Exploring **calcium's potential** in cheesemaking

Advancing milk processing and curd formation to tailor cheese properties.

Calcium plays a key role in shaping the texture, firmness, and melting properties of cheese. It induces protein aggregation making cheeses like Cheddar and Parmesan firm and crumbly, while cheeses with less calcium, like Brie or Camembert, are soft and creamy. Calcium also affects how cheese ages - high-calcium cheeses break down more slowly, while low-calcium ones ripen faster, developing stronger flavors. It influences melting too; cheeses with more calcium tend to be rubbery and less meltable, whereas those with less calcium melt smoothly, like Mozzarella.

The pH and temperature during cheesemaking also influence calcium content in the cheese, at higher pH, more calcium stays in the cheese, making it firmer, while lower pH causes calcium loss resulting in a softer texture. Too much calcium can make cheese dry and chalky, while too little can lead to weak structure and excessive moisture loss. The temperature of milk storage before cheesemaking also influences calcium loss or retention. The manufacture of cheese involves many processes such as preconditioning, concentration, acidification, salting, cooling and heating, all of which change the distribution of calcium between the serum and the cheese. This often results in challenges regarding product quality and consistency, both very important for consumers.

The project "ProCalcium - calcium dynamics during manufacturing of cheese" primarily focused on gaining a better understanding of what happens with the calcium distribution in milk between the serum phase of milk and the caseins during processing and consequences for the final cheeses. Mineral and calcium kinetics have been established during storage of milk to enable the development of models to predict curd and cheese quality.

During the project, a total of five studies were carried out to clarify calcium dynamics in a number of processes commonly used in cheese making. The first one



BY LILIA M AHRNÉ, PROFESSOR, DEPARTMENT OF FOOD SCIENCE, UNIVERSITY OF COPENHAGEN

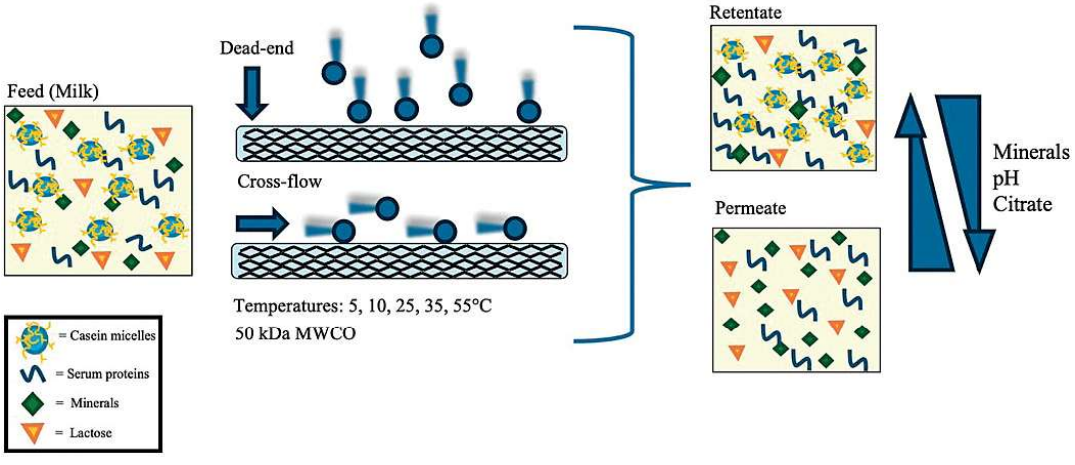


Figure 1. Schematic representation of ultrafiltration cross-flow and dead-end

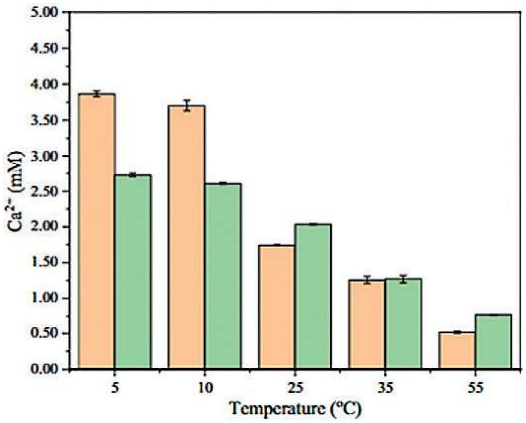


Figure 2. The influence of ultrafiltration set-up on ionic calcium concentration of retentates produced after 120 minutes filtration as a function of the temperature. Green bars represent the cross-flow and orange bars the dead-end filtration (Published in International Dairy Journal, 2024, 77 (3) 884-892), https://doi.org/10.1111/1471-0307.13097

PROJEKT OVERVIEW

Title: ProCalcium - calcium dynamics during manufacturing of cheese

Project leader: Lilia M Ahrné, Copenhagen University, Department of Food Science, Rolighedsvej 26, Frederiksberg C, Lilia@food.ku.dk

Project group: Professor Leif Skibsted, Assistant, Professor Giovanni Barone and Dr Yuan Jiang, Copenhagen University, Department of Food Science, Rolighedsvej 26, Frederiksberg C

Dr Valentin Rauh and Dr Søren Lillevang, Arla Food Amba, Arla Innovation Center, Agro Food Park 19, 8200 Aarhus

Project period: 01/10/2020 - 31/12/2023

Objective: To predict, control and underpin calcium dynamic and distribution in milk and cheese during dairy processing.

PROJECTS RELATED TO THE DANISH DAIRY RESEARCH FOUNDATION

established a mathematical model of calcium equilibria in milk during milk storage at different temperatures. It was essential to understanding how temperature influences the dynamics of calcium from the farm to the dairy and until it is used in the cheese production. It was established that calcium moves into the whey phase from the casein relatively fast in the first four hours of storage at a conventional cold storage temperature and then gradually becomes steady after six hours of storage.

As membrane filtration of milk is often used for standardising cheese composition, two studies examined the calcium equilibria and properties for casein micelles during milk ultrafiltration at different temperatures. Additionally, the setup of membrane filtration was also studied (Figure 1). The results obtained help the dairy industry to improve filtration performance while predicting the calcium speciation and content in the concentrates used for cheesemaking (figure 2). The calcium dynamic during the salting of milk and cheese were also studied to understand the role of ionic strength on calcium partition. The final study combined all the obtained knowledge in an effort to try and better understand the formation of curds made with different acids, temperatures and times, and thus made it possible to identify the suitable time and calcium dynamic for achieving the best suitable cheese curd for tailored products.

What can it be used for?

The project has increased the understanding of what processing during cheesemaking means for calcium and overall mineral content, equilibria and distribution between the whey phase and casein. This has been studied in relation to temperature changes, concentration by membrane filtration, acidification and salting. The results obtained in this study help the dairy industry optimise milk processing and gel formation by controlling calcium balance, protein interactions, and acidification effects. It aids in designing customised dairy products with desired firmness, hydration, and stability. Also, the insights obtained can help to optimise filtration efficiency and reduce production costs. However, there is more to be clarified to fully understand calcium partitioning effects on final cheese functionality for selected applications (e.g., pizza, cheese sause, etc). This is now the scope of the new project MinCurd - Influence of milk mineral on curd forming properties. ●

ABSTRACT

The project "ProCalcium - calcium dynamics during manufacturing of cheese" has investigated the relationship between common dairy processing related to cheesemaking and calcium dynamic between casein and serum phase of milk. The project has shown that calcium and thus cheese quality can be controlled during all the common processing steps used by the dairy industry, making standardisation and quality of dairy products more consistent. It was also shown that the selection of acid for making acid-induced cheese and time significantly influences the final curd. Overall, the knowledge generated during the project is now implemented to control calcium in dairy products to produce tailored high-quality dairy cheese.