



CULTURES USED IN DAIRY INDUSTRY

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graph TD; A[INTENTIONALLY ADDED MICROORGANISMS] --> B[Primary Cultures (Starter laktik asit bakterileri)]; A --> C[Secondary (Adjunct) Cultures]
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INTENTIONALLY ADDED MICROORGANISMS

Primary Cultures (Starter
laktik asit bakterileri)

Secondary (Adjunct)
Cultures

Primary (starter) culture

- These microorganisms are also called as “**starter bacteria,**” “**lactic cultures,**” or **starter lactic acid bacteria (LAB)** because of their properties **to start (initiate) the production of lactic acid from lactose** (Parente and Cogan, 2004).
- In this respect, the primary role of starter bacteria is to acidify the milk and decrease its pH.
- **Starter culture:** ‘Microorganisms used to obtain standard products under controlled conditions.’
- Lactic acid bacteria are accepted as GRAS (Generally Recognized As Safe)

Primary (starter) culture

Major functions of starter cultures:

- To **develop lactic acid in the product**, increasing acidity, lowering pH
- To limit the growth/activities of unwanted and pathogenic bacteria by their **antimicrobial activity (mainly depend on bacteriocin synthesis)**,
- **To improve taste, aroma and texture** by producing aroma components such as acetic acid, acetaldehyde and diacetyl
- To promote human health if the culture has probiotic properties,
- Contributing to ripening with enzyme systems.

Primary (starter) culture

- Mesophilic Starter Cultures (opt. 20-30 °C) -cheese, fermented milk
 - *Lactococcus lactis subsp. lactis*,
 - *Leuconostoc lactis*,
 - *Leu. mesenteroides subsp. cremoris*
- Thermophilic (opt. 37-45 °C) Starter Cultures -Yoghurt
 - *Streptococcus thermophilus*,
 - *Lactobacillus helveticus*

Types of starter cultures

- defined starter culture: usually composed of one or more strains with known characteristics (The individual strains in defined starter cultures are usually isolated from undefined complex starter cultures to obtain single strain cultures)
- undefined starter cultures: mix and complex cultures (Undefined starter cultures; usually originate from production plants, environments, or farms. e.g. During artisanal productions, usually undefined cheese starter LAB appear)

Defined starter LAB:

- Several genera of LAB, including *Lactobacillus delbrueckii* subsp. *lactis*, *Lactococcus lactis* subsp. *lactis*, *L. lactis* subsp. *cremoris*, *Leuconostoc* spp., *Streptococcus thermophilus*, and *Lactobacillus helveticus*

- Defined starter cultures are generally more vulnerable to bacteriophage attacks than undefined complex starters

What is Bacteriophage?

Bacteriophage or phage are viruses that infect bacteria. It causes bacterial cells to lyse (penetrate the cell and reverse the bacterial metabolism to form new phage particles)

Defined (commercial) starter cultures are much more susceptible to bacteriophage attacks (subject to rotation in production alternately)

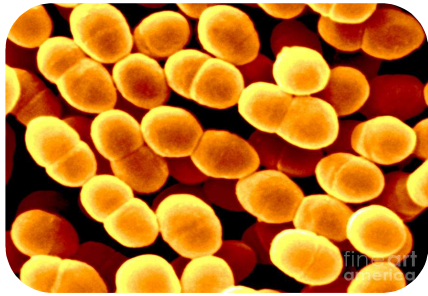
Undefined (non-commercial, such as NSLAB) cultures are resistant to bacteriophage.

e.g Nisin (inhibits the development of Clostridium species, which are capable of forming gas by fermenting lactate).

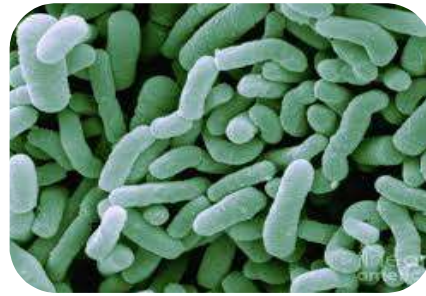
Bacteriophage resistance of cultures

- The number of subpass/sub-culture/passage should be reduced
- Rotation should be preferred
- Phage sensitive strains should be eliminated (To use phage resistant cultures)
- Culture preparation department should be separated from production
- DVI (Direct Vat Inoculation) and DVS (Direct Vat Set) usage can be preferred
- Sanitation conditions should be improved

Main starter cultures in dairy industry



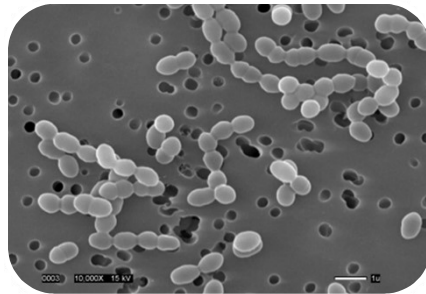
Lactococcus
spp.,



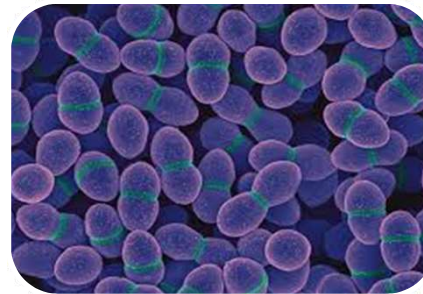
Lactobacillus
spp.,



Streptococcus
spp.,



Leuconostoc
spp.



Enterococcus
spp.

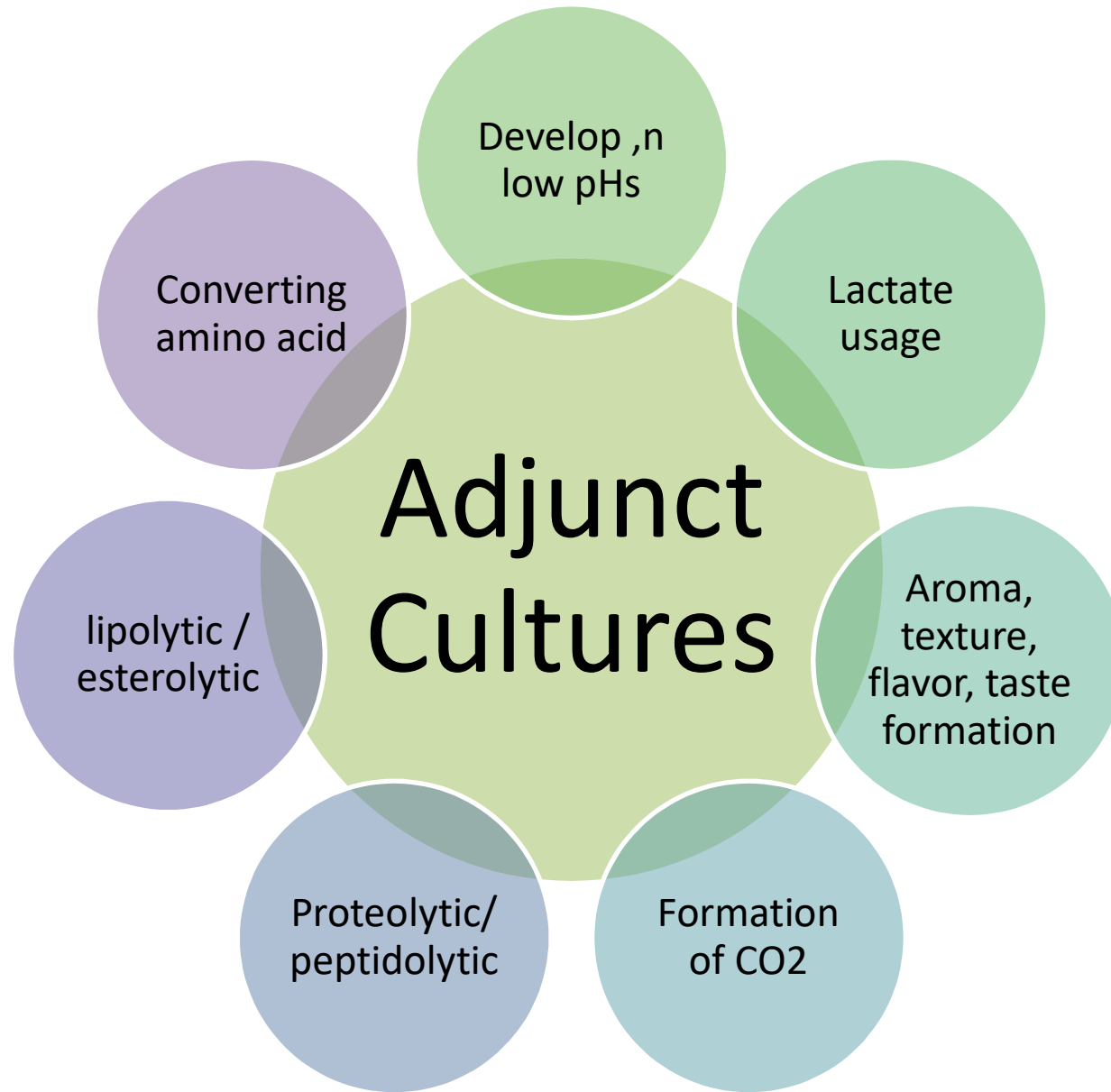
Secondary (Adjunct) Cultures

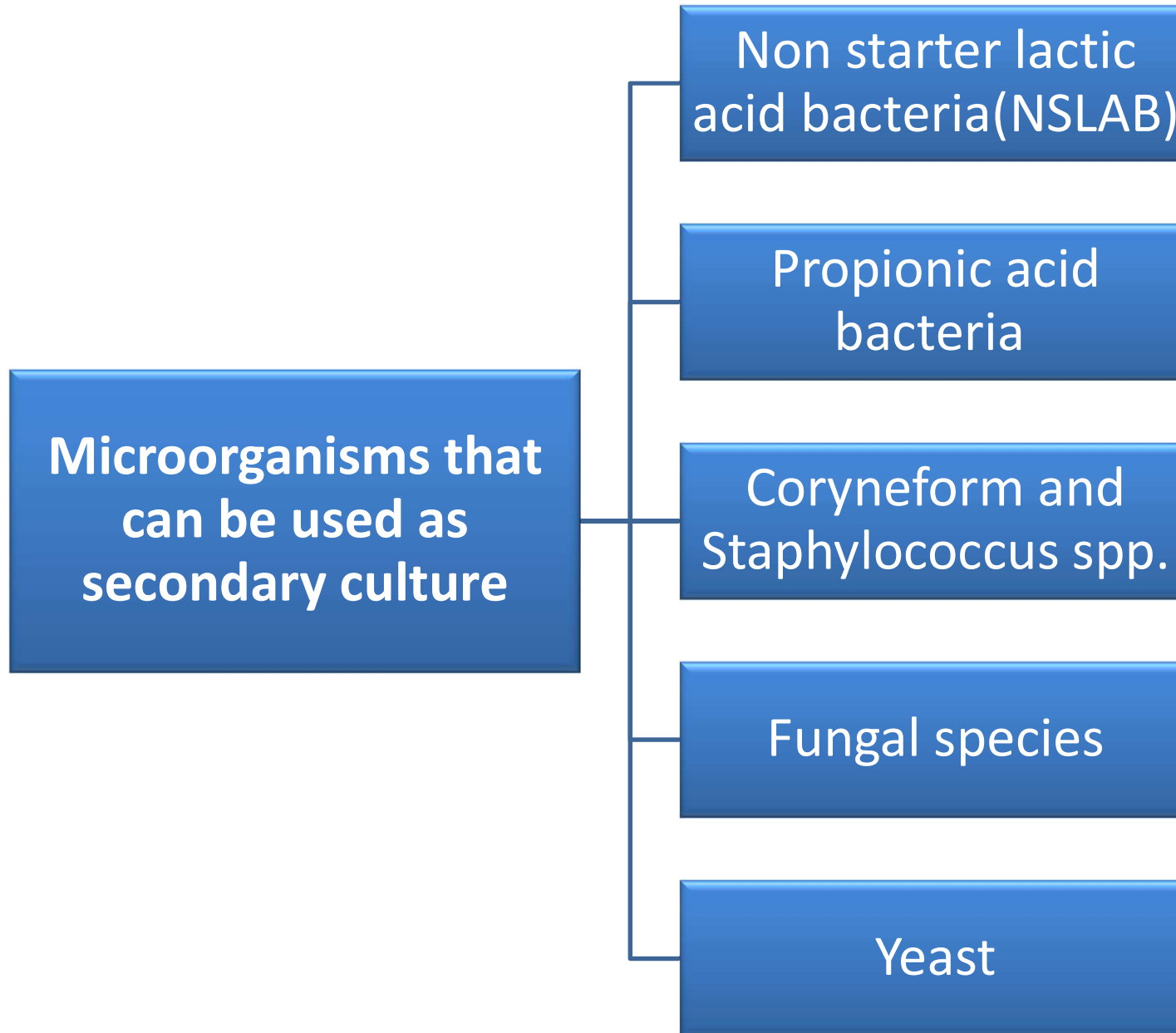
- These microorganisms are deliberately added as adjuncts to blends of the primary acid-producing starter cultures
- They have no function in lactic acid production and are only involved in ripening.
- Their major role is to contribute to the biochemical changes through their diverse enzymatic systems, thus formation of aroma, taste, texture.
- Secondary cultures can be bacteria, yeast, or fungi

Secondary (Adjunct) Cultures

They can be incorporated into milk or applied deliberately on to the surface of cheese;

- *Brevibacterium linens*, *Arthrobacter* spp., and coryneform bacteria in surface-ripened cheeses such as Tilsit, Munster, and Limburger,
- *P. roqueforti* in Blue-veined cheeses,
- *P. camemberti* in Camembert cheese,
- *Propionibacterium freudenreichii* subsp. *shermanii* in Swiss-type cheeses
- *Geotrichum candidum*, *D. hansenii*, and *Kluyveromyces* spp. .





UNINTENTIONALLY ADDED (ADVENTITIOUS) MICROORGANISMS

- This group of microorganisms are the most important contributors to the ripening in raw milk cheeses.
- They tolerate the hostile environment well and strongly influence the biochemistry of curd maturation, contributing to development of the final characteristics of cheese.
- The best example of this group of microorganisms are **Non-Starter lactic acid bacteria (NSLAB)**.

Nonstarter lactic acid bacteria (NSLAB)

- NSLAB are naturally occurring microorganisms present in milk or beneficial contaminants originated from cheese production environments.
- The presence of NSLAB in cheese was reported to lead to an increase in the level of small peptides and amino acids in cheese and consequently they were reported to play a role in secondary events, such as **flavor formation**.

Nonstarter lactic acid bacteria (NSLAB)

- Other than the favorable effects, NSLAB also introduced variability into the ripening process that can result in fluctuations in the final characteristics .
- Due to these properties, significant differences were reported between cheeses produced at the same factory on different days and between cheeses from different vats of the same day.
- To minimize microbial variability during the ripening process, the dominance of desired NSLAB could be selected and used as a secondary

Nonstarter lactic acid bacteria (NSLAB)

Lactobacillus

- *Lb. casei*
- *Lb. plantarum*
- *Lb. curvatus*
- *Lb. paracasei*
- *Lb. brevis*

Pediococci

- *P. acidilactici*
- *P. pentosaceus*

Enterococci

- *Enterococcus durans*
- *E. faecalis*
- *E. Faecium*

Leuconostoc

- *Leuconostoc mesenteroides* subsp. *cremoris*
- *Leu. lactis'dir*

Properties of starter cultures

- Must be resistant to temperature changes and salt
- Must show resistance to bacteriophage
- Should not have an allergic reaction
- Should not be toxic or pathogenic
- No antibiotic resistance
- Should not be lysogenic bacteria (bacteria carrying prophage in its DNA)
- Strains should be in harmony with each other (mix strains)
- Technological properties must be appropriate (acid forming, proteolytic, lipolytic, aroma-forming activities)
- Should produce inhibitory substance such as bacteriocin, H₂O₂, etc
- Shouldn't produce biogenic amines

Probiotics

Probiotics are live microorganisms that, when administered in adequate amounts, confer a health benefit on the host, influencing positively the gut microbiota

In order for a microorganism to be evaluated as a probiotic, it must have certain criteria:

- human origin,
- non-pathogenic, non-toxic,
- resistant to degradation by gastric and pancreatic juices,
- must be found in an appropriate number of viable cells (at least 1×10^7 CFU/g) ,
- must be able to adhere to the intestinal epithelium,
- must be able to colonize the gastrointestinal tract/survive in the gastrointestinal system,
- must be a producer of antimicrobial substances,
- must be a modulator of the immune response,
- having a proven beneficial effect on human health,
- maintain the stability in the product,
- having acceptable sensory properties.

HEALTH EFFECTS OF PROBIOTICS

- Prevention of Diarrhea
- Effect on Lactose Intolerance
- Cholesterol Lowering Effect
- Improvement of Immune System
- Anticarcinogenic Effect
- Other
 - Prevention of gastritis and ulcer through the inhibition effect on the activity of *Helicobacter pylori*
 - Prevention of uregenital infection by inhibition effect on the of activity of *Candida albicans*
 - Increase the synthesis of vitamin B
 - Prevention of dental caries by the way of antimicrobial activity against *Streptococcus* spp.
 - Reducing allergic reactions such as atopic eczema

Prebiotics

Prebiotic is a non-digestible substance of food origin which, when administered in adequate amounts, is beneficial to the consumer due to the selective promotion of growth and/or activity of one or more bacteria already present in the gastrointestinal tract or taken together with the prebiotic.

Prebiotics must have some particular characteristics:

- They must not be hydrolyzed nor absorbed in the upper digestive tract.
- They must represent a selective substrate for one or more beneficial bacterial species in the colon stimulating their growth or activity.
- They must be able to modify the intestinal microflora of the colon promoting a healthy composition

Prebiotics are used only by beneficial microorganisms that colonize the gut.

Synbiotics

- The products formed by the use of probiotics and prebiotics are called synbiotics.
- With synbiotic application, probiotic bacteria can survive longer and can proliferate better in the colon.
- The aim of the using synbiotic products is to increase the beneficial effects of bacteria on host's health..

Functional foods

- Functionality for foods can be explained as having a **physiological and metabolic effect on human health**, apart from the nutritional properties of food
- Functional food means foods that benefit body health beyond basic nutrition. Therefore, functional foods are very important in terms of **health improvement, risk reduction and prevention of diseases**