

CHAPTER 1

INTRODUCTION OF FOOD MICROBIOLOGY

- 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

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.

How to prevent deterioration of the food by microorganisms?

- Minimize the contact between microorganisms and food
- Eliminate microorganisms from foods
- Understand about preservation of the food

What are the importance of microorganisms in food?

Good (desirable)	Bad (undesirable)
<ul style="list-style-type: none">• Food bioprocessing	<ul style="list-style-type: none">• Foodborne disease
<ul style="list-style-type: none">• Food biopreservation	<ul style="list-style-type: none">• Food spoilage
<ul style="list-style-type: none">• Probiotics	

GOOD (DESIRABLE)

Food bioprocessing

- 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.

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).

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.

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

- Microorganisms used food supply as a source of nutrients by their own growth.

- Spoilage leads to wastage of food and economic loss.

PROBIOTICS

Definition:

Probiotic is a concentrated supplements of beneficial live bacteria culture taken orally intended to improve our health. It is a friendly bacteria which play vital role in keeping us fit and healthy.

Probiotics means “for life”

The good friendly bacteria are good because they promote the body's natural to keep our body fit and to help our digestion.

Advantages

1. By increasing the absorption of mineral and vitamins and it also can improve digestion system especially of milk product. In our food, only vitamins that properly absorbed and digested are useful. Probiotics also improve lactose intolerance.
2. Taking probiotics can support out immune system which is fight bad bacteria and infection in keeping s cope from being run down. It produced antimicrobial substances that can deter various bad bacteria. It is so important because many of the disease begin in the intestinal tract.
3. Produced specific protein that act as antigen and stimulates the immune system.

4. Increase the absorption of calcium, important mineral in the prevention of osteoporosis.
5. Preventing intestinal tract infections that are caused by *Candida spp.* and *Helicobacter pylori*.
6. Normalising bowel elimination problems and promoting regularity.
7. Clean the colon and improve constipation.
8. Fights pathological moulds, yeast, fungus, viruses, parasites and bacteria.
9. Stimulates β -lymphocytes and related antibody production.
10. Supporting healthy liver function.
11. Alleviating bowel wind, bloating and flatulence.
12. Assisting in cholesterol management.

The example of probiotics in food

Milk- baby milk 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*.

Buttermilk- *Lactobacillus bulgaricus*

Side effect of probiotics to human

Even though probiotic are beneficial bacteria, sometimes it can cause indirect or long term side effect especially if taken inappropriately.

Factors that can produce side effect:

- a) Probiotics supplement in food are not safe or not working inside the body.
- b) Product that has been taken (food) did not deliver probiotics to specific area to perform its function.
- c) Not all probiotics product in market today are created sufficiently enough for body necessity. Some of them are over concentrated and some are less than minimal requirement.

Side effect that occurs include:

- a) Excessive drainage syndromes.
- b) Headache.
- c) Diarrhea.
- d) Bloating.
- e) Constipation.
- f) Production of intestinal gas.

Bacteria in the intestine

The variable and greatest number of bacteria lives in large intestine.

Lactobacillus acidophilus guard small intestine.

Bifidobacter protect large intestine.

Lactobacillus bulgarium is a travelling transient bacteria that aids the two it bases through our body.

CHAPTER 2

CHARACTERISTICS OF PREDOMINANT MICROORGANISM IN FOOD

Mophology and structure of microorganisms

a) Moulds

- Eucaryotics cells*
- Multicellular
- Non motile, filamentous and branched
- Compose of large numbers of filaments called hyphae which are aggregated and called mycelium
- Reproduction occurs from spore formation
- Eg: *penicillium spp*

b) Yeasts

- Eukaryotic cells*
- Unicellular
- Oval, spherical or elongated
- Non motile, can see budding formation
- Eg: *Sacchromyces cerevisiae*

Eukaryotic cells* - generally are:

- Larger cells (20 to 100µm)
- Cells have rigid cell walls and thin plasma membrane

- Cytoplasm contains organelles such as mitochondria and vacuoles

c) Bacteria

- Prokaryotic cells
- Unicellular
- Three morphology forms:
 - Spherical (cocci) – eg: *streptococcus spp*
 - Bacilli (rod) - eg: *bacillus spp*
 - Curved (coma) – eg:
- Can be motile or non motile
- The cytoplasmic materials are enclosed in a rigid wall on the surface and a membrane beneath the wall
- The organelle does not enclosed in a separate membrane
- Bacterial are grouped as:

Gram negative = contain outer membrane which is compose of lipopolysaccharides (due to many enzymes, antibiotics, salts, etc)

Gram positive = have thick wall composed of several layers of mucopeptide and teicnoic acids

d) Viruses

- Non cellular entities
- Most important: bacteriophages (bacterial viruses)
- Virus contain nucleic acid (DNA and RNA) and protein

FOOD SPOILAGE

1. INTRODUCTION

- Food spoilage can be defined as any changes in the visual, smell and texture of food that makes it unacceptable for consumption.
- Most serious economic problem in food processing industry.
- Foods are subject to attack by microorganisms in a variety of ways. Such attack is harmful to the quality of food.
- Foods are organic substance and hence provide adequate nutrients for the growth of wide varieties of microbes.
- The physical and chemical characteristics of food and how it is stored determine the susceptibility to microbial attack.
- Spoilage may be due to one of the following:
 - a. Growth and activity of microorganisms.
 - b. Insects.
 - c. Action of enzymes to the plant and animal food.
 - d. Chemical reactions.
 - e. Physical changes (freezing, burning, drying,

pressure)

2. TYPE OF FOOD SPOILAGE

- a. Physical spoilage
 - Dehydration of vegetable
- b. Chemical spoilage
 - Oxidation of fat
 - Browning of fruits and vegetables
- c. Microbial spoilage
 - Growth of microorganisms
 - Enzyme production

3. CRITERIA / PARAMETERS ASSOCIATED WITH FOOD SPOILAGE

- Odour
- Texture
- Shape
- Formation of slime
- Colour
- Flavour
- Gas production

4. SEQUENCE OF EVENTS IN FOOD SPOILAGE

Microorganisms have to get into the food
from a source or more



Food environment should favour
the growth of microbes



Food need to be stored under the growth
condition for a sufficient length of time:

- To allow sufficient number necessary to cause spoilage or changes in food.
- To allow the produced enzyme to spoil the food.

5. HOW SPOILAGE OF FOOD IS DONE BY MICROORGANISMS?

These microorganisms use the food as their source of nutrients for growth. By increasing their numbers, utilizing nutrients, producing enzymatic changes and contributing off flavours by means of breakdown of a product or synthesis of new compounds; microorganisms can spoil the food.

6. WHY DOES YOUR FOOD CONTAIN MICROORGANISMS?

- The interaction between microorganisms, plant and animal are natural and constant. The food supply consists basically of plants and animals and products derived from them; it is understandable that our food can contain microorganism in interaction with the food.
- Food are derived from the soil (directly or indirectly) which is the habitat for most microorganisms.
- Microorganisms can also originated from exposure to air, water or from natural microflora present in food as commensals.

7. CLASSIFICATION OF FOOD

- Perishability is a function of moisture content (A_w).
- Stable food are those with low moisture content (low A_w) whereas unstable foods have high water content (high A_w)
- To avoid any spoilage, food must be stored under condition that microbial growth is slow or do not occur at all.

- Foods can be classified into three groups based on ease of spoilage:

I. Stable or non perishable foods.

Foods which do not spoil unless handle carelessly.
Example: Sugar, flour and dry beans.

II. Semi perishable foods.

If these foods are properly handled and stored, they will remain unspoiled for a fairly long period.
Examples: potatoes, apples and nuts.

III. Perishable foods.

This group includes most of our important daily foods that spoil readily unless special preservative methods are used. Examples: meats, fish, milk, vegetables, eggs and etc.

IMPORTANT MICROORGANISMS IN FOOD

A. IMPORTANT MOLD GENERA

1. Genus *Aspergillus*

- Widely distributed and contain many species important in food.
- Septate hyphae and produce asexual spores on conidia.
- Xerophilic; causing spoilage in grains, jams, nuts and vegetable.
- Example: *Aspergillus flavus* produce aflatoxin (a kind of mycotoxin)
- Strains used in food processing:
 - i. *A.oryzae* : hydrolyze starch in sake production.
 - ii. *A.niger* : citric acid production.

2. Genus *Geotrichum*

- Septate hyphae and produce arthrospore.

- Grow and forming a yeastlike cottony, creamy colony.
- Often grow on dairy products. Example: *Geotrichum candidum*

3. Genus *Mucor*

- Widely distributed
- Nonseptate hyphae and produce sporangiophores
- Some species are used in food fermentation and others can cause spoilage of vegetables e.g: *Mucor rouxii*

4. Genus *Rhizopus*

- Hyphae are aseptate and form sporangiophores
- Common in spoilage of foods and vegetables
- *Rhizopus stolonifer* : common black bread mould

5. Genus *penicillium*

- Widely distributed and contain many species

- Septate hyphae and form conidiophores on a brushlike conidia head. *penicillium roquerfortii* and *Penicillium camembertii* are used in cheese production.
- Some species can cause spoilage in fruits, vegetables, grains, bread etc.
- The can also produce mycotoxin

B. IMPORTANT YEAST GENERA

1. Genus *saccharomyces*

- Cells may be round, ovate, and elongated.
- Reproduction is by budding or by aospore formation.
- *S.cerevisiae* is employed in many food industries e.g bread manufacturing, wines, alcohol etc.
- *S.fragilis* and *s.lactis* is important in milk and milk products because they are common spoilage microorganism.

2. Genus *Torulopsis*

- General spoilage yeast.

- Spoils a variety of food products e.g.: beer, milk products, fruit juices and some refrigerated foods.

3. Genus *Candida*

- Many spoil foods with high acid, salt and sugar form pellicle on the surface of liquids.
- Some can cause rancidity in butter and dairy products e.g: *Candida lipolytica*.
- Can form pseudohyphae or true hyphae with many budding cells.

4. Genus *Rhodotorula*

- Red, pink or yellow yeasts may caused discolourations on food such as in meat, fish and sauerkraut.

5. Genus *Pichia*

- Oval or cylindrical yeasts may form pseudomycelia.
- Ascospores are round or hat shaped.
- Form pellicle in beer, wine and brine.

C. IMPORTANT BACTERIA GENERA

1. Genus *Bacillus*

- Different species may be mesophilic or thermophilic, lipolytic or proteolytic.
- Spores produce by this bacteria are generally heat-resistant.
- Some species may cause foodborne diseases (*Bacillus cereus*) and food spoilage in canned products (*Bacillus coagulans* and *Bacillus stearothermophilus*)
- The soil is an important source of this species.

2. Genus *Clostridium*

- Rod shaped cells, anaerobic and form endospores.

- Found in soil, marine sediments, animal and plant products.
- Some are pathogens e.g.: *Clostridium botulinum* and *Clostridium perfringens* while others are important in food spoilage.
- *C.perfringens* cause stormy fermentation in foods (disruption of curd in milk)

3. Genus *Escherichia*

- Found in faeces, gram negative rod isolated from the intestinal tract of warm blooded animals.
- E.g. *Escherichia coli* used as an indicator of sanitation in the coliform and fecal coliform group.
- Many strains are non-pathogenic but some can be pathogenic to humans and animals (foodborne disease).

4. Genus *Lactobacillus*

- Rod shaped facultative anaerobic, non-motile, mesophilic.
- Can be homo or heterolactic fermentors.

- Found in plant sources, milk, meat and feces.
- Usage:
 - i. Food bioprocessing: *L. bulgaricus*,
L. lactis.
 - ii. Probiotics: *L. acidophilus*
- Spoilage:
 - i. Wine or beer production.
 - ii. Cheese making.
 - iii. Can survive pasteurization.

5. Genus *Pseudomonas*

- Gram negative, aerobic, rod shaped, motile.
- Important in fish and meat spoilage.
- E.g: *P.aeruginosa* and *P.fluorescens*.

6. Genus *Staphylococcus*

- *S. aureus* are frequently involved in foodborne diseases.
- It usually gives yellow to orange growth.
- Many beta haemolytic, coagulase positive strains are pathogenic and produce enterotoxin which causes food poisoning.

7. Genus *Streptococcus*

- *Streptococcus pyogenes* - important in foodborne diseases. A cause of human septic sore throat, scarlet fever. Can be found in raw milk.
- *Strep. Thermophilus* is important in cheese making and yogurt.

D. **GRUOPS OF BACTERIA IMPORTANT IN FOOD BACTERIOLOGY**

1. Lactic Acid Bacteria
2. Acetic Acid Bacteria
3. Butyric Acid Bacteria
4. Propionic Acid Bacteria
5. Proteolytic Acid Bacteria
6. Lipolytic Acid Bacteria
7. Saccharolytic Bacteria
8. Thermophilic and Thermoduric Bacteria

9. Halophilic and Osmophilic Bacteria
10. Pigmented Bacteria
11. Slime or Rope Forming Bacteria
12. Gas Forming Bacteria
13. Fecal and Non-fecal Coliform group

1. Lactic Acid Bacteria

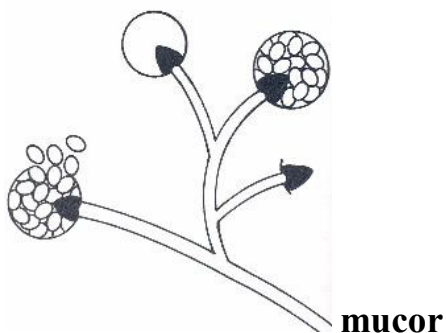
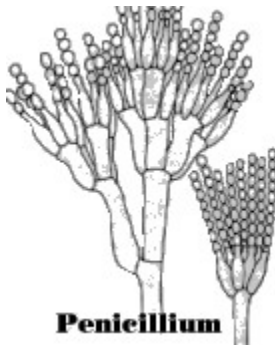
- Ability to ferment sugars to lactic acid e.g: important in cheese making but undesirable in term of spoilage of wines.
- Major genera: *Leuconostoc*, *Lactobacillus*, *Streptococcus*, *Pediococcus*.

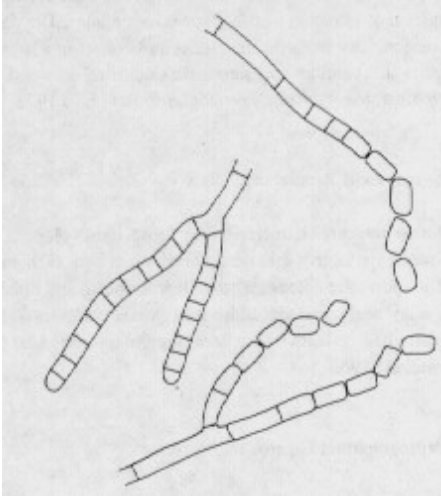
2. Proteolytic Bacteria

- Produce extracellular proteases (enzymes which diffuse outside of the cells) and catalyzes the breakdown of protein.
- Important genera : *Bacillus*, *Pseudomonas*, *Clostridium*, *Proteus*

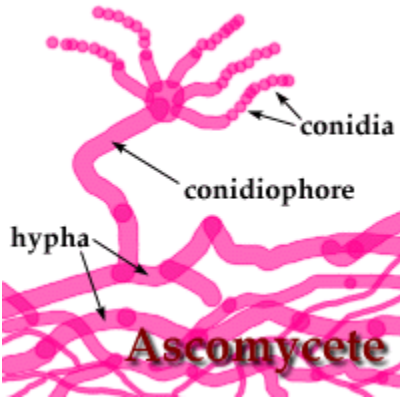
3. Fecal coliform and coliform group

- Definition: Short rods, aerobic or facultative anaerobes, gram negative, non-spore forming bacteria which ferment lactose with gas forming.
- Major genera: *Escherichia*, *Enterobacter*
- The fecal coliform groups includes coliforms capable of growth at an elevated temperature (44.5°C)

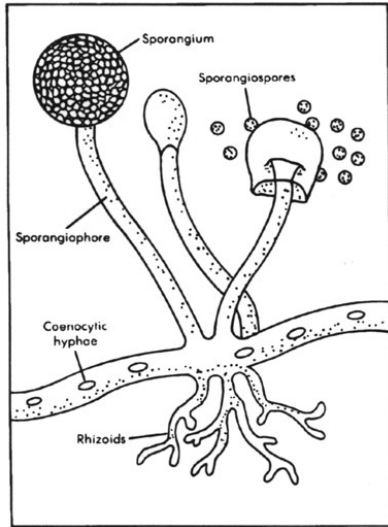




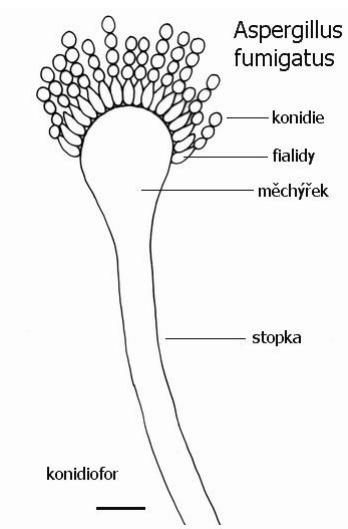
geotrichum



neurospora (monilia)



rhizopus



aspergillus