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INDUSTRIAL MICROBIOLOGY
Lec. 5
Role of Microorganisms in dairy products
by

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1. Introduction

Microorganisms (bacteria, yeasts, molds) play essential roles in transforming milk into a variety of dairy products.

Their activities influence:

- Flavor
- Texture
- Aroma
- Shelf life
- Nutritional value
- Safety

Dairy microbiology includes both **beneficial microbes** (used in fermentation) and **spoilage or pathogenic microbes** (unwanted).

2. Beneficial Microorganisms in Dairy Industry

A. Lactic Acid Bacteria (LAB)

These are the most important microbes in dairy fermentation.

Common LAB species

- *Lactococcus lactis*
- *Streptococcus thermophilus*
- *Lactobacillus delbrueckii* subsp. *bulgaricus*
- *Lactobacillus acidophilus*
- *Leuconostoc mesenteroides*

Functions of LAB

- Convert **lactose** → **lactic acid** (acidification)
- Lower pH → inhibits pathogens
- Curd formation (coagulation of casein)
- Contribute flavor compounds (diacetyl, acetaldehyde)
- Improve texture and viscosity
- Produce bacteriocins (e.g., nisin)

B. Yeasts in Dairy Fermentation

Important species

- *Kluyveromyces marxianus* (ferments lactose)
- *Saccharomyces cerevisiae*
- *Candida kefyr*



Roles

- Produce $\text{CO}_2 \rightarrow$ gas/effervescence (kefir)
- Produce alcohol and flavor compounds
- Utilize lactic acid \rightarrow prevents over-acidification

C. Molds in Dairy Fermentation

Important species

- *Penicillium roqueforti* (blue cheese)
- *Penicillium camemberti* (Camembert, Brie)
- *Geotrichum candidum* (surface-ripened cheeses)

Roles

- Lipolysis (breakdown of fats \rightarrow aroma)
- Proteolysis \rightarrow softening of texture
- Color development (blue/white mold)
- Surface rind formation

3. Microorganisms in Major Dairy Products

A. Yogurt

Starter cultures

- *Streptococcus thermophilus*
- *Lactobacillus delbrueckii* subsp. *bulgaricus*

Roles

- Acid production \rightarrow coagulation
- Aroma compounds (acetaldehyde)
- Improved digestibility (lactose breakdown)
- Probiotic effect (in some forms)

B. Cheese

Microbial groups

1. Starter LAB \rightarrow acidification
2. Adjunct cultures:
 - *Propionibacterium freudenreichii* \rightarrow CO_2 holes in Swiss cheese
 - *Penicillium camemberti* \rightarrow surface-ripening
 - *Penicillium roqueforti* \rightarrow blue veins
3. Non-starter LAB \rightarrow flavor development during ripening
4. Yeasts and molds \rightarrow rind formation



Microbial contributions to cheese

- Proteolysis → texture + flavor
- Lipolysis → aroma
- Production of carbon dioxide → eye formation
- Deacidification during ripening

C. Butter

Major microbe

- *Lactococcus lactis* subssp. *lactis* & *cremoris*
- *Leuconostoc* species → produce diacetyl

Roles

- Flavor development (diacetyl)
- Controlled fermentation of cream

D. Kefir

Microbial composition

- LAB: *Lactobacillus kefiri*, *Lactococcus*, *Leuconostoc*
- Yeasts: *Saccharomyces*, *Kluyveromyces*
- Acetic acid bacteria

Roles

- Produce CO₂ & ethanol → effervescence
- Synergistic fermentation
- Health benefits (probiotics)

E. Sour Cream

Cultures

- *Lactococcus lactis*
- *Leuconostoc mesenteroides*

Roles

- Lactic acid production
- Flavor compounds (diacetyl)
- Thickening of cream



F. Probiotic Dairy Products

Common probiotic bacteria

- *Lactobacillus acidophilus*
- *Lacticaseibacillus rhamnosus*
- *Bifidobacterium bifidum*
- *L. casei, L. plantarum*

Health benefits

- Improve gut microbiome
- Enhance immunity
- Reduce lactose intolerance
- Antimicrobial effects

4. Microorganisms Causing Dairy Spoilage

Spoilage bacteria

- *Pseudomonas* spp. → proteolysis, off-flavors
- *Bacillus* spp. → spore-formers, coagulation defects
- *Coliforms* → gas formation

Yeast

- *Candida, Torulopsis* → cause off-flavors, gas

Molds

- *Mucor, Aspergillus, Penicillium* → surface spoilage

5. Pathogenic Microorganisms in Milk (Food Safety)

Examples

- *Listeria monocytogenes*
- *Salmonella* spp.
- *E. coli* O157:H7
- *Brucella* spp.
- *Staphylococcus aureus* (enterotoxin)
- *Mycobacterium bovis*



Control methods

- Pasteurization
- Sanitation
- Rapid cooling
- Good manufacturing practices (GMP)
- HACCP systems

6. Industrial Use of Microbial Enzymes in Dairy

Microorganisms also produce enzymes used in dairy processing:

Examples

- **Rennet substitutes** (microbial proteases)
- **Lactase enzyme** → lactose-free milk
- **Lipases** → flavor enhancement
- **Catalases, peroxidases** → quality control

7. Advantages of Microbial Fermentation in Dairy Industry

- Preservation of milk
- Development of unique flavors
- Improved nutritional value
- Probiotic benefits
- Increased shelf life
- Safety (acidification inhibits pathogens)