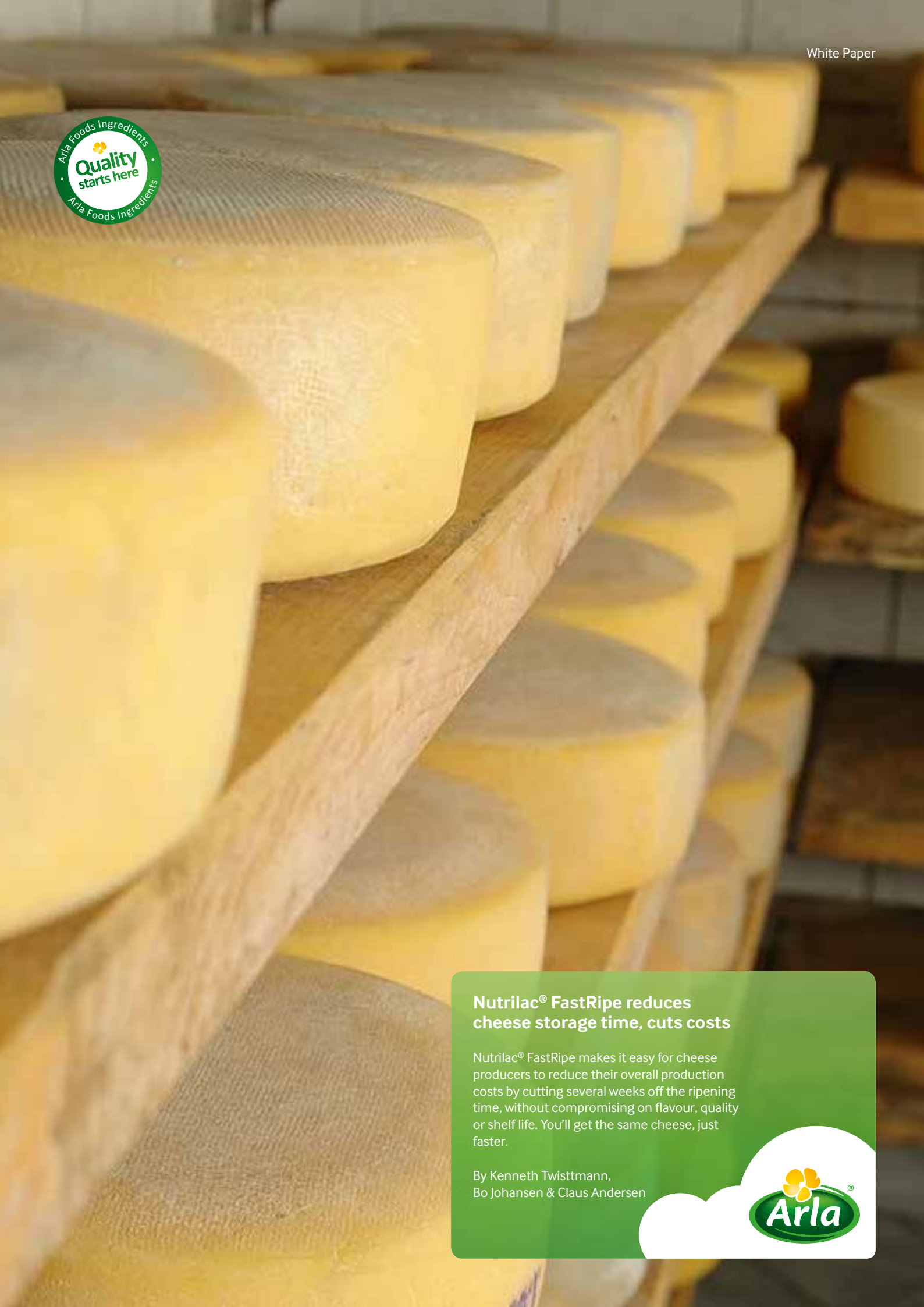


Nutrilac® FastRipe reduces cheese storage time, cuts costs

Nutrilac® FastRipe makes it easy for cheese producers to reduce their overall production costs by cutting several weeks off the ripening time, without compromising on flavour, quality or shelf life. You'll get the same cheese, just faster.

By Kenneth Twisttmann,
Bo Johansen & Claus Andersen

Arla®

Introduction

The ripening process is key to the creation of continental- and cheddar-type cheeses, allowing a cheese to develop its unique characteristics.

During cheese ripening the organic materials of protein (casein), milk fat (lipids) and carbohydrates (lactose) undergo enzymatic and biophysical changes.

The proteolysis of proteins is the dominant factor for hard- and semi hard cheeses. During ripening the proteins are broken down into peptides and amino acids, flavour compounds are released, and the cheese texture becomes smooth, sliceable and pleasant to consume.

Depending on the exact cheese type, ripening time ranges from 3-4 weeks to more than a year. So although ripening is a vital part of creating the perfect cheese, it can also be quite a costly period, with huge amounts of money committed to storing the ripening cheese.

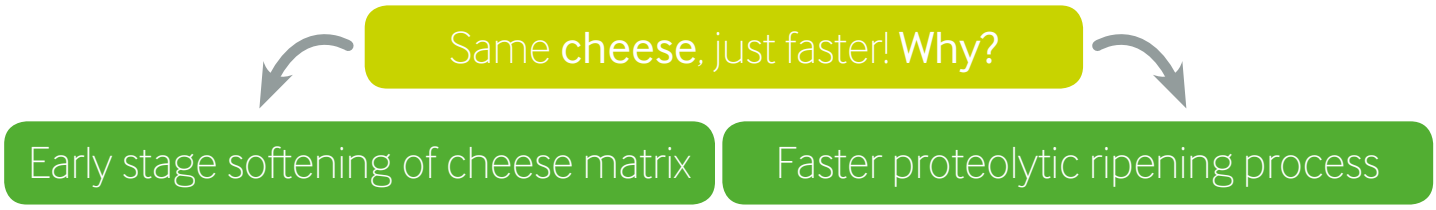
At Arla Foods Ingredients we have the solution for reducing the ripening time for your cheese – and thereby reducing storage costs by as much as US$16.50 per ton over a 3-week period.

Nutrilac® FastRipe, also known as Nutrilac® CH-4560, is based solely on functional milk proteins and is an easy-to-use powder that speeds ripening time without affecting the final flavour, texture or shelf life of the cheese. This White Paper outlines the unique advantages of Nutrilac® CH-4560.

Nutrilac® CH-4560 is the optimal choice because...

Nutrilac® CH-4560 is an easy-to-handle, all-natural ingredient for natural cheeses, specially designed for easy addition to the cheese milk, and for controllable modification of both reduced- and full-fat cheeses. In most countries, you do not need to declare Nutrilac® CH-4560 as an ingredient on the product label, because it derives purely from milk.

For you as a cheese producer, it is vital that the addition of powder is as simple as possible, in order to keep the original production setup intact. Nutrilac® CH-4560 powder disperses quickly, allowing it to be easily mixed into either cheese milk or water.



The versatility of Nutrilac® CH-4560 makes it useful for many types of natural cheeses. Figure 1 shows the effect of Nutrilac® CH-4560 on the reduction in ripening time.

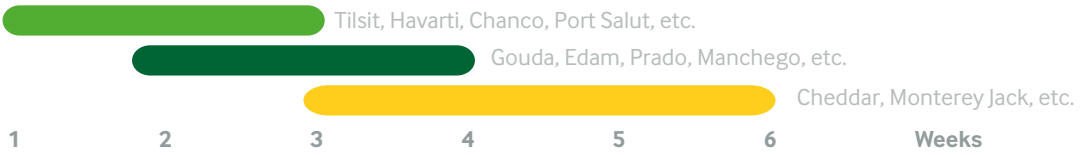


FIGURE 1
Different cheese types and their expected reduction in ripening time when adding Nutrilac® CH-4560.

Same cheese, just faster!

One of the most important things to note is that the overall cheese-making process is not affected by adding Nutrilac® CH-4560. The only change is the addition of powder and the final shortening of the ripening period – a clear and simple benefit.

Figure 2 shows the two basic elements involved in cheese ripening, leading to a ready-to-consume cheese. Nutrilac® CH-4560 speeds up both elements, and the following sections tell you why.

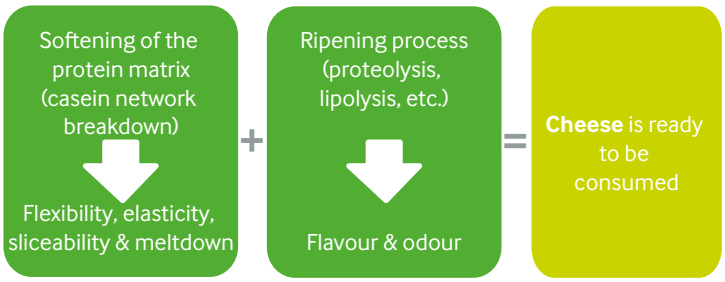


FIGURE 2
Basic model for cheese development during storage.

Nutrilac® CH-4560 softens the cheese matrix

The strength and cohesiveness of cheese is initially determined by the bonds that hold the casein network together. Addition of Nutrilac® CH-4560 has a clear effect on the hydrophobic bonds between the casein molecules. These bonds are very important when it comes to the hardness and chewiness of cheeses.

Figure 3 illustrates that the number of hydrophobic bonds between the casein molecules are reduced by the Nutrilac® CH-4560 particles, and consequently the cheese reaches the desired point of softness and flexibility at an earlier stage of the ripening.

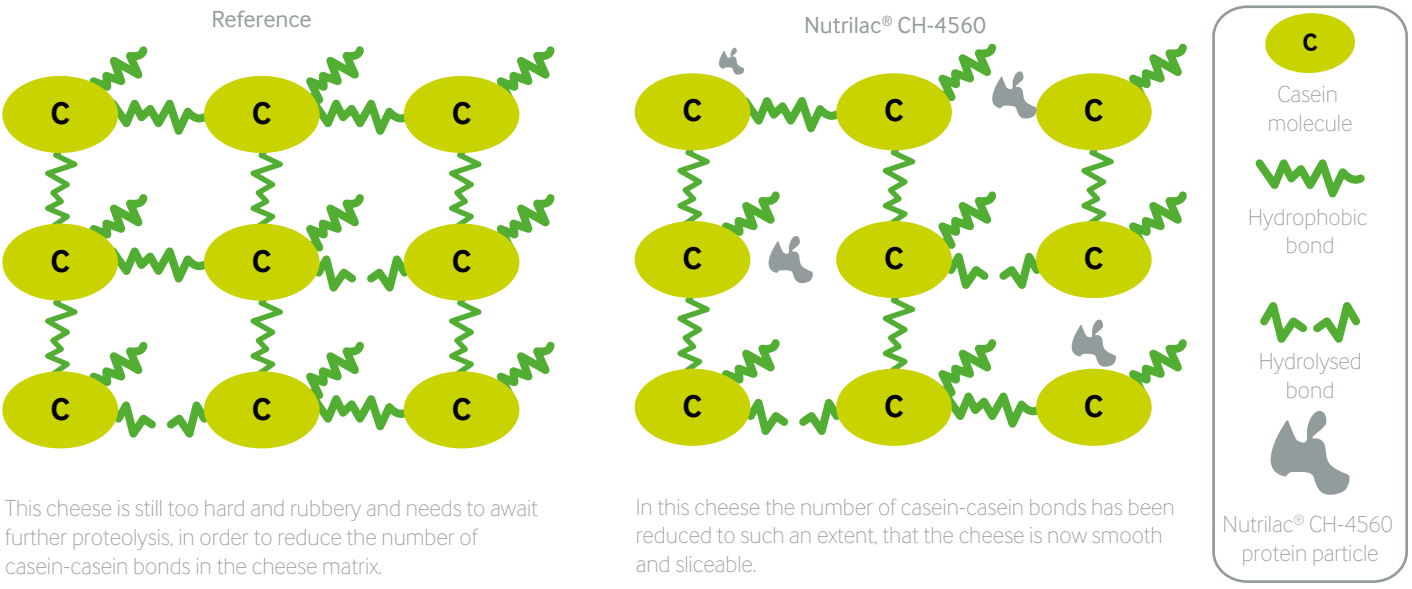


FIGURE 3
Schematic layout of the cheese protein network in a reference cheese and a cheese containing Nutrilac® CH-4560, respectively.

Figure 4 shows the two cheeses from figure 3 under a microscope. The pictures of the cheese matrices show a clear difference between the samples; the Nutrilac® CH-4560 protein particles are visible as light green particles present in the protein network (picture to the right). The presence of Nutrilac® CH-4560 protein particles reduces the protein-protein interactions and induces the water-protein interactions, due to the relatively higher water binding capacity of Nutrilac® CH-4560.

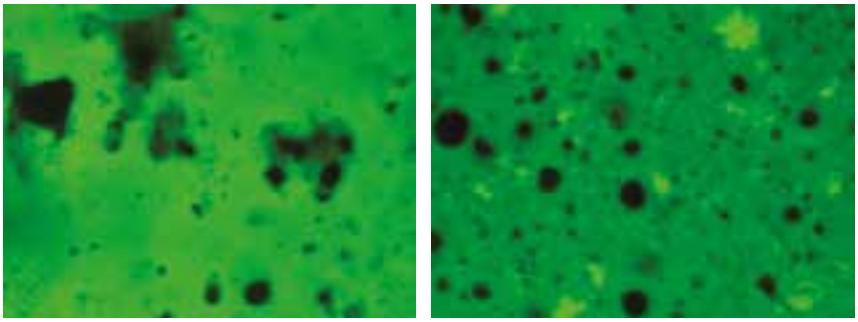


FIGURE 4
Pictures (confocal microscopy) of the microstructure of a reference full fat cheese (to the left) and a full fat cheese containing Nutrilac® CH-4560. Black areas represent fat globules, dark green areas represent casein, and the light green particles (picture to the right) are Nutrilac® CH-4560 particles.

"Extensive study conducted at the University of Wisconsin Center for Dairy Research (CDR) compared control low fat (6% fat) Cheddar cheeses against low fat Cheddar made with 0.50% Nutrilac® CH-4560. Texture Profile Analysis (TPA) was performed on the cheeses looking specifically at changes in hardness during ripening. The results showed that cheeses made with Nutrilac® CH-4560 were much softer than control cheeses at 30 days. Low fat Cheddar cheese tends to be typically quite firm and difficult to shred and slice at an early age. Softening the cheese texture by using Nutrilac® CH-4560 during the manufacture of low fat cheese can help in that regard."

– John J. Jaeggi,
Wisconsin Center for Dairy Research, University of Wisconsin – Madison

A key sensory parameter in cheese ripening is the speed of mouth meltdown when chewing the cheese. Speeding up the softening of the cheese matrix by Nutrilac® CH-4560 makes the creamy mouth meltdown occur earlier than usual, and the overall creaminess of the cheese is increased.

Nutrilac® CH-4560 speeds up the ripening process

When it comes to proteolysis, this is a highly complex area with several factors such as residual rennet activity, enzymes from lactic acid bacteria (starter, adjunct or surface ripening), including cheese matrix pH, temperature, water activity, as well as the composition of the cheese, all affecting the overall ripening of the cheese.

The casein molecules are broken down into peptides and further into amino acids. In these steps the low molecular weight volatiles are released, which is the most important factor when it comes to the development of the desired flavour and odour in the specific cheese.

Nutrilac® CH-4560 is not hydrolysed during ripening and the inert protein particles remain in the cheese matrix throughout the whole ripening period. This means that, compared to adding ripening-inducing cultures and enzymes – which often induce the breakdown of the proteins excessively making the cheese ready faster but also shortening overall shelf life – Nutrilac® CH-4560 contributes to making the cheese ready for sale more quickly while retaining quality and shelf life.

As the case study (see later section) in this paper shows, the formation of amino acids can be increased in a controllable way by the addition of Nutrilac® CH-4560, even though the cheese moisture level remains the same.

When Nutrilac® CH-4560 is added, the degradation of peptides into amino acids will typically happen significantly faster, compared to a control cheese. The mechanisms behind this are:

- In most cases the addition of 0.2-0.3%* Nutrilac® CH-4560 leads to an increased moisture level in the cheese of 0.5-1.0% points. It is a well proven fact that increased moisture levels increase the proteolysis and thereby the amount of free amino acids.

- Adding Nutrilac® CH-4560 results in an increased proteolysis, even in cheeses where the moisture level is not increased. This indicates that the growth and/or the autolysis of the lactic acid bacteria are affected in a positive way.

Due to the effect of both factors (early stage softening of the cheese matrix and faster proteolytic ripening), Nutrilac® CH-4560 is capable of moving the limit where consistency and taste is perceived to "be ready".

Shorter maturation time delivers significant cost savings

Huge amounts of money are committed when continental- and cheddar-type cheeses are stored while being ripened ready for sale. The average storage cost for a tonne of continental- and cheddar-type cheese is US$5.50 per week – so being able to reduce ripening time by 1 to 6 weeks clearly offers significant potential cost-savings:

Case study

- The ABC Dairy company produces 30,000 tonnes of Gouda cheese each year.

- If ABC Dairy chooses an addition of 0.25% Nutrilac® CH-4560
  it reduces the storage time of its annual production of Gouda by 3 weeks.

- As a result the ABC Dairy makes a significant reduction in its costs:

The cost saving per tonne of cheese	(3 weeks x US$5.50)	**= US$16.50 per tonne**
The cost saving per year	(30,000 tonnes x US$16.50)	**= US$495,000 per year**

* Recommended dosage weight/weight of total amount of cheese milk.

Case study: Nutrilac® CH-4560 speeds ripening of full fat cheddar-type cheese by one month

Purpose

We investigated the impact of adding 0.3% Nutrilac® CH-4560 on the properties of the cheese during ripening – including a potential reduction in ripening time, meaning the cheese would be ready for sale faster.

Method

We made two cheeses:

1. A reference full fat cheddar-type cheese (Monterey Jack) without added Nutrilac® CH-4560.

2. A full fat cheddar-type cheese with added 0.3% Nutrilac® CH-4560. We mixed Nutrilac® CH-4560 (0.3% of total cheese milk) into water (2.0% of total cheese milk) using a high-speed mixer, hydrated this mix overnight, then added it to the cheese milk right before pasteurisation.

Normally, you would expect an increase in the water content of the cheese when adding Nutrilac® CH-4560. We controlled for this so both cheeses had the same final moisture level, and thus the same macro-nutritional composition. To achieve this we increased the scalding temperature from 36°C to 37°C in the cheese added Nutrilac® CH-4560.

Table 1 shows the recipe, and figure 5 shows an overview of the cheese production process.

TABLE 1
Initial cheese milk composition of the two cheeses produced.

Dosage in %	Reference	Nutrilac® CH-4560
Skimmed milk	89.60	87.30
Cream (38% fat)	10.00	10.00
Water	0.29	2.29
Nutrilac® CH-4560	-	0.30
Culture (RST 630)	0.08	0.08
Rennet (Hannilase L205)	0.03	0.03

FIGURE 5
Flowchart showing the steps in the production of cheddar-type cheese containing Nutrilac® CH-4560.
The differences in production between the two cheeses are written in italic types.

Analyses & results

Table 2 shows the composition and other characteristics of the final cheeses.

TABLE 2
Final composition, pH and water activity of the two cheeses produced.

Component in %	Reference	Nutrilac® CH-4560
Fat	29.7	30.0
Moisture	40.9	40.1
Protein	24.4	24.5
NaCl	1.5	1.6
Fat in dry matter	50.1	50.1
pH	5.26	5.23
Water activity	0.935	0.932

With an initial amount of 100 kg cheese milk and 2.0% salt added on top during cheddaring, the yield for both cheeses was 11.1 kg.

Based on a protein recovery degree of 65% of Nutrilac® CH-4560, the expected amount of protein and its distribution in the cheeses is shown in table 3. Figures 6 and 7 show how the two cheeses performed in terms of sensory evaluation (e.g. flavour intensity and elasticity) and texture firmness.

TABLE 3
Expected protein distribution in the two cheeses produced.

	Reference	Nutrilac® CH-4560
Total protein	24.4%	24.5%
– of which is Nutrilac® CH-4560	–	0.9%
Nutrilac® protein/total protein	0/100	3.7/96.3

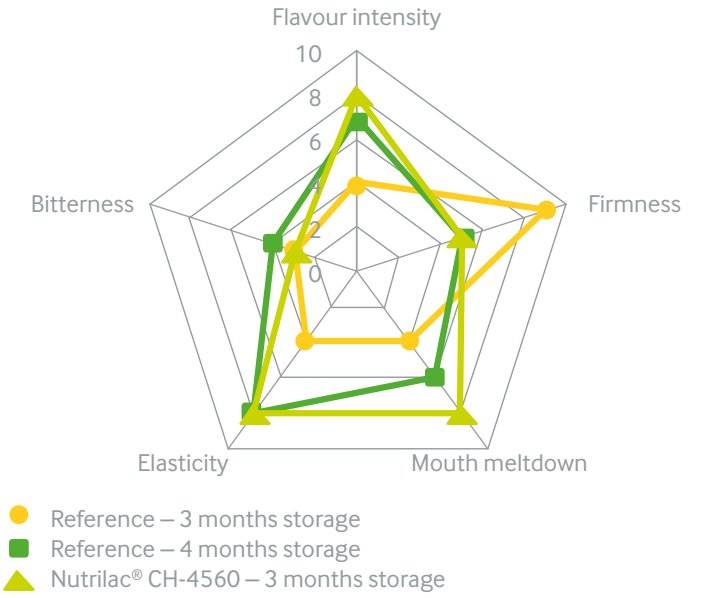


FIGURE 6
Sensory evaluation (trained panel) of the cheeses after 3 and 4 months of ripening.

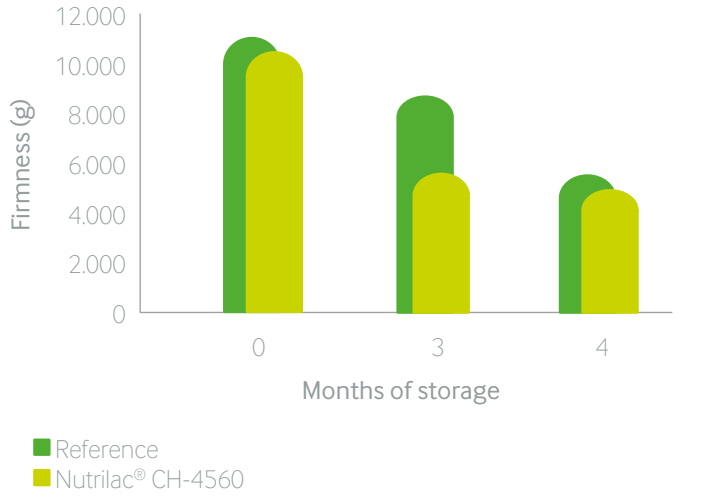


FIGURE 7
Texture firmness measurements of the cheeses after 0, 3 and 4 months of ripening (Texture Analyzer).

Table 4 shows the content of free amino acids and biogenic amines for the cheeses after 3 months of ripening, and figure 8 shows a picture of the two cheeses..

TABLE 4
Content of free amino acids and biogenic amines for the cheeses after 3 months of ripening.

Component in [ppm]	Reference	Nutrilac® CH-4560
Alanine	103	111
Glycine	19	25
Valine	111	151
Leucine	252	302
Isoleucine	24	29
Threonine	33	42
Serine	46	60
γ-amino butyric acid	93	129
Proline	79	94
Asparagine	120	148
Aspartate	28	32
Methionine	56	69
Glutamate	221	318
Phenylalanine	363	416
Glutamine	197	209
Ornithine	81	<LOD
Lysine	88	115
Histidine	41	45
Tyrosine	86	98
Tryptophan	10	10
Cadaverine	3	3
Spermidine	<LOQ	41
Total	1.971	2.446

LOD = Limit of detection
LOQ = Limit of quantification

FIGURE 8
Cheeses (reference to the left and with Nutrilac® CH-4560 to the right) after 3 months of ripening.

Discussion

The macro-nutritional composition of the two cheeses is very similar (table 2), and the only differences between the cheeses were firmness and taste.

Our findings show the acceleration of cheese matrix softening when adding Nutrilac® CH-4560 (the optimal taste profile and firmness are reached after 3 months, compared to 4 months for the reference cheese, see figure 6 and 7).

The free amino acid analyses (table 4) clearly indicate that adding Nutrilac® CH-4560 results in a faster buildup of total free amino acids (24% increase) which act as flavour precursors, beneficially influencing the overall sensory properties of the final cheeses (figure 6).

Conclusion

This case study clearly indicates that even with an equal dry matter content, Nutrilac® CH-4560 is capable of both accelerating the proteolysis and modifying cheese texture, in a way that enables the producers to send the cheeses to the consumers several weeks earlier.

About Arla Foods Ingredients

Arla Foods Ingredients is a leading developer and supplier of nutritional and functional milk-based ingredients to the global food industry. The company operates production facilities in Denmark, Sweden, Argentina and Germany, applications centres located in Denmark and Argentina, as well as a worldwide network of sales offices. Arla Foods Ingredients is a subsidiary of Arla Foods, one of Europe's principle dairy groups.

For more information about this White Paper, or for information about the range of products Arla Foods Ingredients can supply, please contact Claus Andersen at clan@arlafoods.com.

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