





1,000
bacteria
/ portion

500,000,000
bacteria / portion

2,000,000,000
bacteria / portion

**THE GOOD, THE BAD
& THE UGLY ...
our daily intake**

Average American: 1.39×10^6 cfu /day

USDA recommended diet: 1.26×10^9 cfu /day

Lang et al., 2014:
The microbes we eat: abundance and taxonomy of microbes
consumed in a day's worth of meals for three diet types

European diet (with fermented components):
 $> 10^{10}$ cfu/day

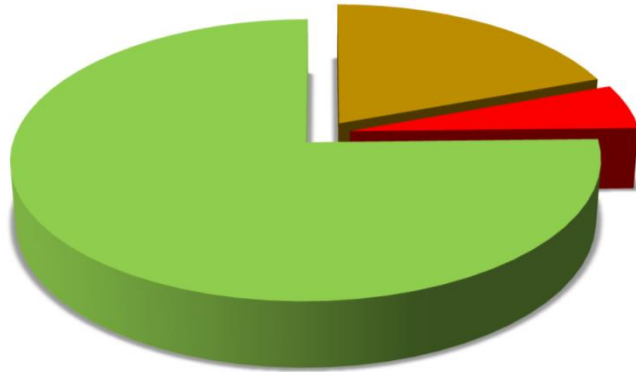
MICROFLORA IN FOOD:

tremendously complex and quite diverse

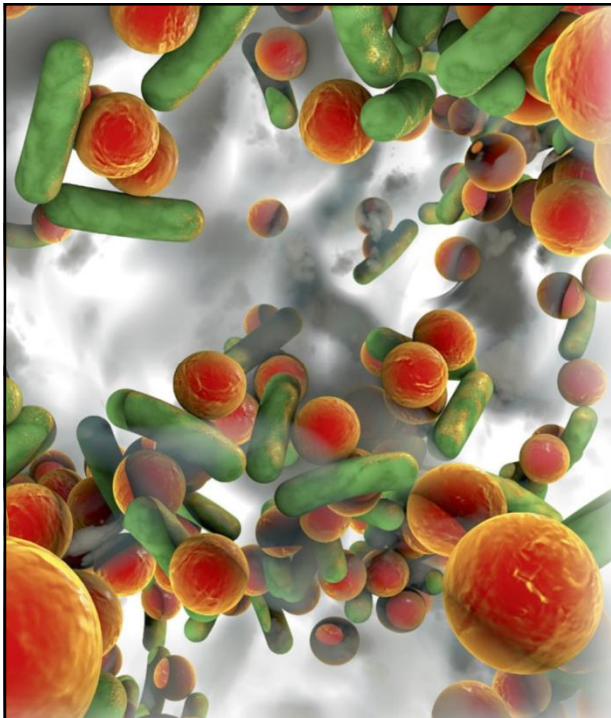
404 bacterial species with a positive impact on food quality or with a "neutral" role in food

104 bacterial species known as spoilage microorganisms

28 pathogenic species or to some extent opportunistic pathogenic species



Number of bacterial species isolated from foods and identified by 16S rRNA sequencing from 2012 until today
(ISI FOOD PROTECTION, 2017)

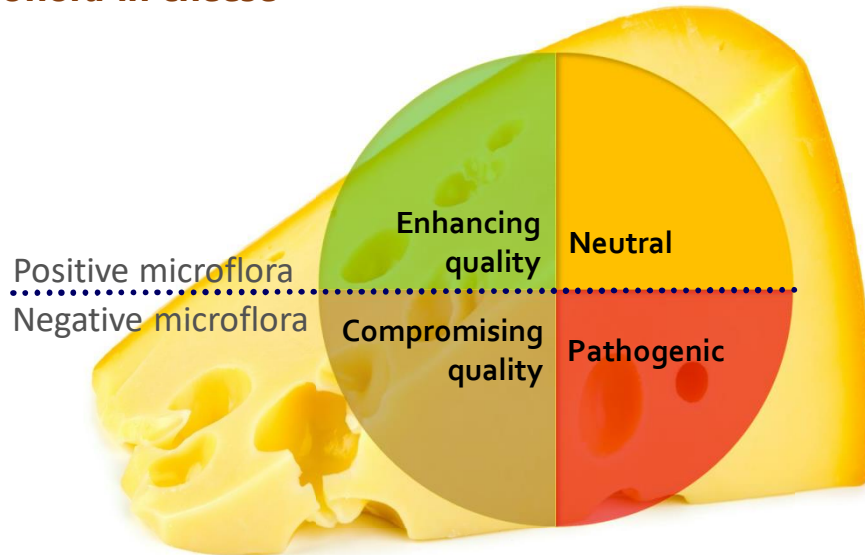


THE GOOD, THE BAD
& THE UGLY ...

Microorganisms in food

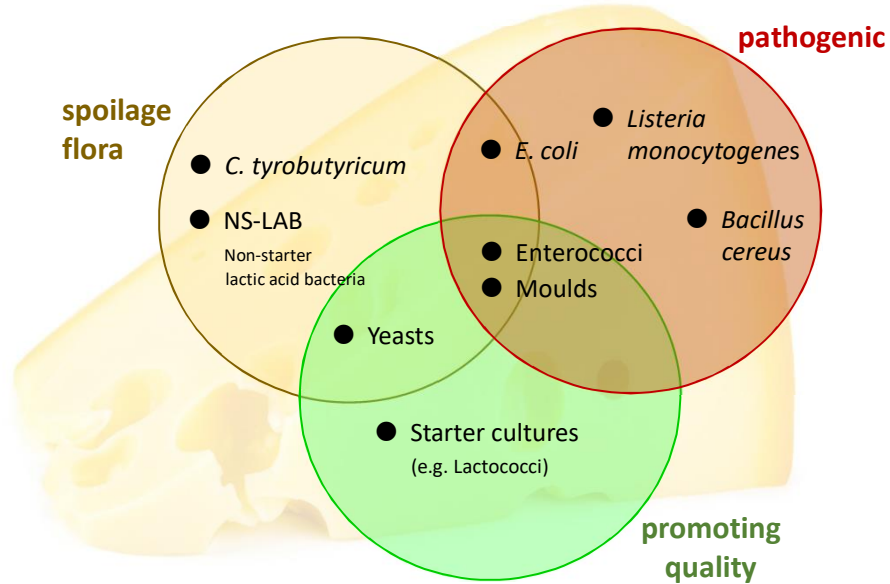
- In most foods, complex societies of microorganisms, embedded in biofilms
- Competition for nutrients
- Species can battle each other (e.g. by forming bacteriocins)
- Species interact with each other (symbiosis)
- Bacteria "talk" to each other (by signal molecules or even by electric signals)

Microorganisms in foods and the production environment:
Microflora in cheese



Microorganisms in foods and the production environment:

Microflora in cheese



THE GOOD, THE BAD
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food fermentation

Did you know that
approximately one-third of all
food eaten by human beings
worldwide is fermented

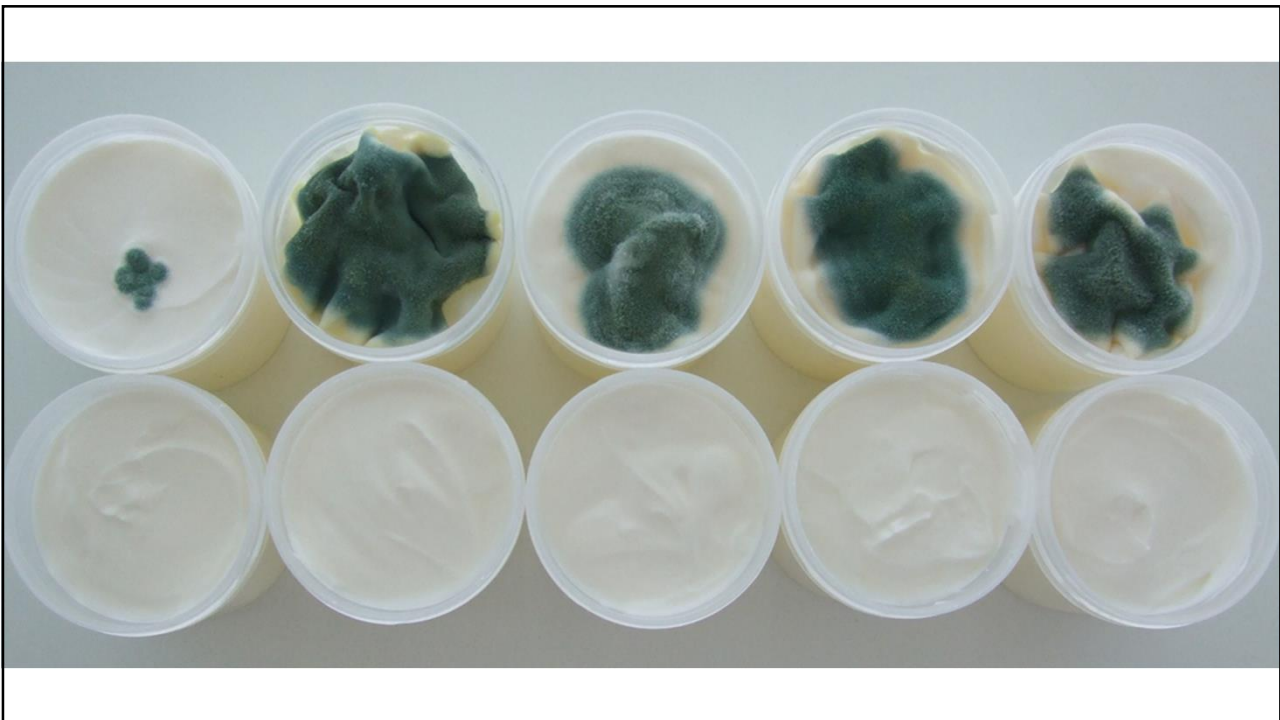


THE GOOD, THE BAD & THE UGLY ...

why **biopreservation** ?

to improve **food safety** and/or
to ensure **food quality** by applying food grade
microorganisms without changing the
organoleptic characteristics of the protected food:

- by competitive exclusion (competition for nutrients)
- by antimicrobial metabolites
- by quorum sensing → quorum quenching



Protective cultures – examples of commercial applications

Function	Microorganisms	Applications	Suppliers
Antilisterial due to bacteriocin production (IIa)	Lactobacilli (<i>Lb. sakei</i> , <i>Lb. curvatus</i> , <i>Lb. plantarum</i> a.o.) <i>Carnobacterium</i>	Fermented meat products Cured/smoked meat and fish Heat-treated RTE meat products Red smear cheese	Chr. Hansen (DK) DuPont (US) SACCO (I)
Inhibition of yeasts and moulds	Lactobacilli and Propionibacteria	Dairy products (yogurt, sour cream, fresh cheese, Quark)	DuPont (US) Chr. Hansen (DK) SACCO (I) BioProx (Fr) DSM (NL)



THE GOOD, THE BAD & THE UGLY ...

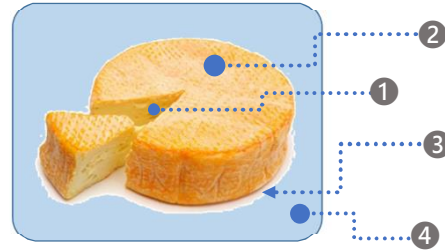
microbiota management

Our Vision:

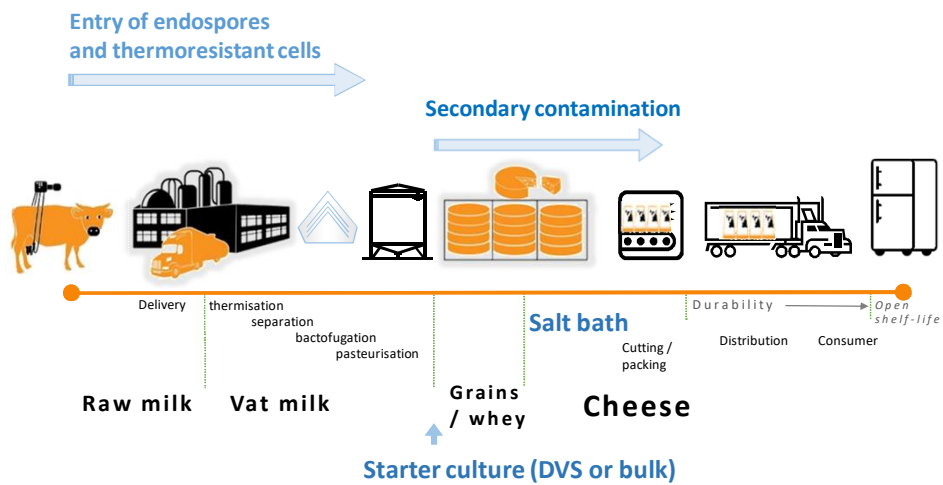
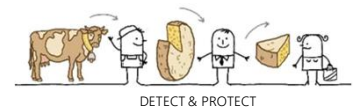
to protect food against unwanted microorganisms and to improve food quality along the entire food production chain by managing the microflora

MONITORING and MANAGEMENT of the microflora in

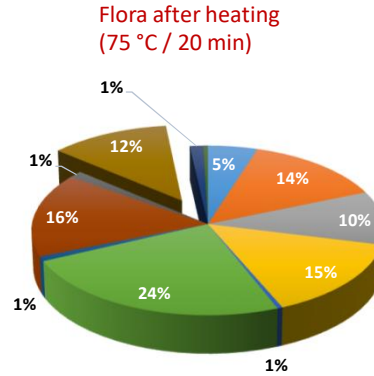
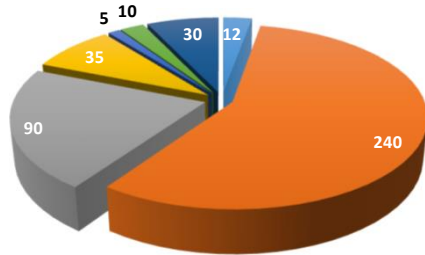
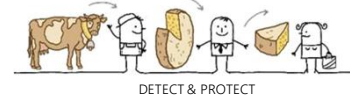
- ① food matrices
- ② food surfaces
- ③ food contact surfaces
- ④ ambient medium (gas, liquids such as salt-bath)



Microflora in cheese - case: Monitoring and evaluation of the flora

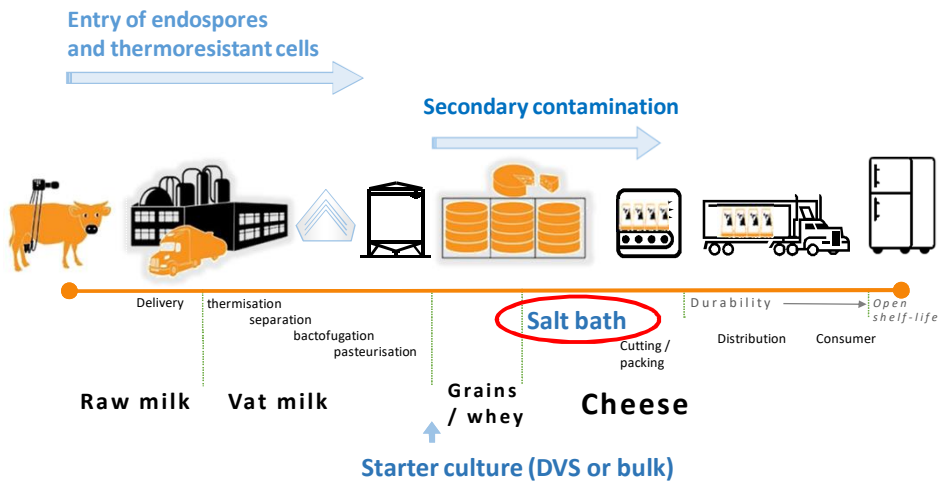
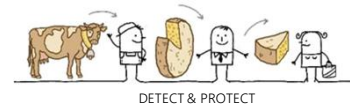


Microflora in raw milk: Monitoring and evaluation of the flora



- | | | | | |
|------------------------|---------------------------|-------------------------------|---------------------------|--------------------------|
| ■ <i>Bacillus</i> | ■ <i>Clostridium</i> | ■ <i>C. amygdalinum</i> | ■ <i>C. beijerinckii</i> | ■ <i>C. bifermentans</i> |
| ■ <i>Enterococcus</i> | ■ <i>Lactobacillus</i> | ■ <i>C. butyricum</i> | ■ <i>C. diolis</i> | ■ <i>C. perfringens</i> |
| ■ <i>Paenibacillus</i> | ■ <i>Rummeliibacillus</i> | ■ <i>C. saccharobutylicum</i> | ■ <i>C. sporogenes</i> | ■ <i>C. tertium</i> |
| ■ <i>Streptococcus</i> | | ■ <i>C. tyrobutyricum</i> | ■ <i>C. xylanolyticum</i> | |

Microflora in cheese - case: Monitoring and evaluation of the flora





ISI FOOD PROTECTION
Centre of Expertise for Applied Food Microbiology

Microorganisms in food:
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