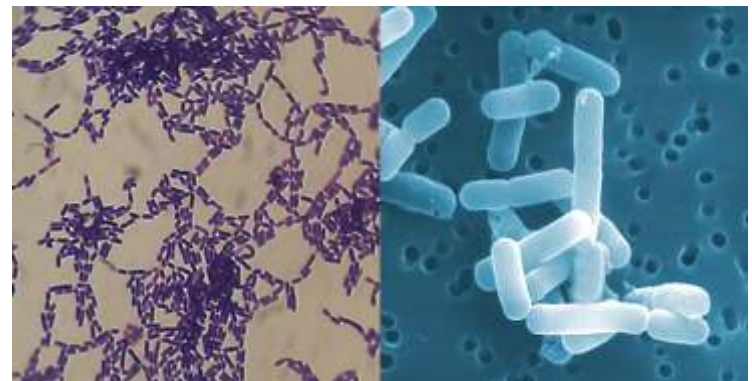
A concentrated preparation of live cells that is added to raw material to initiate fermentation rapidly.



- Food biopreservation

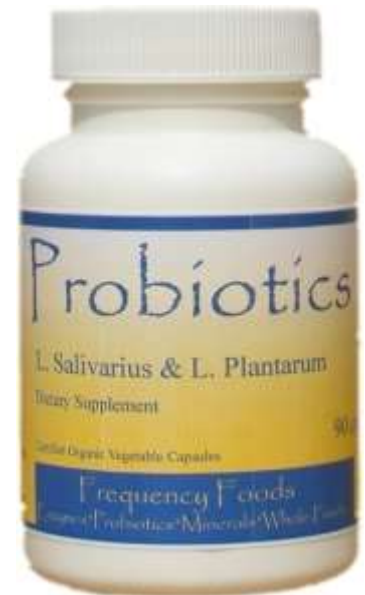
Is a food biological preservative by using antimicrobial metabolites (taken from certain microorganisms in order to control pathogenic and spoilage microorganisms in foods)

- In biopreservation, beneficial bacteria are used to prevent food spoilage and get rid of harmful pathogens.
- Lactic acid bacteria (LAB) are the most commonly used due to their unique properties and because they are harmless to humans.
- LABs release antimicrobials(such as lactic and acetic acid, hydrogen peroxide, and peptide bacteriocins) that stop spoilage and inhibit the growth of potentially harmful pathogens.



- Probiotics

Is a concentrated supplement of beneficial live cells of bacteria (friendly bacteria) culture taken orally intended to improve our health by promoting our body's natural immunity and improving digestion system.



The example of probiotics in food

- Milk- baby nowadays is added with *Lactobacillus acidophilus* and *Bifidus* bacteria.
- Yogurt- rich with live bacteria culture such as *Lactobacillus bulgaricus* and *Streptococcus thermophilus*.
- Cheese- friendly bacteria that is added in cheese is *Lactobacillus*.



- **BAD (UNDESIRABLE)**
- **Foodborne disease**

Is a disease cause by consumption of contaminate during various stage of handling between production and consumption by many pathogenic microorganisms (bacteria, molds and viruses).



- Food spoilage.

is a condition of contaminate food due to:
growth of microorganisms in food

OR

The action of microbial heat stable enzymes

-Spoilage leads to wastage of food and economic loss.

Factors influencing growth of microorganisms in foods

(a) Intrinsic factors:

These are inherent in the food. They include:

- Hydrogen ion concentration (pH),
- moisture content,
- nutrient content of the food,
- antimicrobial substances
- biological structure

1. Hydrogen ion concentration (PH)

- Most bacteria grow best at neutral or weakly alkaline pH usually between 6.8 and 7.5.
- Other microorganisms especially yeasts and molds and some bacteria grow within a wide pH range, e.g. molds grow between 1.5 to 11.0, while yeasts grow between 1.5 and 8.5.

Table : pH values of some food products

Food type	Range of pH values
Beef	5.1 - 6.2
Chicken	6.2 – 6.4
Milk	6.3 – 6.8
Cheese	4.9 - 5.9
Fish	6.6 - 6.8
Oyster	4.8 - 6.3
Fruits	< 4.5 (most < 3.5)
Vegetables	3.0 – 6.1

- Microorganisms that are able to grow in acid environment are called **acidophilic microorganisms**.
- These microorganisms are able to grow at pH of around 2.0.
- **Yeasts** and **molds** grow under acid conditions.
- Other microorganisms such as *vibrio cholerae* are sensitive to acids and prefer **alkaline conditions**.
- **Most bacteria** are killed in strong acid or strong alkaline environment except Mycobacteria.

2. Moisture content

- The effect of moisture is in terms of water activity, the amount of free water in a food medium.
- The amount of free water is important for growth of microorganisms.
- If there is lack of this free water microorganisms will not grow.

3. Nutrients content of the food

- Microorganisms require proteins, carbohydrates, lipids, water, energy, nitrogen, sulphur, phosphorus, vitamins, and minerals for growth.
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- Various foods have specific nutrients that help in microbial growth.
- Foods such as milk, meat and eggs contain a number of nutrients that are required by microorganisms.
- These foods are hence susceptible to microbial spoilage.

Antimicrobial substances

- Antimicrobial substances in food inhibit microbial growth.
- Various foods have inherent antimicrobial substances that prevent (inhibit) microbial attack.
- Such inhibitors are like **lactinin** and **anti-coliform factors** in milk and egg-white **lysozyme** in eggs.

Biological structures

- Some foods have biological structures that prevent microbial entry.
- For example, meat has fascia, skin and other membranes that prevent microbial entry.
- Eggs have shell and inner membranes that prevent yolk and egg white from infection.

(b). Extrinsic factors

- Are factors external to the food that affect microbial growth. They include:
 - Temperature of storage,
 - Presence and concentration of gases in the environment
 - Relative humidity of food storage environment.

1. Temperature

- The growth of microorganisms is affected by the environmental temperatures.
- Various microorganisms are able to grow at certain temperatures and not others.
- microorganisms can therefore be divided into the following groups depending upon their optimum temperature of growth.

(i). Psychrophilic

- These grow best at about 20°C but also down to -10°C in unfrozen media.
- Psychrophilic bacteria can cause food spoilage at low temperatures.
- Several of the microorganisms found in the soil and water belong to this group.
- Bacteria of the genera
 - *Achromobacter, Flavobacterium, Pseudomonas, and Micrococcus* are psychrophiles
 - moulds of the genera *Penicillium, Cladosporium* and *Mucor* are psychrophiles.

(ii). Mesophilic

- These organisms grow between 25°C and 40°C, with an optimum growth temperature close to 37°C .
- None of the mesophilic bacteria are able to grow below 5°C or above 45°C.
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- Most pathogenic bacteria belong to this group.

(iii). Thermophilic

- These grow at temperatures above 45°C.
- Often their optimum growth temperatures is between 50°C and 70°C.
- Growth of some bacteria occur at 80°C.
- Bacteria in this group are mainly spore formers and are of importance in the food industry especially in processed foods.
- *Bacillus stearothermophilus* can survive ultra-high-temperature treatment (UHT) of milk (135°C for 2 seconds).

2. Concentration of gases in the environment

- This relates to the presence and concentration of gases in the food environment.
- Various microorganisms require for growth, either high oxygen tension (aerobic), low oxygen tension (microaerobic) or absence of oxygen (anaerobic).
- Some microorganisms may grow either in high oxygen tension, or in the absence of oxygen (facultative anaerobes).

Microorganisms can be grouped into categories based on their requirement to oxygen:

1) **Aerobes**

- Grow in the presence of air that contains molecular oxygen.
- **Obligate aerobes** require oxygen for growth and carry out aerobic respiration.

2) **Microaerophiles**

- Grow only at reduced concentrations of molecular oxygen - 5%

3) Facultative anaerobes

- Can grow in the presence or absence of air. If oxygen is not available, they will carry out anaerobic respiration.

4) Anaerobes

- Do not require oxygen for growth, therefore grow only in the absence of air.
- **Strict anaerobes** are sensitive to oxygen and even to a brief exposure to oxygen will kill such organisms e.g. Clostridium spp

3. Relative humidity

- Relative humidity is the amount of moisture in the atmosphere or food environment.
- Foods with low water activity placed at high humidity environment take up water, increase their water activity and get spoiled easily.
- For example, dry grains stored in an environment with high humidity will take up water and undergo mold spoilage.