DEMYSTIFIYING ADJUNCT CHEESE CULTURES

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AMERICAN CHEESE SOCIETY

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DEMYSTIFIYING ADJUNCT CHEESE CULTURES

- AGENDA
  - Origin of flavor in cheese: overview
  - Principles of flavor development
  - Cheese Adjuncts
    - Types and functions
  - Use of Adjuncts
    - Technical Information
    - Application, Dose

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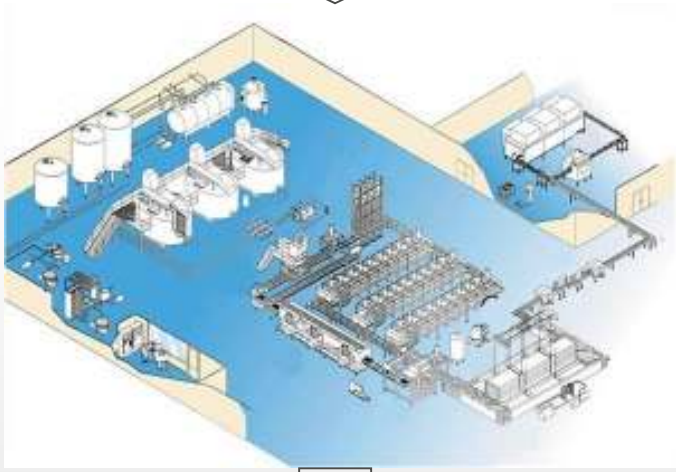
Origin of Flavor

- Animal
- Breed
- Diet/Season
- Milk quality
- Equipment
- Process
- Enzymes
- Microorganisms



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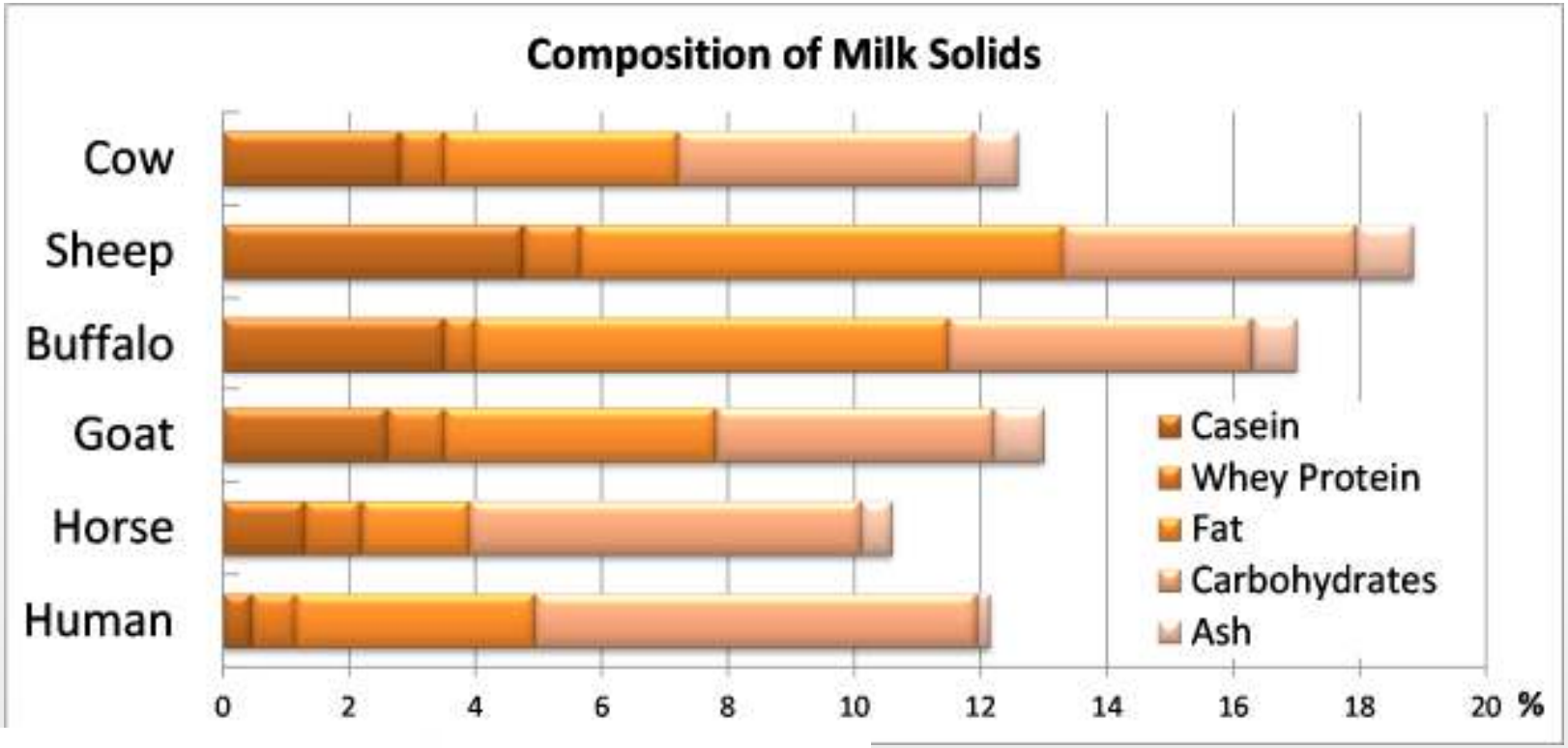
Origin of Flavor – Animal



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Origin of Flavor – Breed

MILK COMPOSITION BY BREED

	HOLSTEIN	BROWN SWISS	AYRSHIRE	JERSEY	GUERNSEY
Fat	3.6	3.8	4.0	5.0	4.6
Casein	2.5	2.6	2.7	3.0	2.9
Lactose	4.6	4.8	4.6	4.7	4.8
Total Solids	11.9	12.7	12.7	14.2	13.7
Whey Protein	0.53	0.55	0.60	0.61	0.63

Each breed offers different milk composition that will dramatically affect the final taste and texture of the cheese you produce.

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Source: WMMB and Wikipedia

Origin of Flavor – Diet/Season

Pasture vs silage
Drought effects
Season

- Amount and composition of fat.
- Size of fat globules
- Reduced fat →increased citrate
- Summer reduction in whey protein, lactose increased
- Spring – changes in fatty acid composition

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Origin of Flavor – Milk Quality

- Animal Health
  - Citrate from mastitic cows
  - Treatment
  - Plasmin levels
- Microbiological quality
  - Farm management
  - Transportation
  - Age
  - Temperature
- Handling

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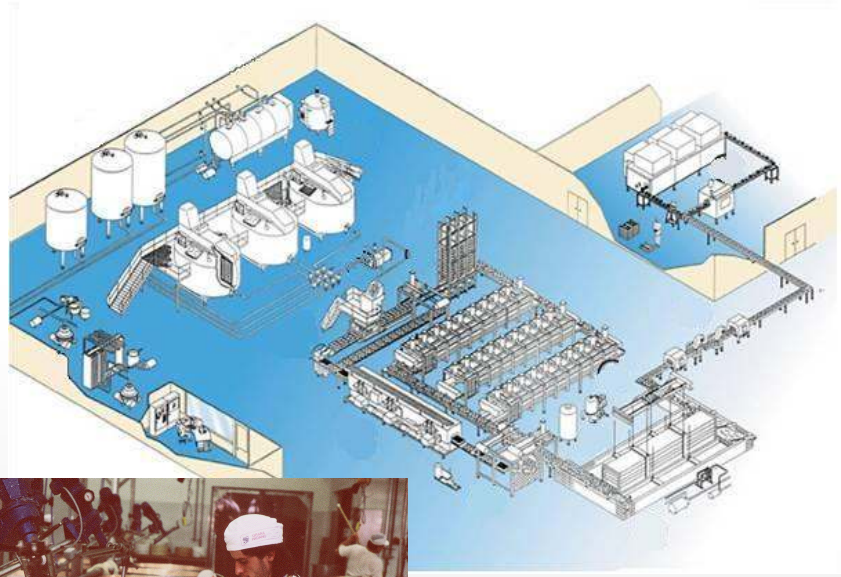
Origin of Flavor – Equipment/Process

- Transport
- Milk treatment
  - Standardization (F/C, P/C)
  - Pasteurization
- Culture/Ripening
- Vats/Tables
- Rennet/Coagulants/Lipases
- Cut/Heal
- Cook
- Whey removal/Washing
- Salting
- Cheese properties – moisture and composition



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Origin of Flavor – Enzymes and Microorganisms

- **Animal:** Cow, Goat, Sheep (e.g. alkaline phosphatase, lactoperoxidase, LPL - lipoprotein lipase)
- **Microorganisms:**
  - Bacteria in raw milk (heat-resistant extracellular proteinases and lipases produced by psychrotrophic bacteria)
  - Bacteria in heat treated milk (thermodurics)
  - Starter cultures
  - Adjuncts
  - NSLABs
- **Enzyme preparations:**
  - Coagulants
  - Lipases

Principles of Flavor Development

24 hours
Cheese manufacture

Weeks to years
Cheese ripening

Primary starter culture

Ripening culture

Milk

Fresh curd

Mature cheese

Cheese ripening :
Propionic fermentation
Proteolysis by
Penicillium/geotrichum/yeast/smearing bacteria
Lactobacillus spp

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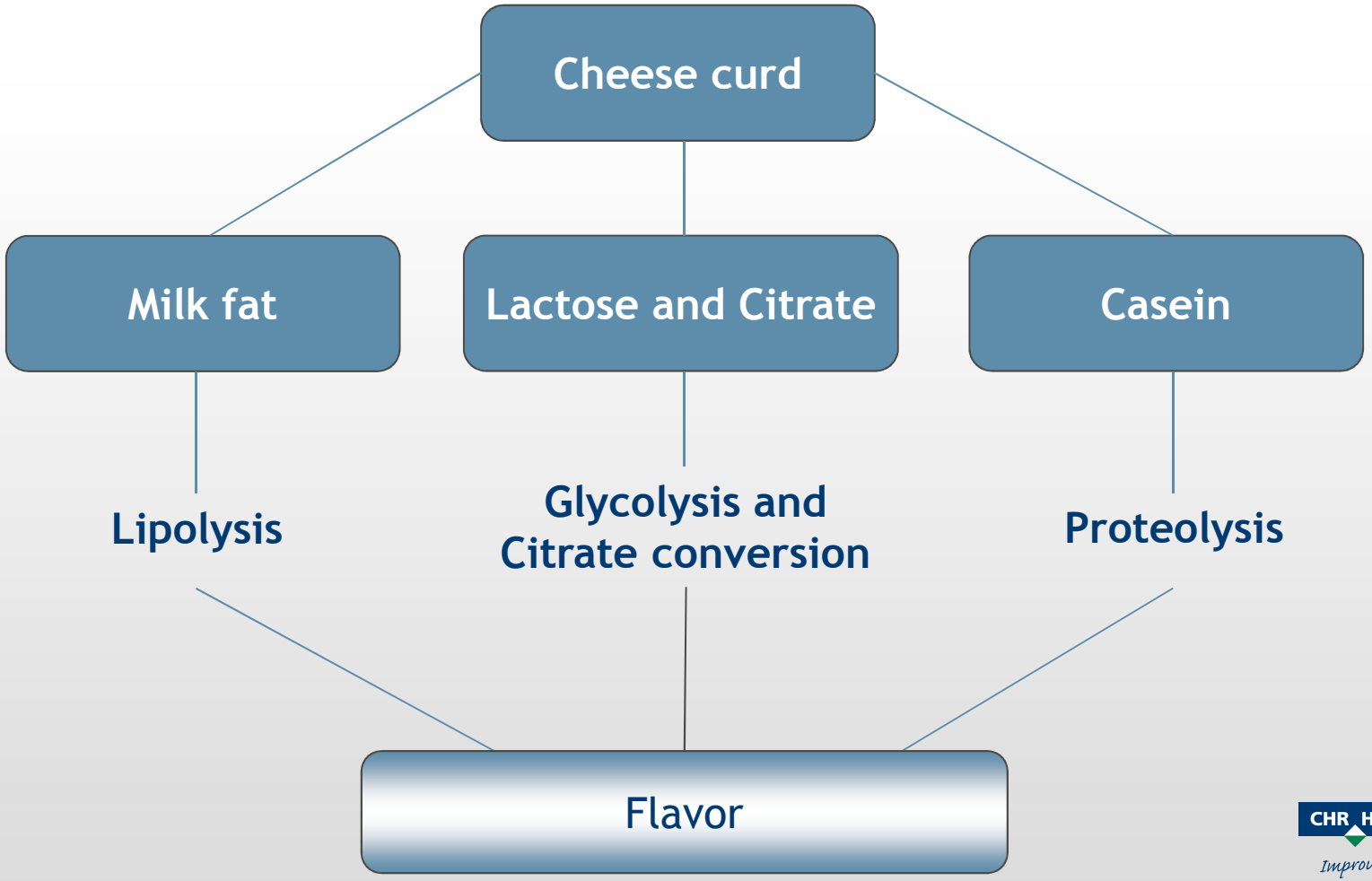
Principles of Flavor Development

Cheese ripening step



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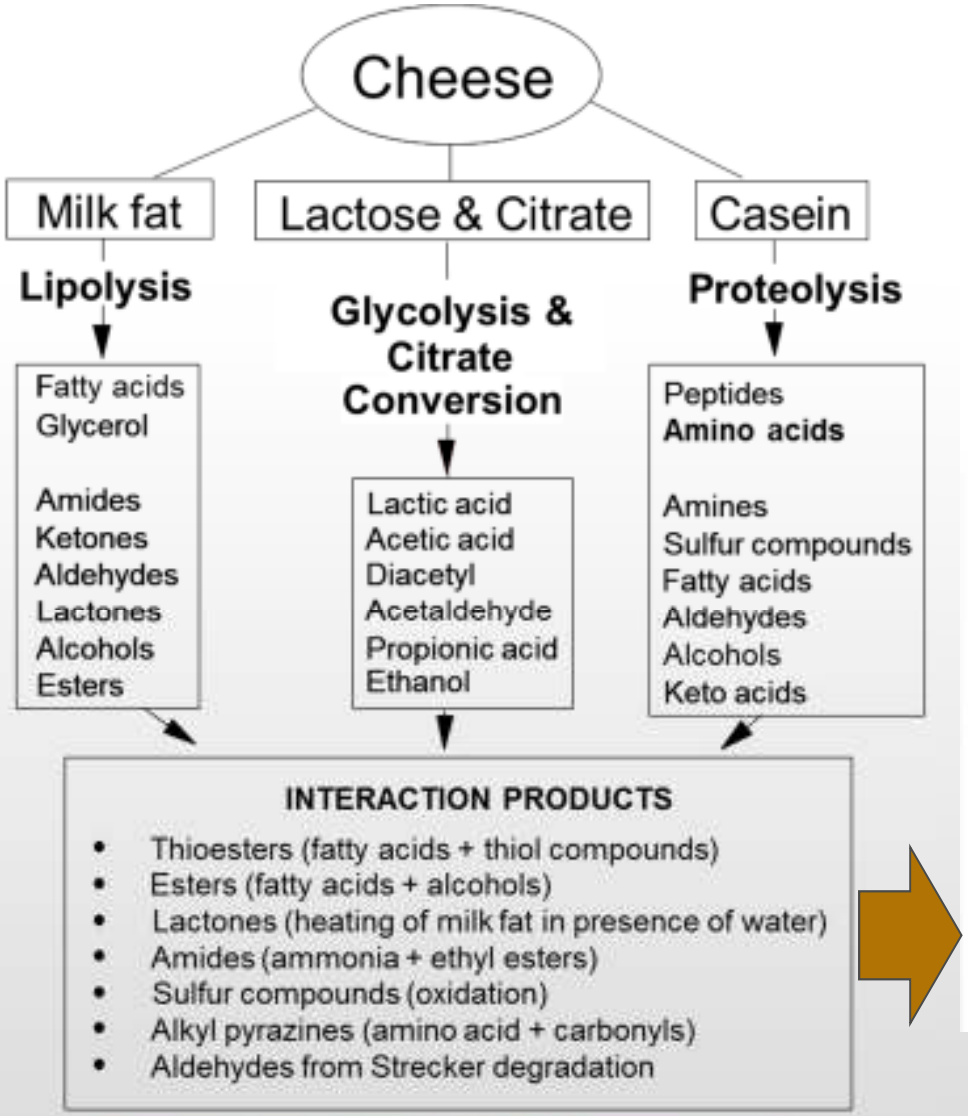
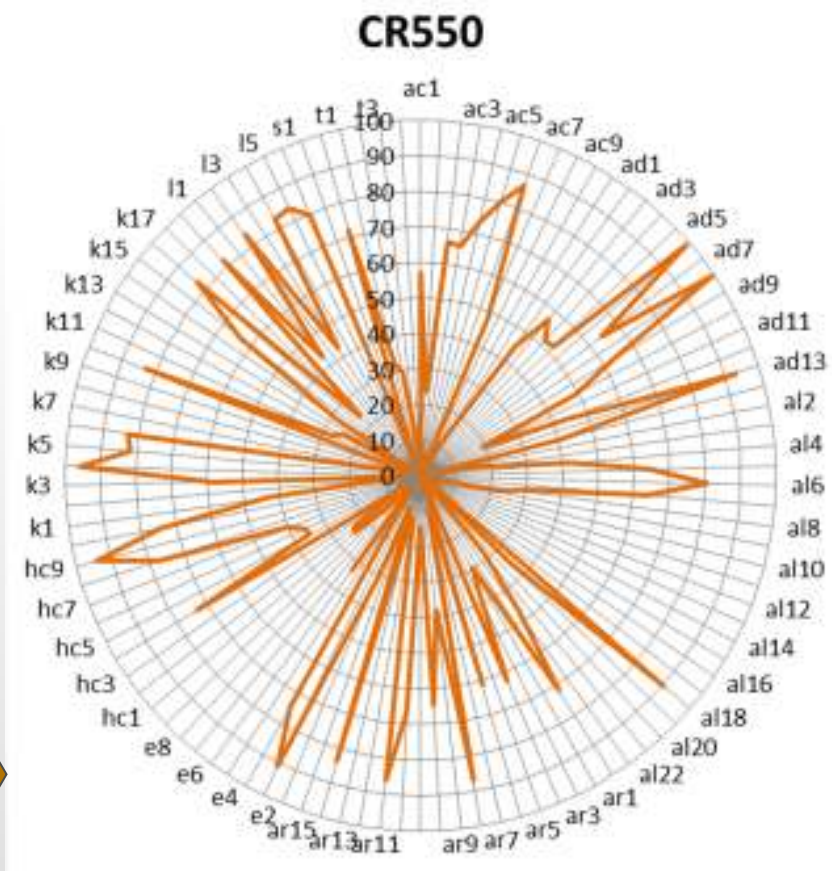
Principles of Flavor Development



Adapted from Adda *et al.* (1982), Griffith & Hammond (1989), Urbach (1993), Urbach (1997), Ardö (1994), El Soda (1997).



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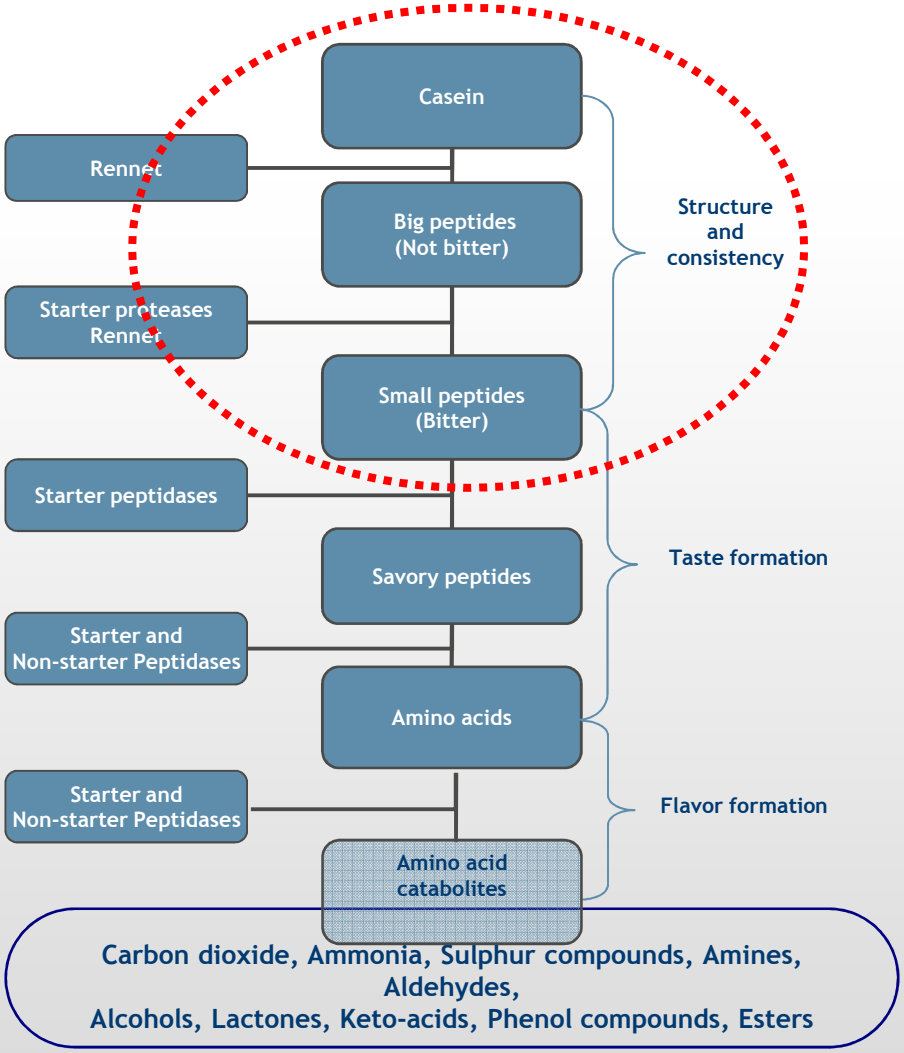
Principles of Flavor Development

Casein degradation: Proteolysis



- Proteases
  - Coagulant
    - Microbial vs. CHY-MAX vs. CHY-MAX M
    - Dosage
  - Starter
    - PI vs. PIII
  - Adjunct
  - NSLAB

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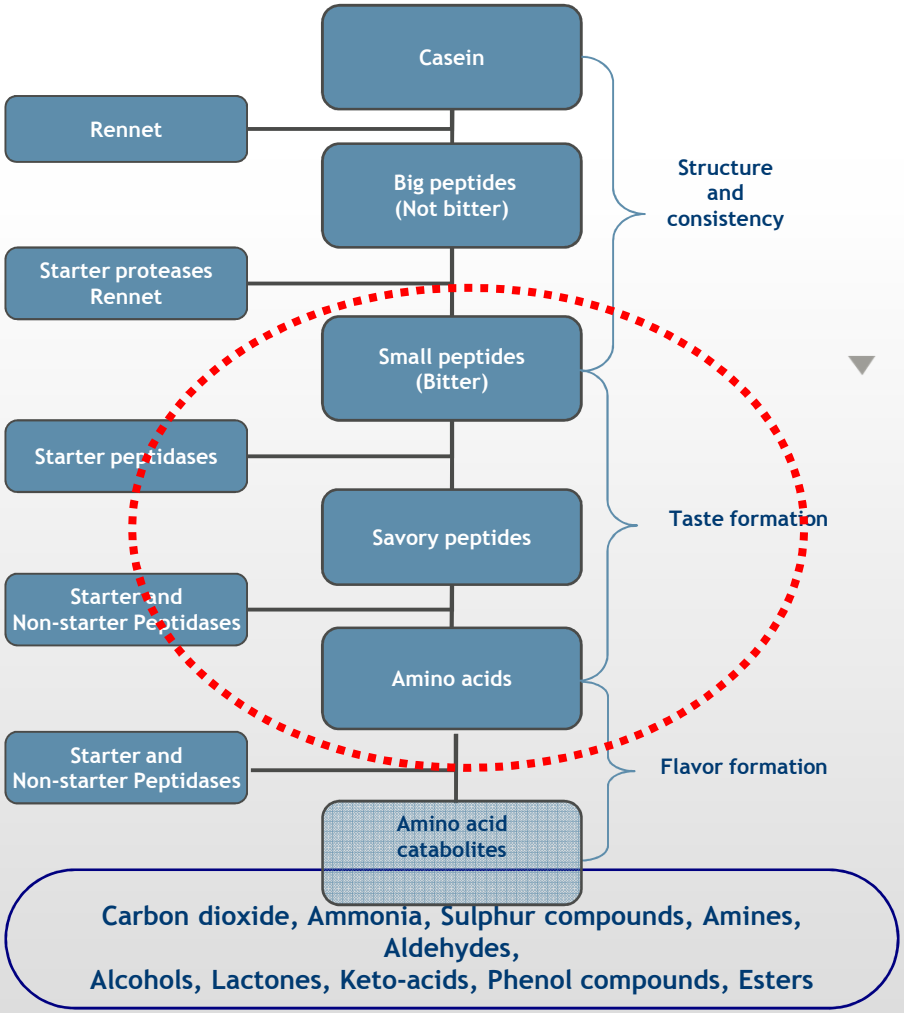
Principles of Flavor Development

Casein degradation: Secondary peptidolysis



- Peptidases
  - Starter, adjunct, NSLAB
    - High PepN vs. low PepN
  - Inoculation rate
  - Lysis
    - High PepX vs. low PepX

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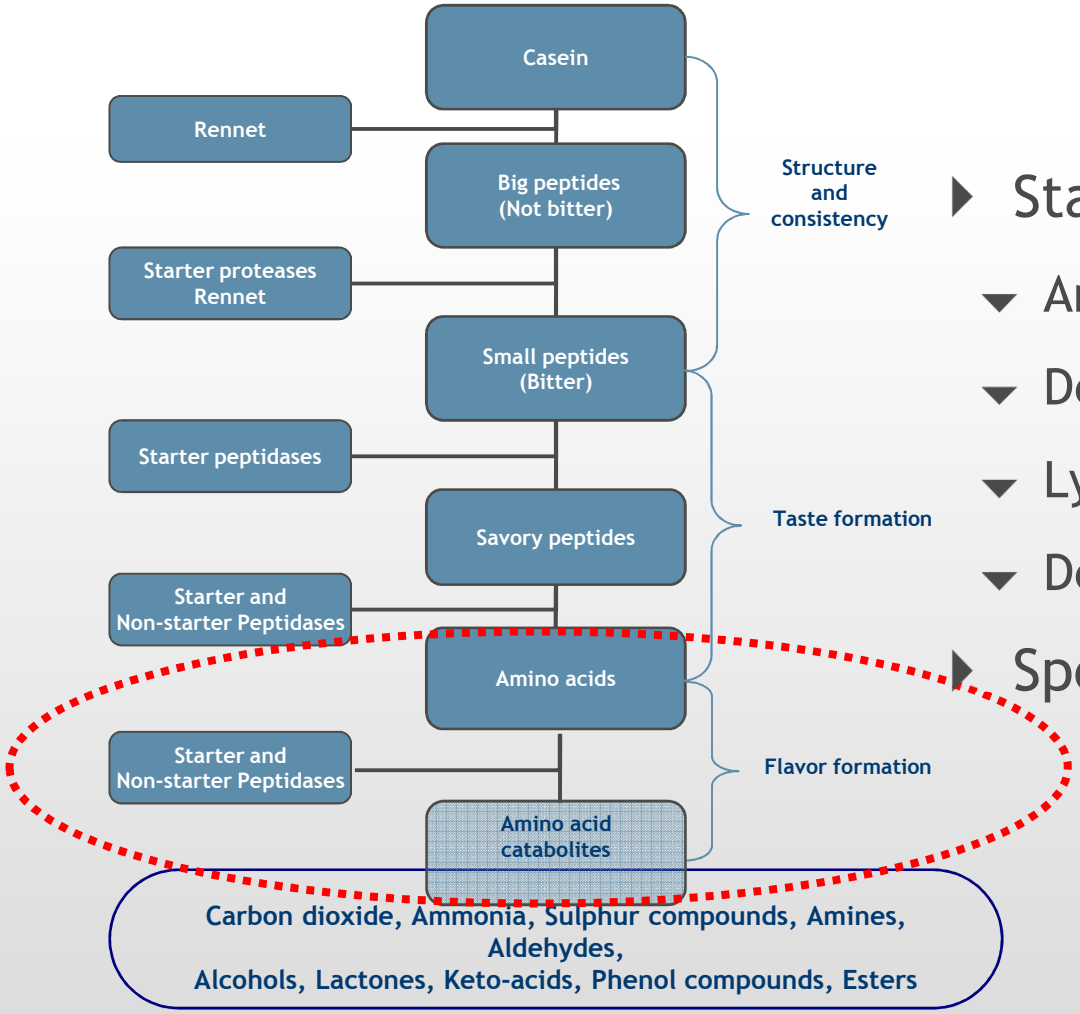
Principles of Flavor Development

Casein degradation: Amino acids degradations



- Starter, adjunct, NSLAB
  - Aminotransferases
  - Decarboxylases
  - Lyases
  - Deaminases
- Species and strain variability

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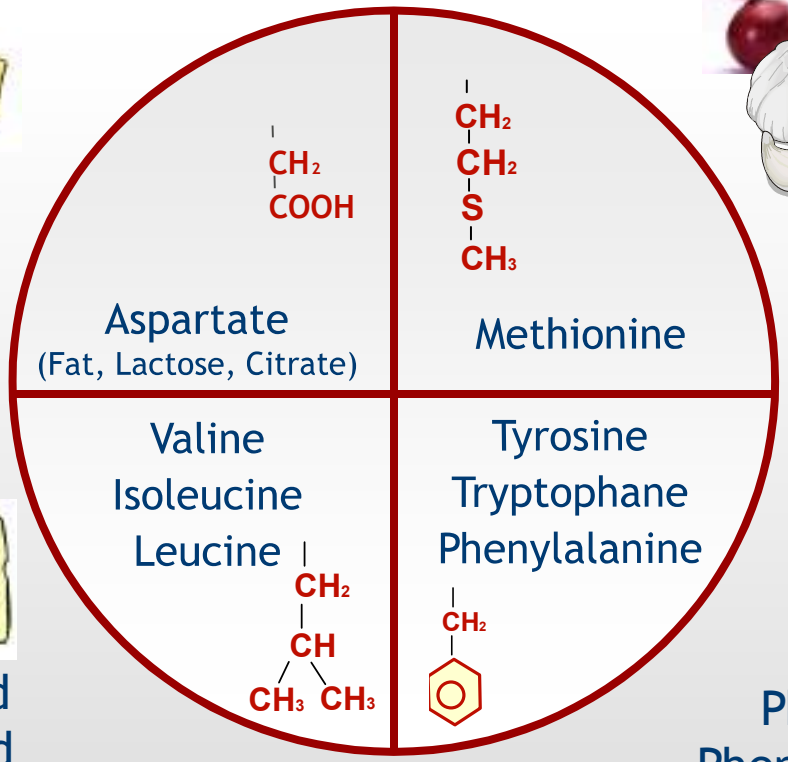
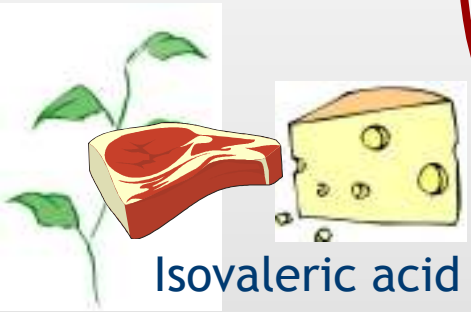
Aroma Notes derived from Amino acids

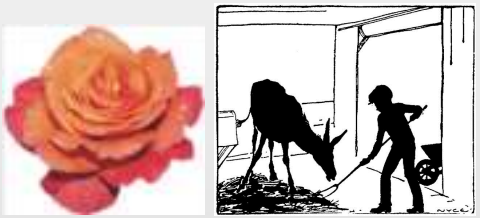
Butanoic acid
Acetic acid
Diacetyl/acetoin
Ethylbutyrate



Methanethiol
Methional
Methyl sulphides



Isovaleric acid
Isobutyric acid
Methylbutanal



Phenylethanol
Phenylacetaldehyde
Phenol, Skatole

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Aroma notes from Curioni & Bosset (2002)

Adjuncts for Cheese

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Aerobic ripening cultures

Type of microorganisms	Function	Examples
Moulds		
Penicillium candidum 	White Sureface Mold	PCA1-PCA3-PC TT033
Penicillium roqueforti KD 	Blue-Green Mold	PR1-PR3-PR4 PRG3
Geotrichum candidum		
Intermediate yeasty Intermediate mouldy mouldy 	Yeast for Flavor	Geo CB Geo CA Geo CD1
Yeast		
Debaryomyces hansenii Candida colliculosa Kluyveromyces marxianus subsp.marxianus Blend (Anti-mucor) 		LAF3 LAF7 LAF4-LAF5 TRIO
Bacteria		
Brevibacterium linens  Brevibacterium casei Micrococcaceae 	Surface reipening	BL1-BL2 BC SALSA1-SALSA2

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Penicillium candidum

What does it bring?

Produces a coating on the curd surface

The rind protects the surface against mucors and blue/black mould contaminants

- It grows just after geotrichum
- By its strong proteolysis, it metabolises casein and peptides which softens texture

- By its lipolysis, it produces fatty acids and methylketoens with strong flavor contribution

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Penicillium roqueforti

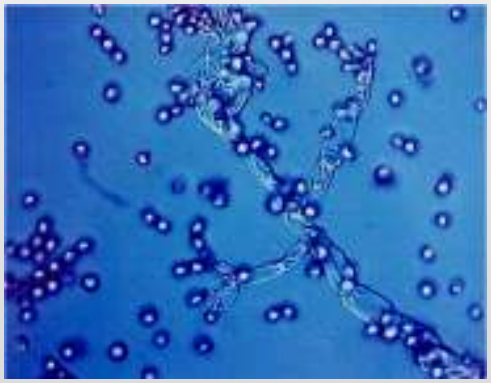
What does it bring?

Produces blue green veins in the curd

- Appears late in the ripening process (only visible after 15 days)

By its strong proteolysis, it metabolises casein and peptides which softens texture

By its lipolysis, it produces fatty acids and methylketones with strong flavor contribution



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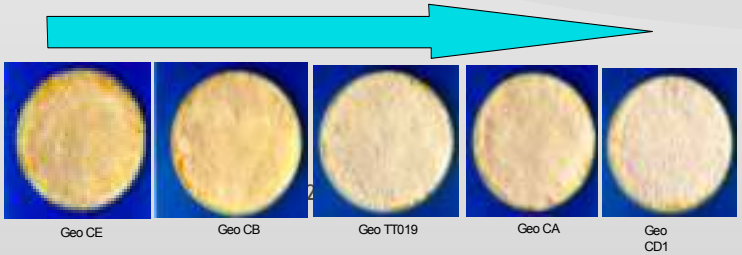
Geotrichum candidum

What does it bring to the cheese?

- It generates a coating on the curd surface
- The rind protects the surface against mucors and blue/black mold contaminants
- It avoids the excess of growth of *P.candidum*

- By means of its peptidase activity it de-bitters curd
- By its consumption of lactate, it neutralizes curd
  - → it reduces the potential activity of acid proteases
  - → it allows the growth of micrococcaceae and brevibacterium
- By means of its proteolytic, lipolytic activities and its amino acid catabolism, it brings various flavors: animal, cowhouse, fresh whey….

Appearance of the mycelium on curd (+anatto) after 12 days



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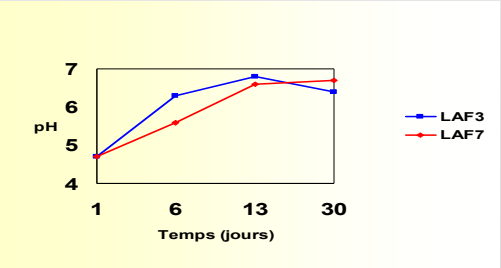
Yeast

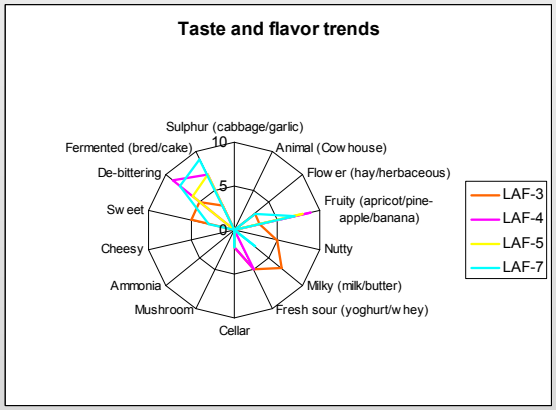
What does it bring?

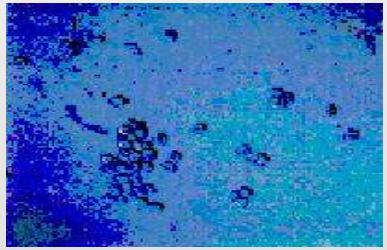
- It generates a bio-film at the surface of the curd
- In some cases, it can inhibit mold contaminants.

- Fermenting yeast produce CO_2, alcohols which combine to fatty acids to generate esters (Fruity flavour)
- Non fermenting yeast consume lactate and neutralise curd → allow the growth of acid-sensitive bacteria.

Neutralisation on model cheese







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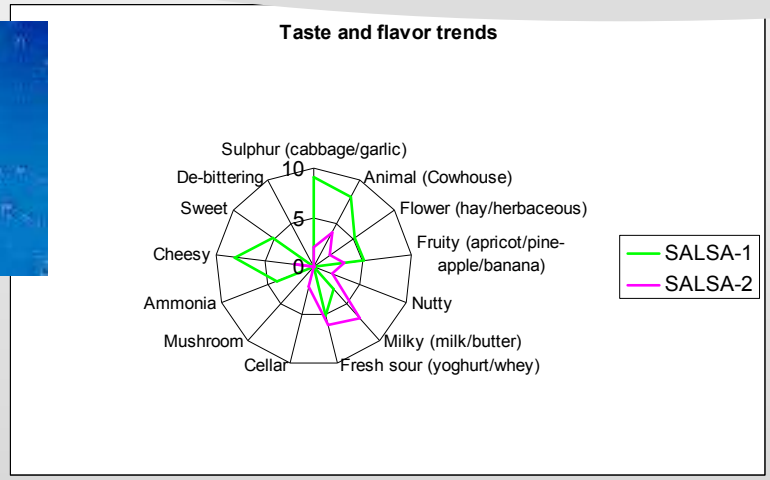
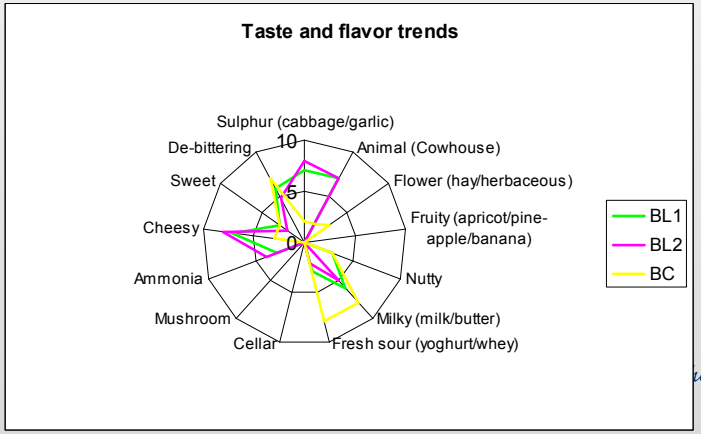
Smear bacteria

What does it bring?

- It generates a bio-film at the surface of the curd
- It colors the curd: on the whole surface (smeared cheese) or on a light layer (White and orange rind).

- Amino-peptidase activity reduces bitterness.
- By their metabolism on amino acid, they bring strong flavor (sulphur compounds by *B. linens* and thio-esters by *S.xylosus*)





Anaerobic ripening cultures

Culture Series	Performance (Low → High)	Product Form: Frozen	Product Form: Freeze Dried
CR 200/300	De-bittering: ■ ■ ■ ■ □ Sweeteness: □ ■ ■ ■ ■ Contribution to flavor: ■ □ ■ ■ ■		
CR 500/FX-200	De-bittering: ■ ■ ■ ■ □ Sweeteness: □ ■ ■ □ ■ Contribution to flavor: ■ ■ □ ■ □		
LH/EMFOUR	De-bittering: ■ ■ ■ ■ □ Sweeteness: ■ ■ □ ■ □ Contribution to flavor: ■ ■ ■ ■ □		
PS	De-bittering: ■ ■ ■ ■ □ Sweeteness: ■ ■ □ □ □ Contribution to flavor: ■ ■ ■ ■ □		
ENZOBACT	De-bittering: ■ ■ ■ ■ □ Sweeteness: ■ □ ■ ■ ■ Contribution to flavor: ■ ■ ■ □ ■		

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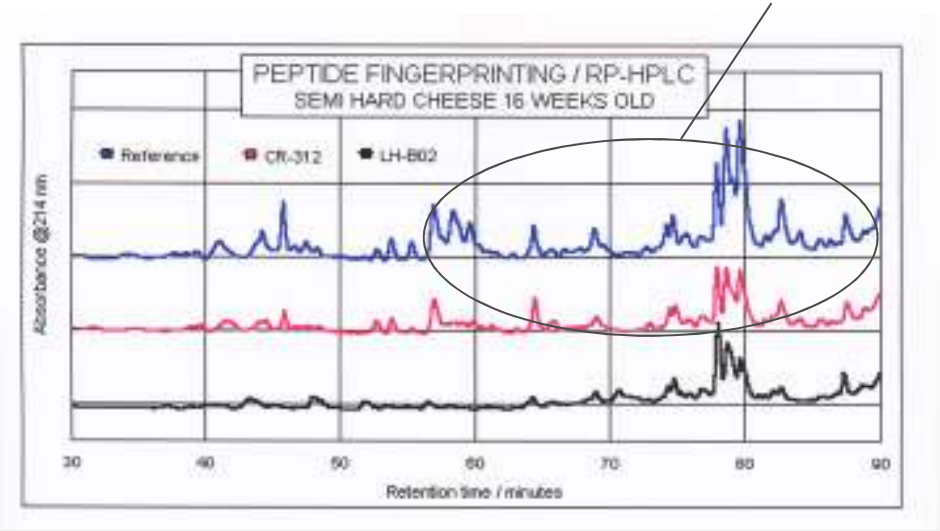
CR 200/300 series

- The range CR 200 and 300 are composed of *Lactococcus lactis* spp *lactis* selected for their ripening properties.

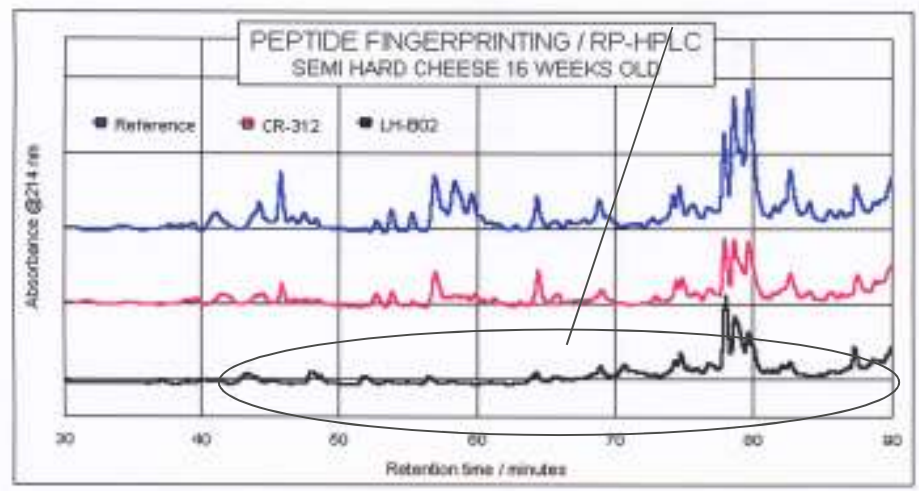
Reduction of hydrophobic peptides



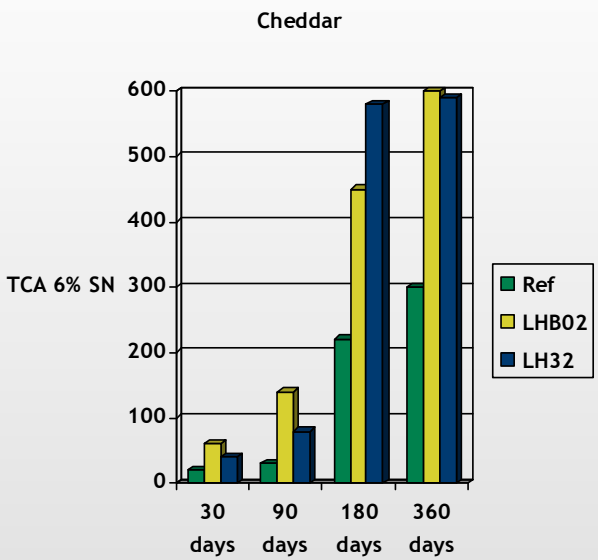
Culture	Features
CR 213	Lac-, standardized in leu-pNa activity, debittering
CR 312	Lac-, high aminopeptidasic activity, debittering
CR 319	Lac+(slow), prt-: No proteinase activiy High aminopeptidasic activity , High autolysis, debittering

LH series

Reduction of hydrophilic and hydrophobic peptides by LH-B02



- The LH range allows to increase ripening speed
- LH give matureness and sweetness



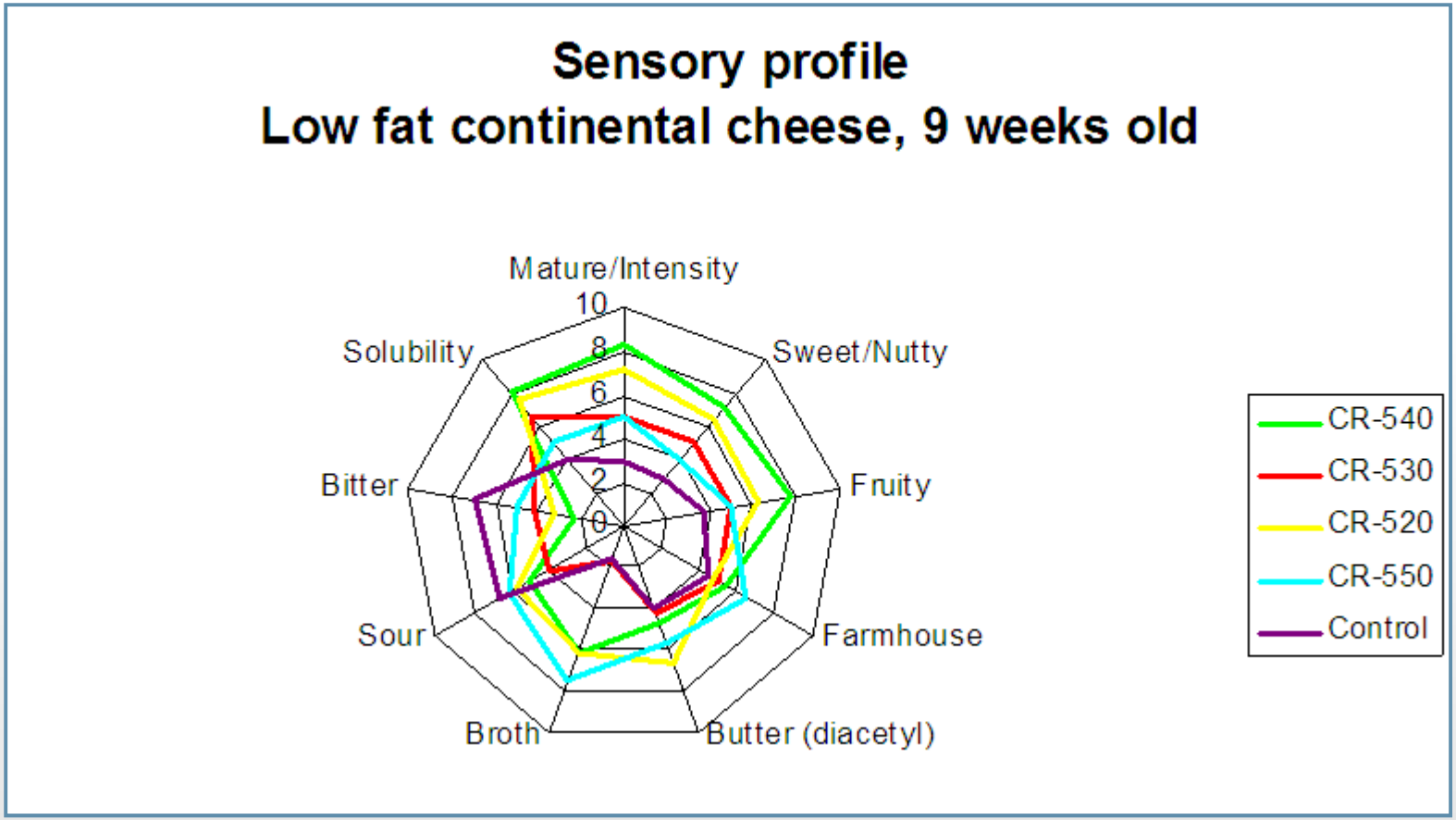
High increase of Soluble nitrogen with LHB02 and LH32

culture	features
LHB01	Low proteolytic activity
LHB02	High proteolysis, Increases mature flavor and sweetness
LH-32	High proteolysis, high Pep-X activity (autolysis), Increases mature/cowhouse flavor
EMFOUR	Increases mature flavor, malt/nutty flavor

CR-500 series: Power and balance

	Features	Application
CR-520	Medium proteolysis	Complex cheese flavor → Continental/Cheddar
CR-530	High aminopeptidasic activity High amino-acids catabolism	Increases mature flavor and nutty notes → Continental/Cheddar
CR-540	High end acidification High proteolysis High aminopeptidasic activity High temperature resistance	Highly flavoring Fruity, nutty → Continental/Cheddar/Propionic cheeses/ hard cheeses
CR-550	No acidification Low proteolysis High aminopeptidasic activity High amino-acids catabolism	Increases broth/bouillon flavor → Soft and semi soft cheeses/Continental

CR-500: power and balance



Recommended dosage: 0.005-0.02%

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DVS® Full Flavor

DVS® CR-Buttery 01
10X500 U Material 710314
For young cheeses / Mesophilic & Thermophilic cultures
Fresh buttery & Malt Chocolate flavor
Dose 500U/5000 ltr. milk

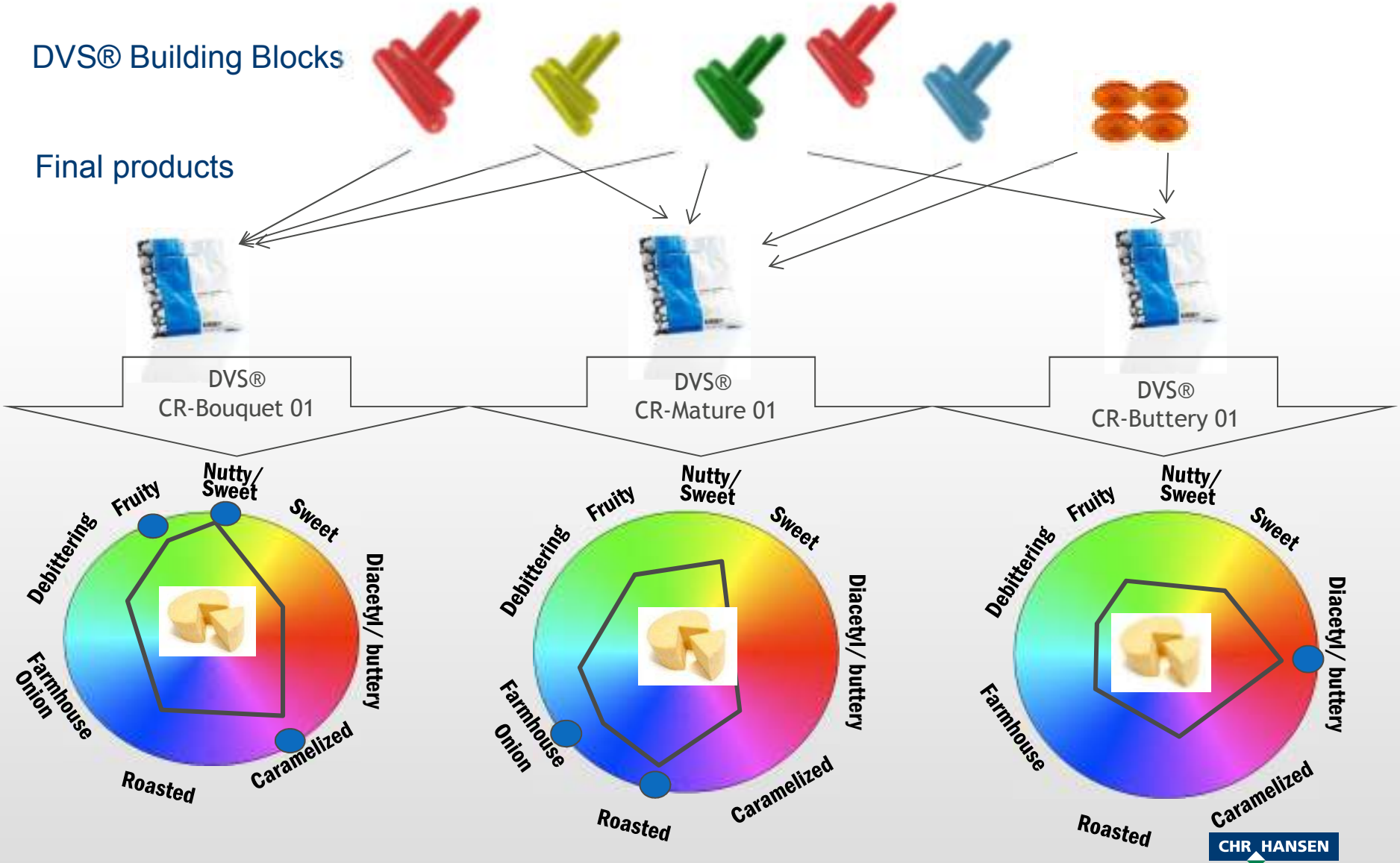
DVS® CR-Mature 01
10X500 U Material 710315
For all cheeses / Mesophilic & Thermophilic cultures
Farmhouse & savory notes
Dose 500U/5000 ltr. milk

DVS® CR-Bouquet 01
10X500 U Material 710317
For all cheeses - Mesophilic & Thermophilic cultures
Fresh fruity and nutty flavor
Dose 500U/5000 ltr. milk

DVS® Full Flavor

DVS® Building Blocks

Final products



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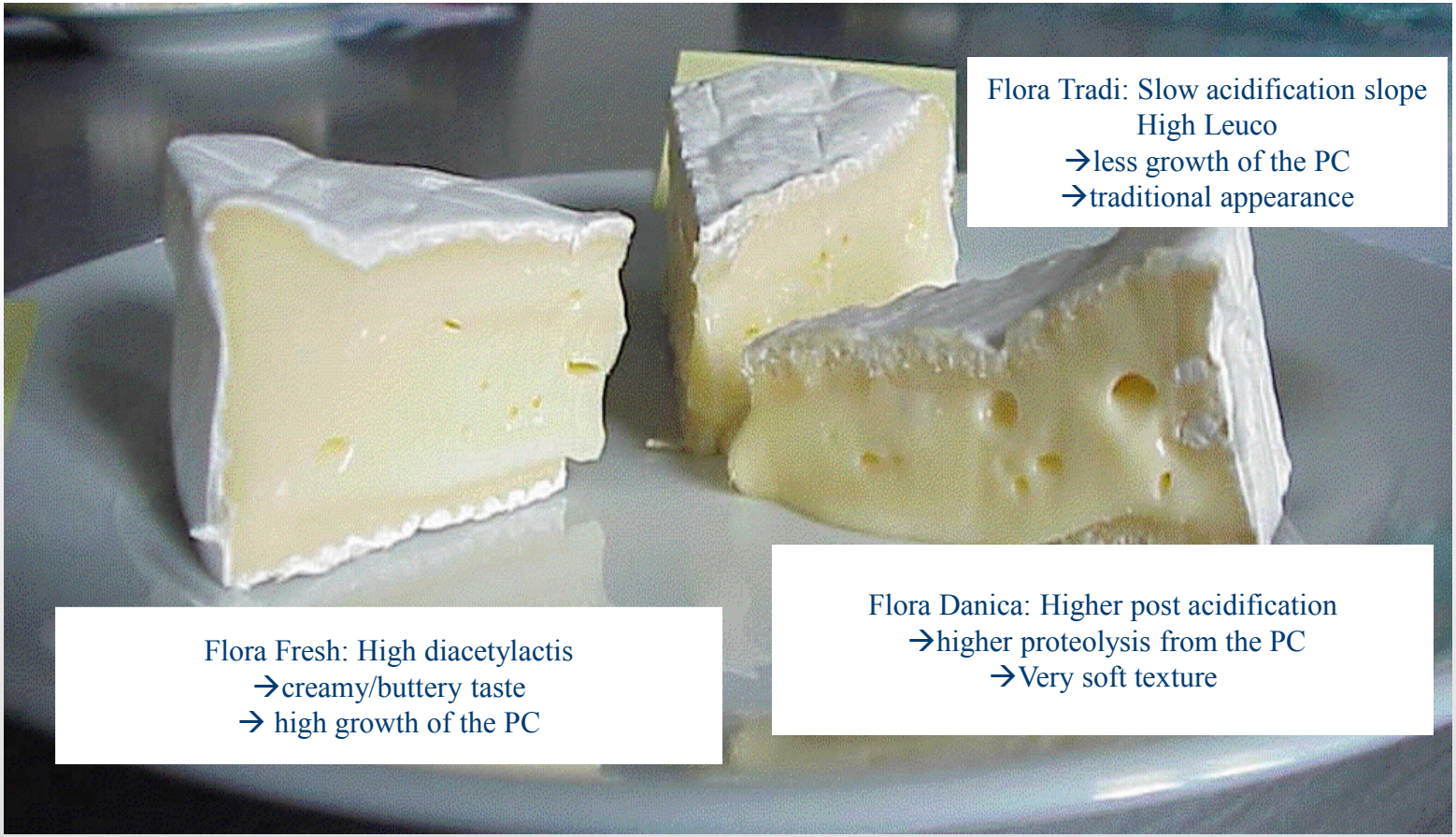
Impact of primary mesophilic culture: Flavor, texture and appearance



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Application of Adjuncts

- How to use different adjuncts?
- What dose do I use?
- Where do I get adjuncts and guidance?

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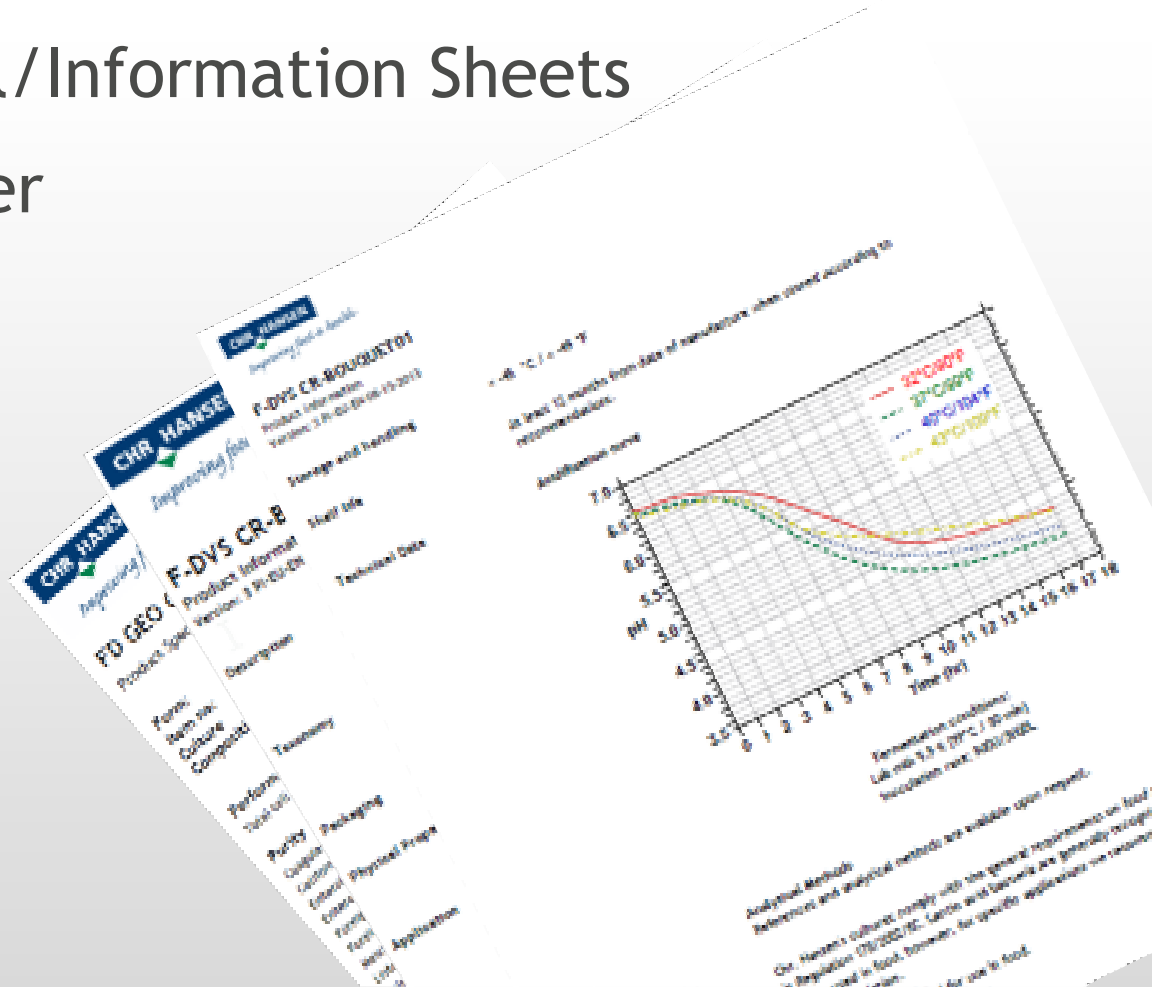
Application of Adjuncts

- Information from:
  - Product Specification Sheets
  - Product Technical/Information Sheets
  - My culture supplier



Technical Sheets – product *specification*

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FD GEO CH\10U

Product Specification

Format

Identification

Strength/Activity

Form:	Freeze-dried SWING
Item no:	683643
Culture Composition:	Geotrichum candidum

Performance	**Specification**
Total cell count spores/U	>=5.6E+7

Purity	**Specification**
Coagulase-positive staphylococci cfu/g	<1
Coliforms cfu/g	<1
Enterobacteriaceae cfu/g	<10
Enterococci cfu/g	<1
Foreign moulds cfu/g	<10
Foreign yeasts cfu/g	<10
Mesophilic aerobic total count cfu/g	<500
Listeria monocytogenes *	Absent in 25 g
Salmonella spp. *	Absent in 25 g

QC Specs

* Environmental and statistically based product testing is carried out on an ongoing basis, details can be supplied on request.

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Technical Sheets – product *information*

or Technical Information

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SWING GEO CH

Product Information

Version: 1 PI-EU-EN 12-12-2012

Description	A selected single strain ripening culture with origin in traditional French cheese making. The SWING® GEO cultures contributes to the flavor, texture, and appearance of cheese. The culture is available as a conidia suspension.		
Taxonomy	Geotrichum candidum		
Packaging	**Material No:** 683643	**Size** 10 U	**Type** Pouch(es) in box
Physical Properties	**Color:**	Colorless	
	Form:	Freezedried	

Technical Sheets – product *information*

Application

Dose

Usage

The culture may be used in production of many types of cheeses including white mold surface (e.g. Camembert type), smeared and mixed rind, soft and semi-hard, and blue mold cheeses.

Suggested dosage

1U to 2U /1000 l of milk or 100 kg cheese.

Usage Guidelines

Directions for Use

Add the culture to the milk before renneting and/or apply to the surface of the cheese a few hours after salting, by spraying or washing. For direct milk inoculation, which is the recommended inoculation method (except for veined cheeses), no particular cautions are required.

For surface application:

1) Dilute the suspension in sterile water with 1% salt (NaCl)

2) Shake well before use.

A prepared dilution using one litre of water is sufficient for about 250 kg of cheese, and should be used on the day of preparation.

Range

Several strains with diverse attributes can be found in the SWING® range. Please contact your local sales representative for further information.

Storage and handling

< -18 °C / < 0 °F

Shelf life

At least 6 months from date of manufacture when stored according to recommendations.

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Technical Sheets – product *information*

Geotrichum candidum contributes to the ripening in different ways:

- Characteristic appearance of the cheese.
- Flavour and texture (proteolysis and lipolysis).
- Neutralisation of the curd.
- Stimulates red smear cultures by curd neutralisation.
- Moderates the growth and proteolytic activity of Pencilium candidum.
- Reduces bitter off flavours.
- Inhibits the growth of numerous mould contaminants (Mucor, blue mould etc).

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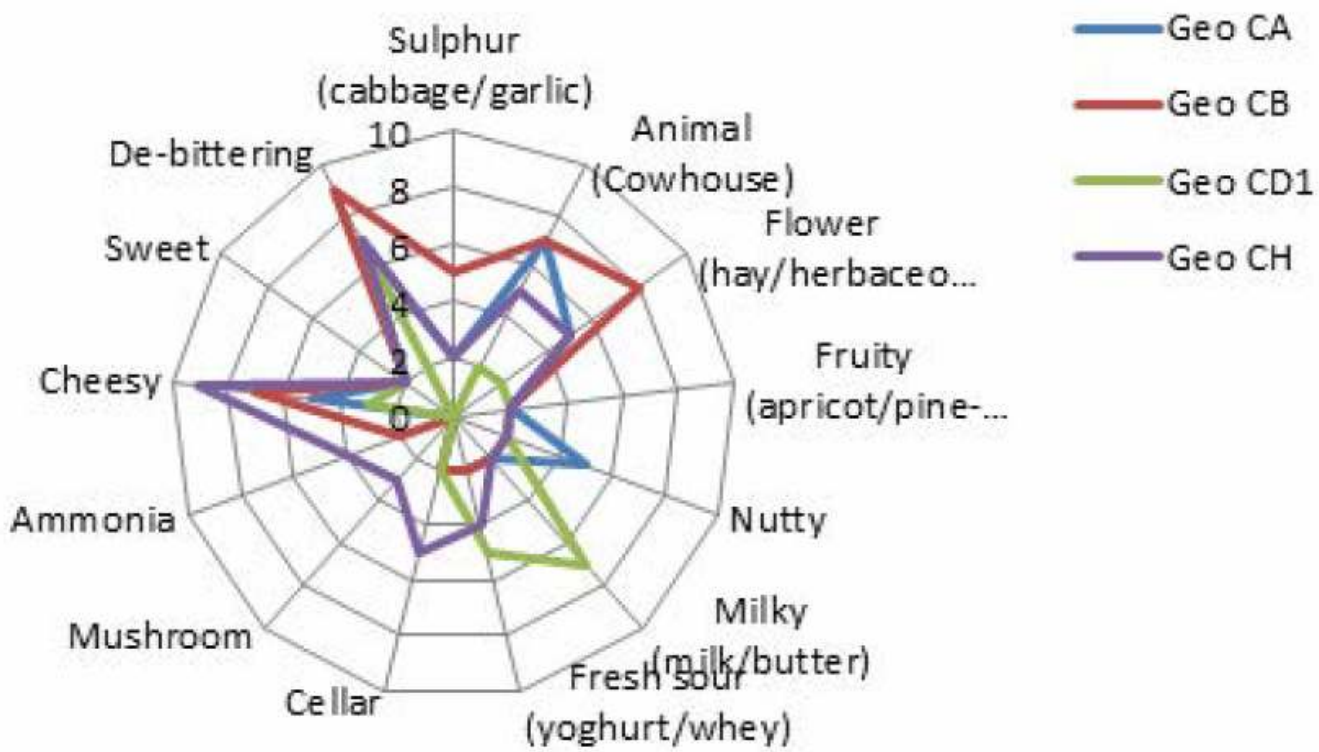
Technical Sheets – product *information*

Flavor profile

Taste and flavor trends of the strain.

Evaluation of flavor and taste made on model cheese ripened at 12°C.



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Technical Sheets – product *information*

Physilogical Data

	GEO CA	GEO CB	GEO CD-1	GEO CE
Aspect on cheese	medium mouldy	medium yeasty	mouldy	yeasty
Aminopeptidase activity	high	high	high	high
Proteolytic activity	medium	medium	medium	medium
Lipolytic activity	high	high	medium	medium
Salt effect	medium sensitivity		high sensivity (above 2%)	medium sensitivity
Temperature effect	min. 4°C, max. 38°C, opt. 30°C			
Flavour profile	animal nutty	cowshed flower slight sulphur	neutral (allows cheese ageing)	milk, whey, sweet

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F-DVS CR-Bouquet01

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F-DVS CR-BOUQUET01

Product Information
Version: 3 PI-EU-EN 08-15-2013

Description

A defined adjunct culture blend which enhances the overall flavor intensity of the cheese by accentuating important flavor notes. It enhances the balanced, mellow, rounded and clean flavors and suppresses unwanted flavors like sour, bitter and flat. The culture contains a nisin producing strain for promotion of bacteria lysis.

Taxonomy

Lactobacillus delbrueckii subsp. lactis
Lactococcus lactis subsp. cremoris
Lactococcus lactis subsp. lactis
Lactobacillus johnsonii

Packaging

Material No:	Size	Type
710317	10X500 U	Bag(s) in box

Physical Properties

Color: Off-white to slightly reddish or brown

Form: Frozen pellets

Application

Usage
The culture is primarily applied in the production of cheeses where normally mesophilic lactic acid bacteria are used. This culture is particularly used in Cheddar, Continental cheeses (rindless cheese), low-fat cheese and cheese containing vegetable fat.

Recommended inoculation rate

Amount of milk to be inoculated	5,000 U	10,000 U	20,000 U
	1,300 gal	2,600 gal	5,200 gal
Amount of DVS culture	500 U	1,000 U	2,000 U

Directions for Use
Remove cultures from the freezer just prior to use. Do not thaw. Disinfect the package prior to opening. Open the package and pour the frozen pellets directly into the pasteurized product. Agitate the mixture slowly for 10-15 minutes to distribute the culture evenly. For more information on specific applications please refer to our technical brochures and suggested recipes.

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Improving food & health

F-DVS CR-BOUQUET01
Product Information
Version: 3 PI-EU-EN 08-15-2013

Storage and handling

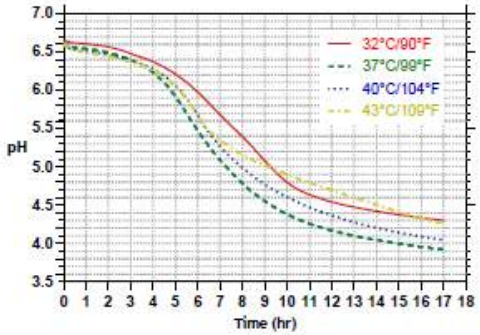
< -45 °C / < -49 °F

Shelf life

At least 12 months from date of manufacture when stored according to recommendations.

Technical Data

Acidification curve



Fermentation conditions:
Lab milk 9.5 % (99°C / 30 min)
Inoculation rate: 500U/5000L

Analytical Methods
References and analytical methods are available upon request.

Legislation

Chr. Hansen's cultures comply with the general requirements on food safety laid down in Regulation 178/2002/EC. Lactic acid bacteria are generally recognized as safe and can be used in food, however, for specific applications we recommend to consult national legislation.

The product is intended for use in food.

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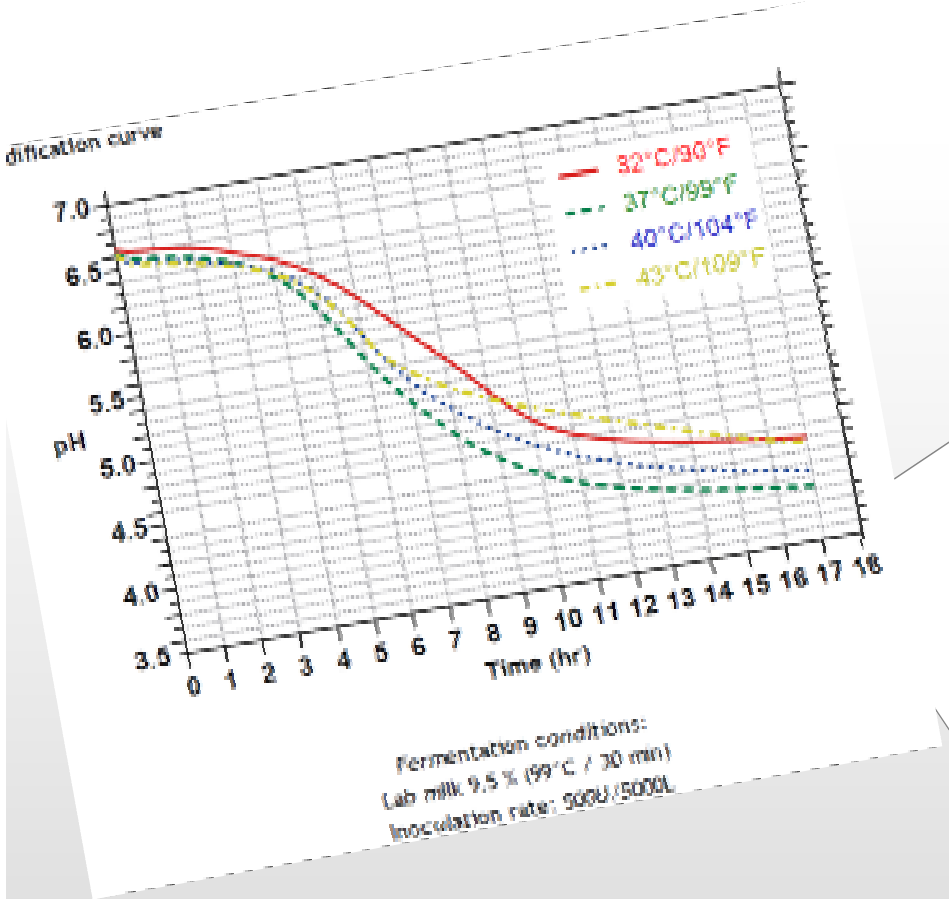
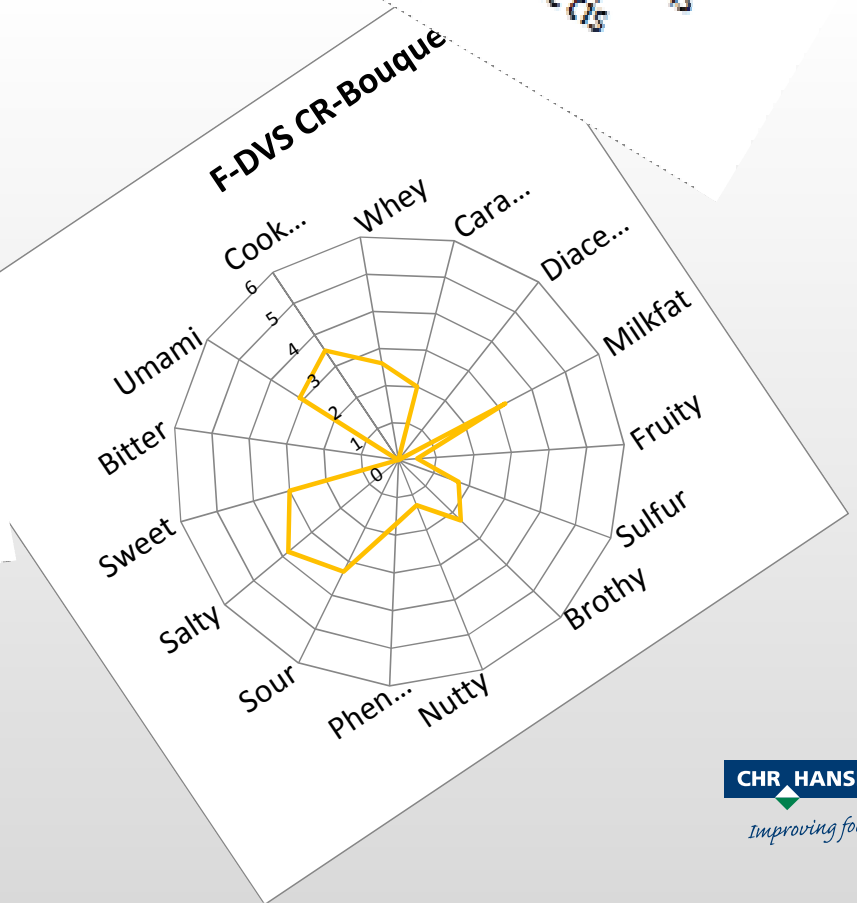
F-DVS CR-Bouquet01

Lactobacillus delbrueckii subsp. lactis
Lactococcus lactis subsp. cremoris
Lactococcus lactis subsp. lactis
Lactobacillus johnsonii





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How to Use, Dose?

- Use guidelines from Technical Sheet for “how to use”
- Start with recommended dose from Technical Sheet
- What units? grams, mLs, cell numbers, activity, units?
- In how much milk?
  - 1-2Units/100L of milk or 100kg of cheese
  - 500U/5000L milk
- **Record** how much you used, how you used it, and document your success …… so you can repeat or improve next time……

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Some Adjunct Suppliers

https://www.fromagex.com/

http://www.cheesemaking.com/

http://www.chr-hansen.com/

http://www.dairyconnection.com/

http://www.midwestsupplies.com/

Thank you!
Questions?

Nature's no. 1

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