MÆLK TIL FJERNE MARKEDER – NYE KRAV TIL HOLDBARHED OG FORBEDRET KVALITET

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NEW MARKETS – NEW DEMANDS

- UHT and powder products
- Temperature fluctuations, both at transport and subsequent storage
- Gentle heat treatments to avoid adverse quality issues
- But still ensure
  - Bacterilogical quality
  - Functional quality
  - Organoleptic qualities
  - Nutritional properties

UHT AREA

- Direct heat treatment
- Indirect heat treatment
- With/without lactose
- In the last decade, UHT processes with ultra-short holding times have been developed
- UHT treatment > 150 °C with holding times of 0.2 s result in a sufficient spore reduction to obtain a commercially sterile product (Huijs, et al., 2004; van Asselt, et al., 2008).

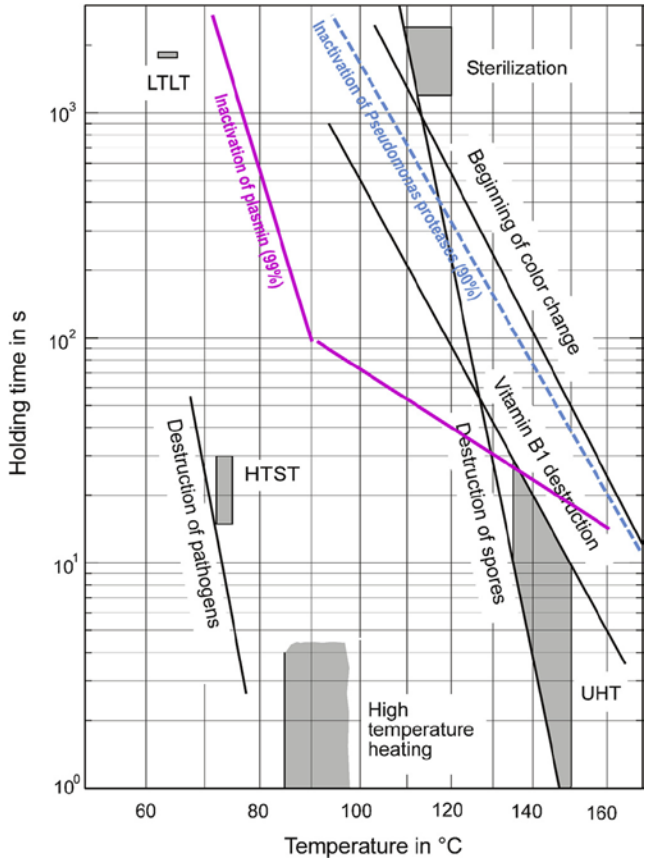


Fig from Stoecket et al (2016). Heat stability of indigenous milk plasmin and proteases from *Pseudomoonas*: A challenge in the production of UHT products. Int. Dairy J. 61, 250-261.

MILK EQUILIBRIUM IN DIFFERENT PHYSICO-CHEMICAL CONDITIONS

Heat treatment:
Denaturation
Modifications in protein backbones
Digestability?
Effect on human health?

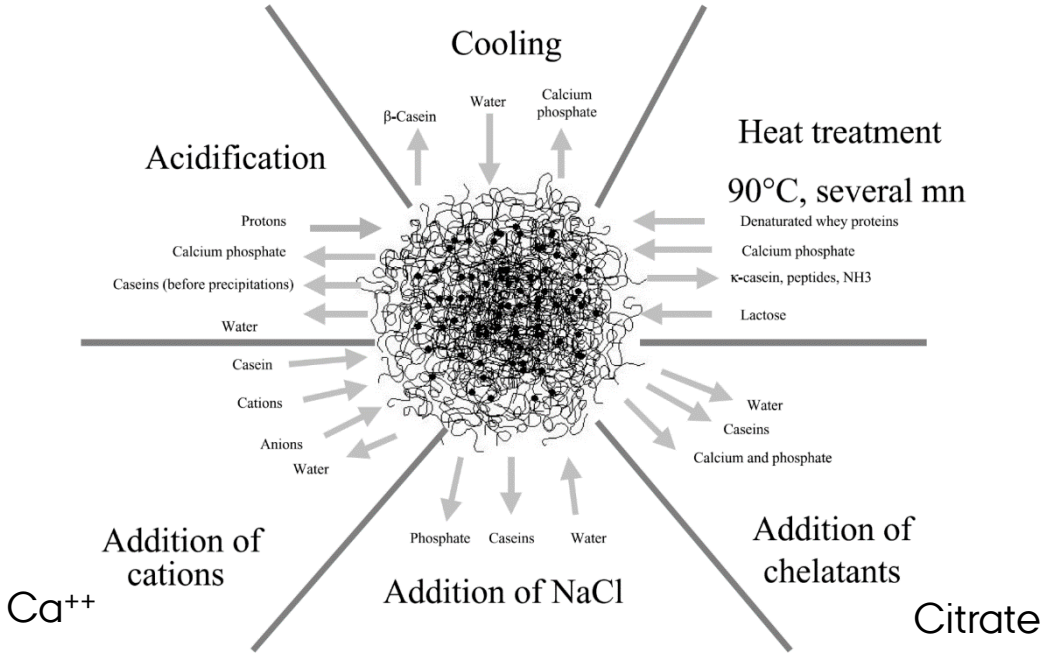


Fig from Gaucheron F (2005) The minerals of milk. Reprod Nutr Dev 45:473–483

FACTORS IN RAW MILK THAT INFLUENCE UHT STABILITY

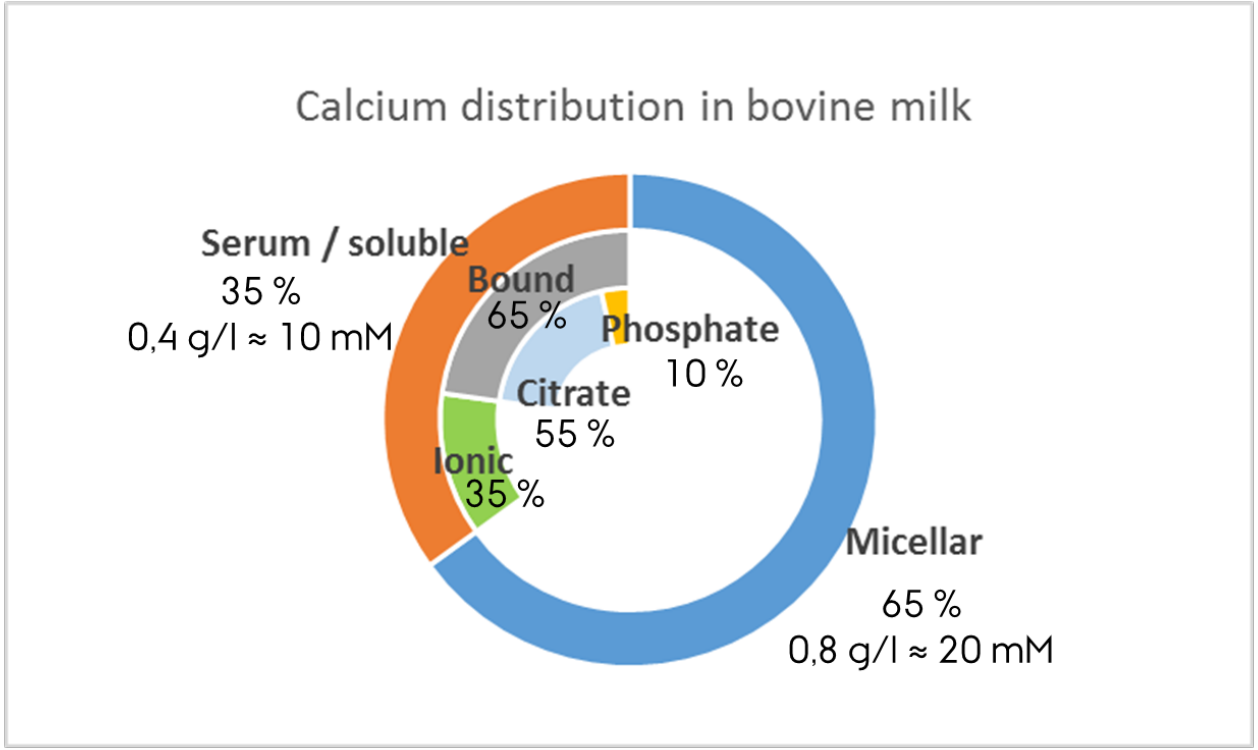
- √ pH of milk
- √ Calcium
- √ Protein composition
- √ Urea
- √ Bacterial count and composition
- √ Bovine enzymes

- √ And the underlying factors behind these parameters

Williams (2002). The relationship between the composition of milk and the properties of bulk milk products. Aust. J. Dairy Technology 57, 30-44.

Calcium in bovine milk

Total Ca 1,2 g/l = 120 mg/100 ml = 30 mM



ROLES OF CALCIUM

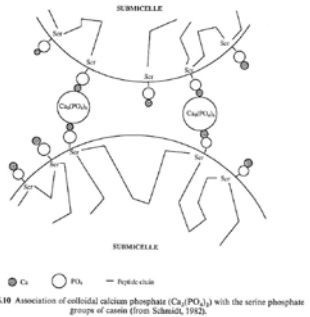


Figure 5.10 Association of colloidal calcium phosphate ($Ca_3(PO_4)_2$) with the serine phosphate groups of casein (from Schmidt, 1982).

Rennet induced coagulation

- High level of calcium needed for aggregation
- Important with stable, Ca loaded micelles
- Enhanced by addition of $CaCl_2$
- $CaCl_2$ increases espc ionic Ca

UHT stability

- High Ca: problems with fouling during heat treatment
- $CaCl_2$ increase sediment formation in UHT milk
- Stabilize: decrease ionic Ca and increase pH of milk

Lewis et al. (2011). Ionic calcium and pH as predictors of stability of milk to UHT processing. Milchwissenschaft 66, 197-200.

Milk differentiation, including organics, with potentials outside the cool chain

Ph D study, Marije Akkerman
Aarhus University - Department of Food Science
Supervisors: Nina A. Poulsen and Lotte B. Larsen, AU-Food, John Sørensen, Arla Foods amba

Milk quality

UHT stability

Issue

Raw milk quality and composition

- Is affected by seasonal changes and management systems
- Has been found to have impact on UHT stability

Aim

Establish relationships between

- Management systems, in relation to pH, calcium and organic acids.
- Milk composition and heat- and storage stability

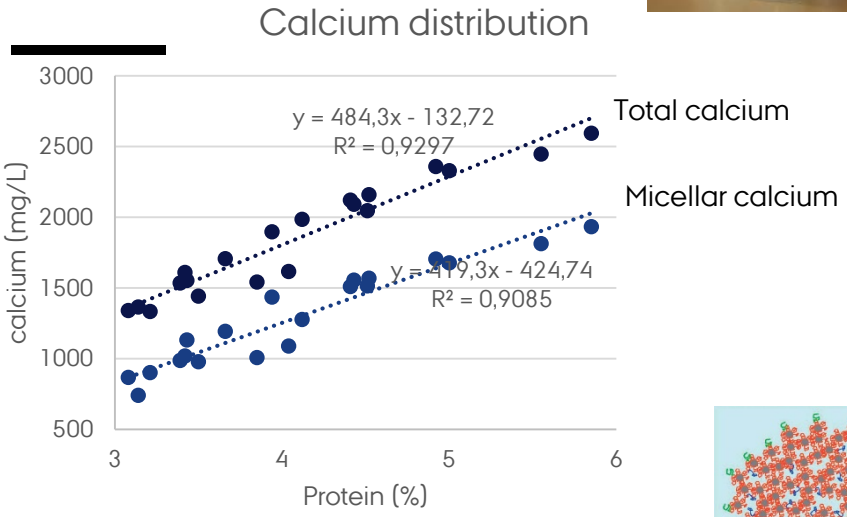
Hypotheses

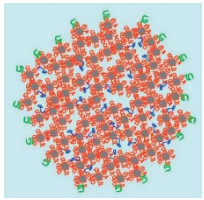
- Feeding affects citrate content which influences the calcium balance
- Decreased ionic calcium levels reduce sedimentation during storage of UHT milk
- Variation in milk quality is larger in organic production due to differences in farming systems

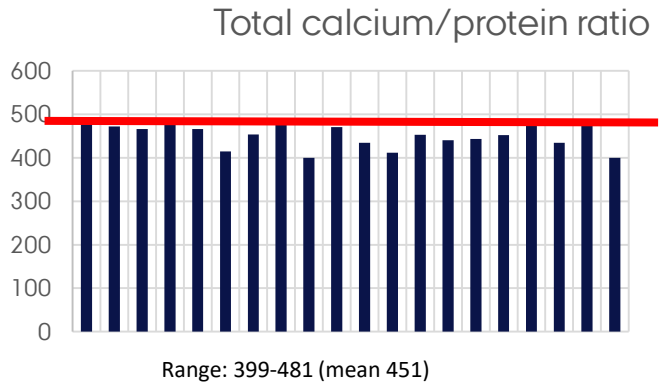
Outcome

- Understand how milk components affect UHT stability for producing high quality products

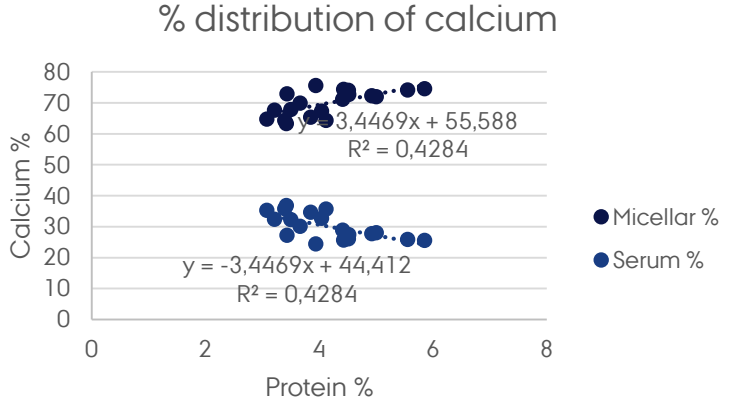
CALCIUM







Range: 399-481 (mean 451)



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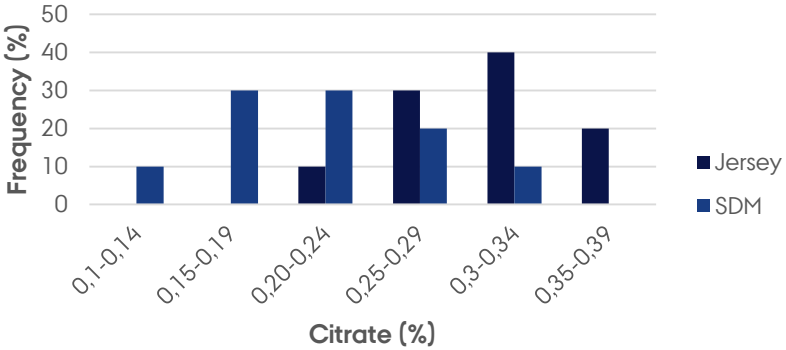
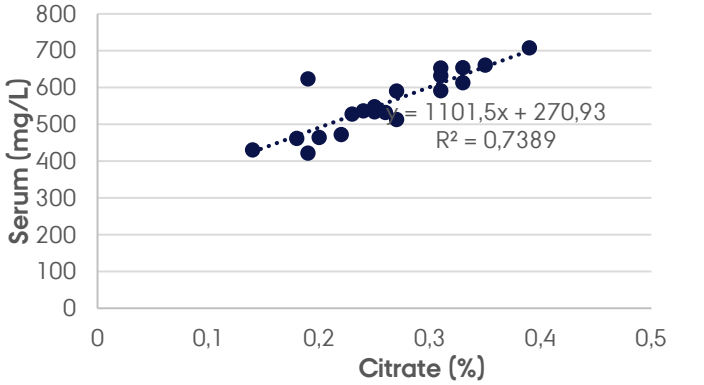
Calcium distribution in relation to total protein content in milk from 10 Holstein and 10 Jerseys
Use high protein milk to reduce serum Ca?

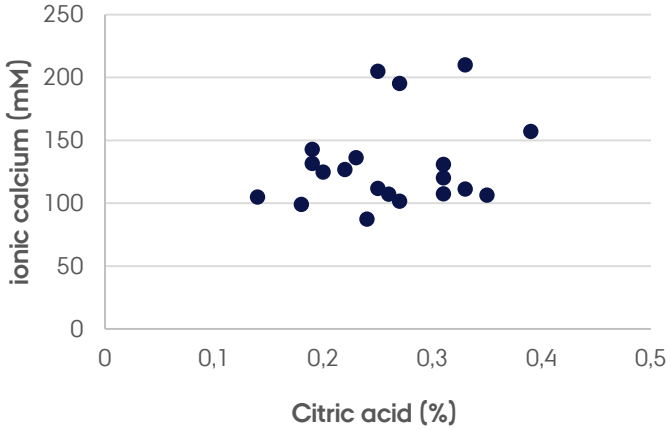
CITRATE

Citrate content distribution



SDM: 0,14-0,31 % (mean 0,21)
Jersey: 0,24-0,39 % (mean 0,31)

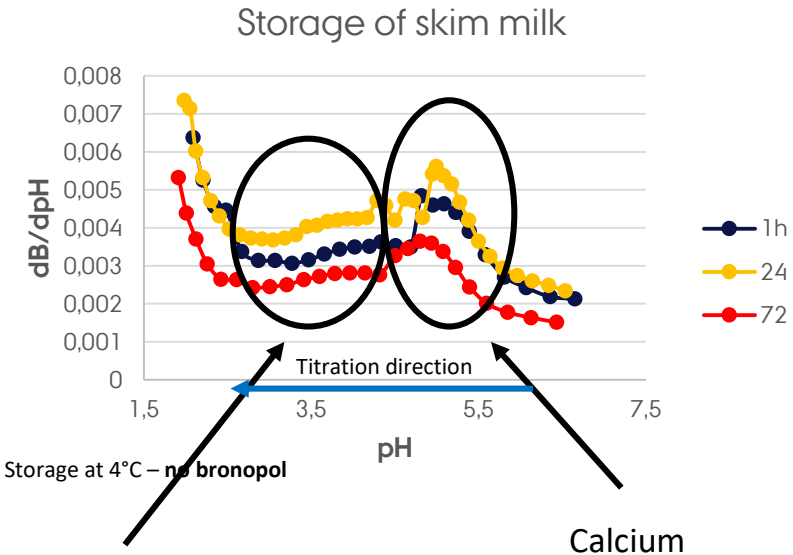


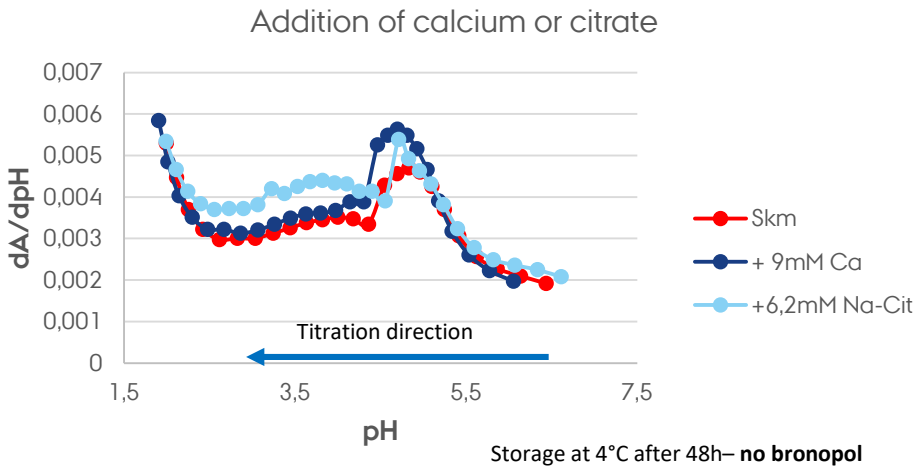


Jerseys higher citrate and linear with serum Ca
Ionic Ca and citrate relation not clear

BUFFERING CAPACITY

$$buffering\ capacity = \frac{dB}{dpH} = \frac{v(acid\ added)}{v(sample)} \cdot \frac{N\ (normality\ of\ acid)}{pH\ change}$$





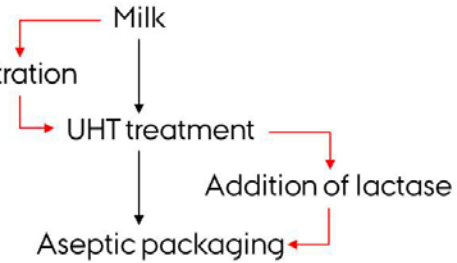
Better buffering capacity – more stable milk?

CASE: LACTOSE REDUCED PRODUCTS

Lactase added to cleave the remaining lactose into glucose and galactose

Complex interplay between proteolysis and Maillard reactions (sugar + protein), which are both enhanced in lactofree milk

Filtrered indirect UHT



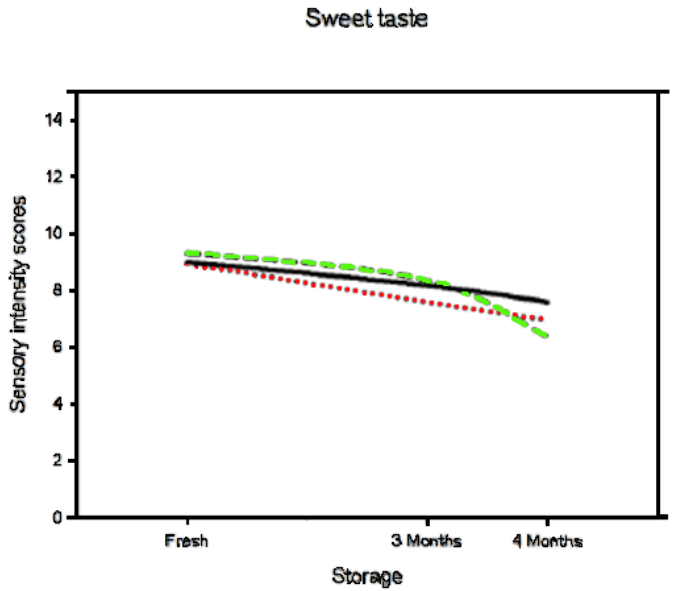
Conventional indirect UHT

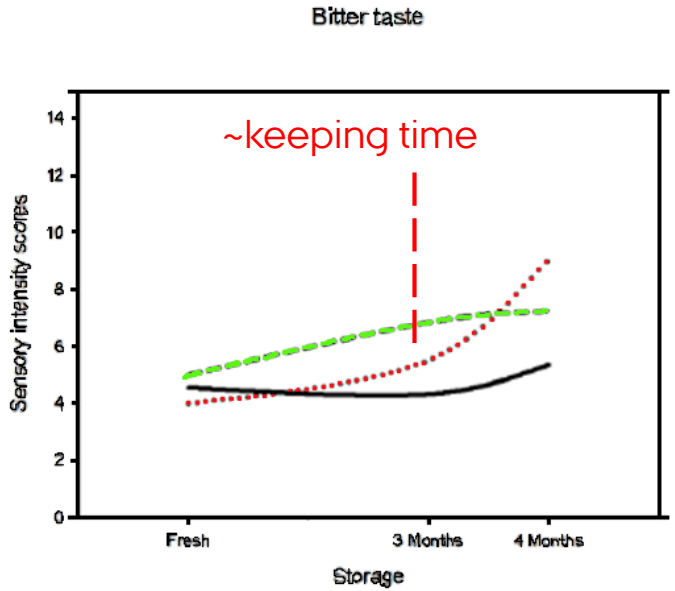
Lactose-hydrolysed direct UHT

Lactose-hydrolysed indirect UHT

SENSORY PROFILING OF STORED UHT MILK
SEMI SKIMMED

Conventional indirect UHT
Lactose-hydrolyzed direct UHT
Lactose-hydrolyzed indirect UHT





Jensen et al. (2015). Storage-induced changes in the sensory characteristics and volatiles of conventional and lactose hydrolyzed UHT processed milk. Eur Food Res Technol 240, 1247–1257

Nielsen et al. (2017). Relation between Sensory properties and Peptides derived from Lactose-hydrolyzed UHT milk during Storage. Int. Dairy J, *in press.*

RELATION BETWEEN SENSORY PROFILE AND GENERATION OF BITTER PEPTIDES AND ALDEHYDE

- 17 bitter peptides identified to be generated during storage of lactofree UHT milk (9 α_{s1}-CN, 7 β-CN, 1 α_{s2}-CN)
- Furthermore undesired aroma component 2-methylbutanal generated after 80 days
- Complex interplay between proteolysis, glycations and early Maillard reaction products
- Current investigations and publication on undesired side activities of lactase enzymes from different companies

Nielsen et al (2017). Relation between Sensory properties and Peptides derived from Lactose-hydrolyzed UHT milk during Storage. Int. Dairy J, *accepted.*

OUTLOOK

- ✓ Connection between raw milk quality and UHT stability
  - Role of calcium content and ionic calcium
  - Breed differences
  - Role of citrate
  - Urea (master project)
- ✓ Role of lactase enzyme in lactose free milk
- ✓ Molecular markers for functional and nutritional quality of UHT and powder products