

# Lesson 3

## Fermented foods

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# 1. Introduction

## Microorganisms involved in food fermentation

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- ✓ Acetic acid bacteria (vinegar)
- ✓ Propionic acid bacteria (emmental cheese)
- ✓ Moulds (cheese, soy sauce, Sake, Tempeh)
- ✓ Lactic acid bacteria
- ✓ Yeasts

# 1.1. Lactic Acid Bacteria (LAB)

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- Gram-positive
- Asporogenic
- Aerotolerant anaerobic (catalase negative)
- Ferment glucose producing:
  - Mainly lactic acid (**homofermentatives**)
  - Lactic acid, CO<sub>2</sub>, ethanol/acetate (**heterofermentatives**)

# Activities of LABs in food

- Lactic fermentation
- Malolactic fermentation                      Malic acid  $\longrightarrow$  Lactic acid

Improves wines (reduces acidity, improves body and tasting..)

- Antimicrobial activity
  - Acid pH (3,5-4,5)
  - Organic acids (Lactic and Acetic)
  - Ethanol (heterofermentation)
  - Bacteriocins (Nisin)
  - H<sub>2</sub>O<sub>2</sub>
  - Diacetyl.....

## Health-promoting effects

- Relief lactose intolerance
- Stimulation of immune system (activate macrophages, increase levels of IgA and  $\gamma$ -interferon)
- Antitumor effects (reduce activity of enzymes that transform pro-carcinogens in carcinogens)
- Hypocholesterolaemic action
- Inhibition of gut pathogens (shorter duration of diarrhoea in human infants)

# 1.2. Yeasts

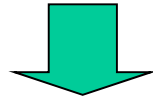
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- *Saccharomyces cerevisiae*: (Fermentations of fruits and vegetables)
  - Aerobiosis: oxidation  $\longrightarrow$  CO<sub>2</sub> + H<sub>2</sub>O (biomass)
  - Anaerobiosis: fermentation  $\longrightarrow$  ethanol + CO<sub>2</sub>
- *Debaryomyces hansenii*: halotolerant (meat in brine, fermented sausages)
- *Kluyveromyces marxianus* (milk fermentation: Kefir, Koumiss, butter)  
Hydrolyze lactose and ferments galactose
- *Schizosaccharomyces pombe* (tropical fermented beverages)
- *Zygosaccharomyces rouxii*: osmo-halo-tolerant (fermentation of vegetables in brine)

## 2. Fermented Meats

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Unprocessed (non-pasteurized) Meat (decontamination with acid solutions)



+ Salts + Spices + Glucose + Starters



15-40°C / 20-60 h (controlled humidity)



Smoked, drying, pasteurization, refrigeration?

LABs (*Lactobacillus*, *Pediococcus*)

Nitrate-reducing bacteria (*Stph.*, *Micrococcus*)

Lipolytic (*Micrococ*, *Penicillium*, *Debaryomyces*)

# 3. Fish fermentations

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Very perishable

neutral pH,  $\uparrow\uparrow$  water and soluble nutrients (nitrogen compounds)


*Rigor Mortis* limited (pH > 6,2)

- **Fish sauce** (Nam Pla): Fish, shelfish (viscera, plankton) + 25% NaCl


3-18 months / 25-35°C : fermentation + autolysis

Filtration and maturation (months)

- **Fish paste**: partially dehydrated (sun-dried, salted), limited autolysis

- **Fish + vegetables** (Izushi): fish meat + 10-20% salt  Sun-dried

Botulism

Lactic fermentation (< 1month)  Vegetables (rice, garlic)





# **4. Fermented Milk**

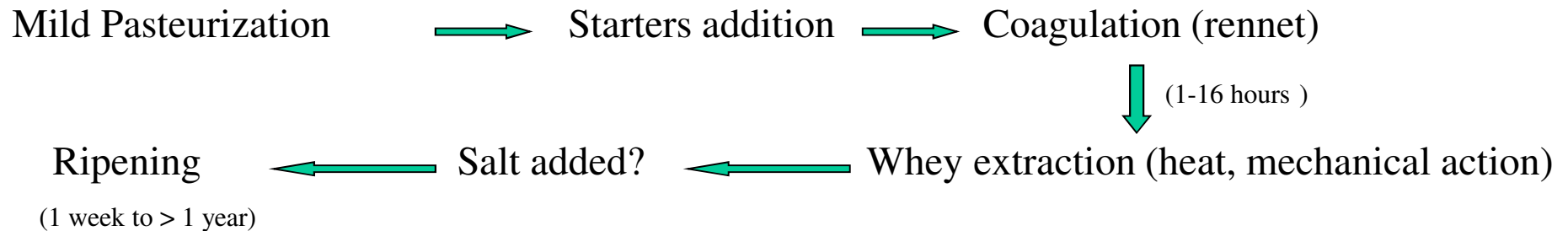
4.1. Cheese

4.2. Yoghurt

# 4.1. Cheese

(Consolidated curd of milk solids in which milk fat is entrapped by coagulated casein)

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## Starters:

*Lc. lactis* + *Lc. cremoris* : Low cooking temperature

*Strep. thermophilus* + *Lb. bulgaricus*: High cooking temperature

+ *Propionibacterium freudenreichii*: Emmental

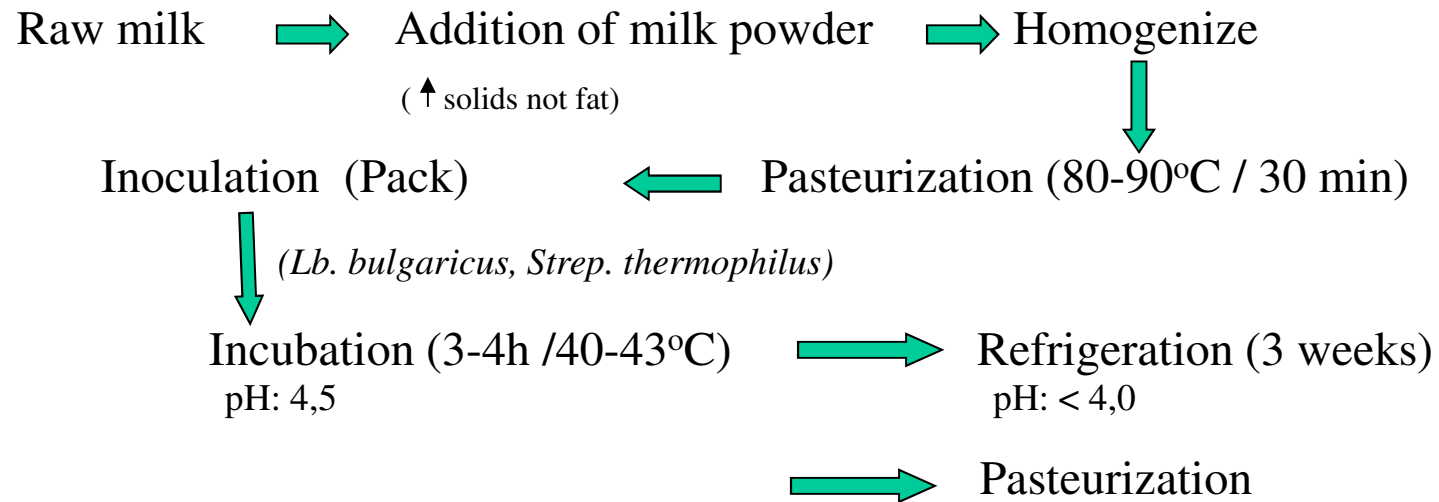
+ *Penicillium roqueforti*: Mould ripened (Roquefort, Cabrales, Blue)

+ *Penicillium camemberti*: Soft cheese (Brie, Camembert)

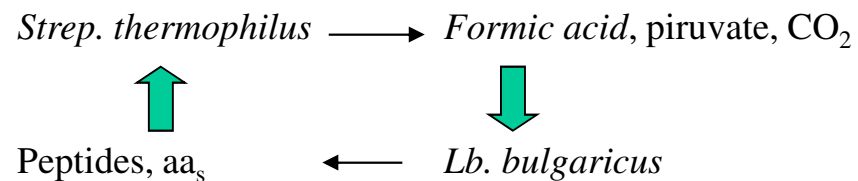
**Problems: Antibiotics, Phage infections**

# 4.2. Yoghurt

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## Cooperative fermentation:



### **Problems:**

- Phage infections
- Antibiotics

# 5. Vegetable Fermentations

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**Natural Fermentation** (no blanching)

**Salting:** selection of LABs + inhibition of pectinolytic enzymes

*Leuco. mesenteroides* → *Lb. brevis* + *Pediococcus cerevisiae* → *Lb. plantarum*

Acidification (pH < 3,8) + anaerobiosis + aromatic substances

**Problems:**

Listeriosis

Spoilage by yeasts (inhibition of LABs due to low pH → ↑ [saccharides] )

**!!Buffered brines!!**