Continental Cheesemaking without curd-washing

Ingredients in the Dairy Industry Seminar- 4th March, 2021

Peter Beierholm Poulsen & Devdutt Rajan, Chr. Hansen

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Cheesemakers are under pressure to extract maximum value from their processes in a highly competitive market

Cheesemakers continue to seek hidden pockets of value in their operations in order to meet growing demand from consumers and food service operators for affordable, high-quality continental cheese

INDUSTRY DRIVERS

- Yield improvement
- Waste reduction
- Efficiency

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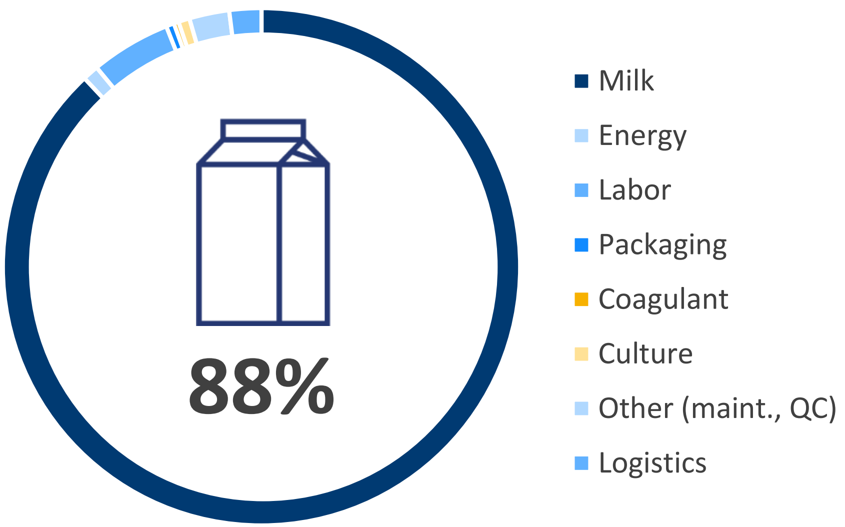
Developing solutions that improve yield and efficiency while reducing waste adds significant value to the dairy ingredient industry

CHEESE PRODUCTION COST[1]

Percentage of total cost



FOCUS ON MAXIMIZING VALUE

- Approximately **88%** of the cost of cheese production comes from the cost of milk
- Higher yields ensure that you **get the most out of your milk**
- Reducing water and energy consumption while minimizing waste helps reduce overhead and improves your environmental impact
- The starter culture comprises only about 1% of the total cost of goods sold, but it can **have a huge impact on bottom line**

1 Data based on conversations with our global customers

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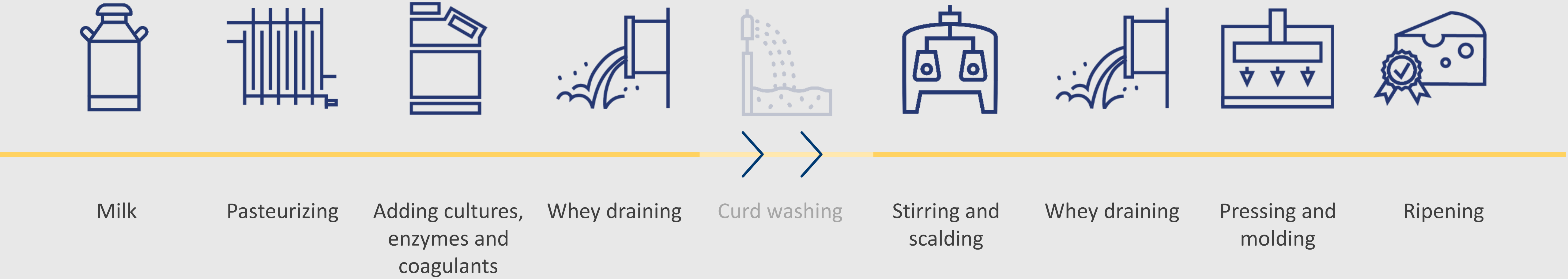
The right culture with optimized process parameters allows us to skip the curd washing step in the continental cheesemaking process



Curd washing has always been a fundamental part of the traditional continental cheesemaking process that helps producers avoid post-acidification and adverse effects on taste and texture.

What if we could eliminate the washing step and get the same functionality - and much more!

How does continental cheesemaking without curd-washing work?

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The control of acidification by the unique culture design allows us to skip the curd washing step

REFERENCE

Removing ~40%
of total milk volume

Water addition dilutes the lactose and controls acidification.

Adding ~30%
of total milk volume

The drained whey is diluted due to higher water content which needs to be removed during drying.

Removing ~20%
of total milk volume

Adding starter culture and coagulant → **1st whey draining** → **Curd washing** → Stirring and scalding → **2nd whey draining** → Pressing

UNIQUE NON-WASHED CURD (NWC) CULTURE

Removing ~20%
of total milk volume

Less whey is drained to avoid the formation of mechanical eyes during molding.

Adding no water

No dilution of lactose. Acidification is controlled by culture design and temperature.

Removing ~30%
of total milk volume

The drained whey is more concentrated (more solids) thus improving the drying capacity of the factory

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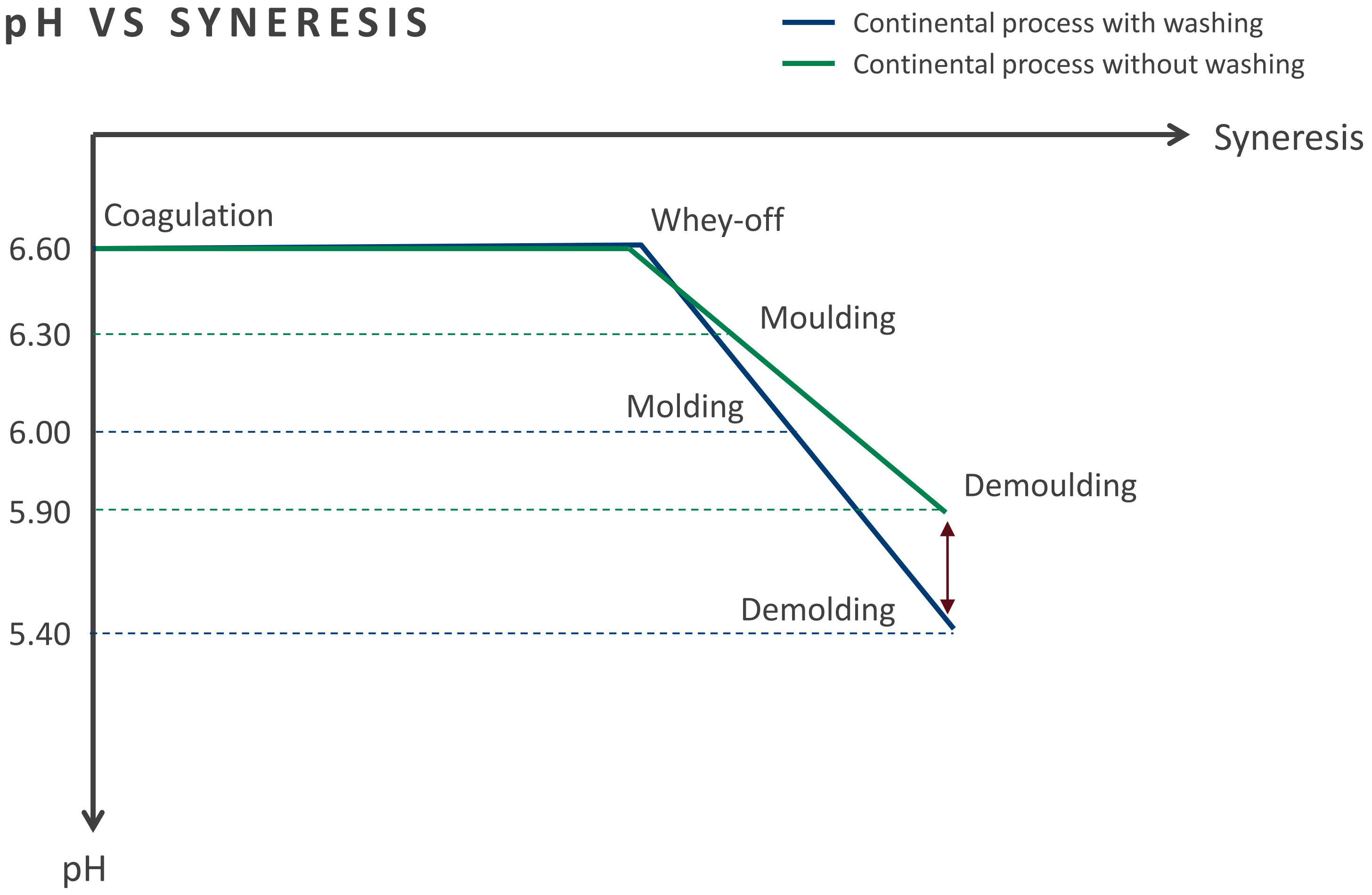
A higher pH at demolding is needed to reach the target flavor and texture at the end of ripening

pH VS SYNERESIS



Main changes to the process

- No curd washing
- Higher pH at molding and demolding

Typical challenges due to changes

- Risk of post-acidification
- Risk of adverse effect on texture and taste

Solution

- Unique culture design
- Temperature control during process

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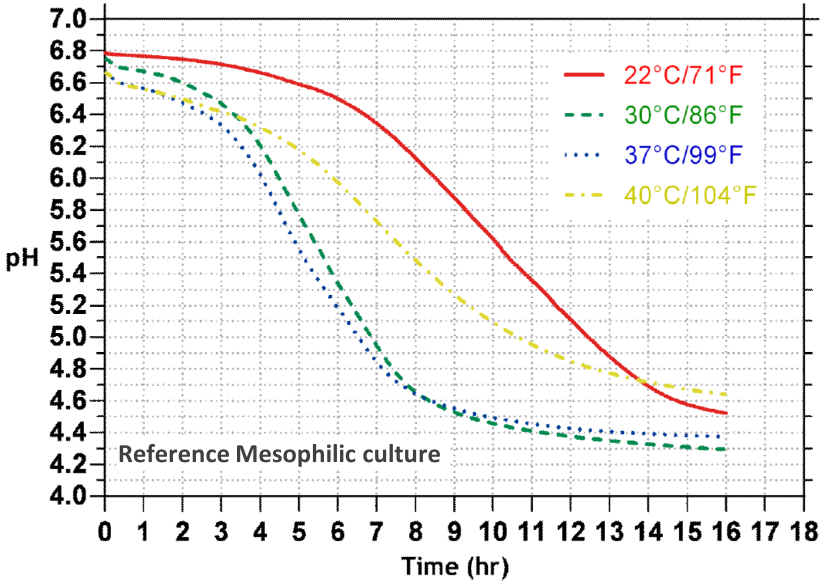
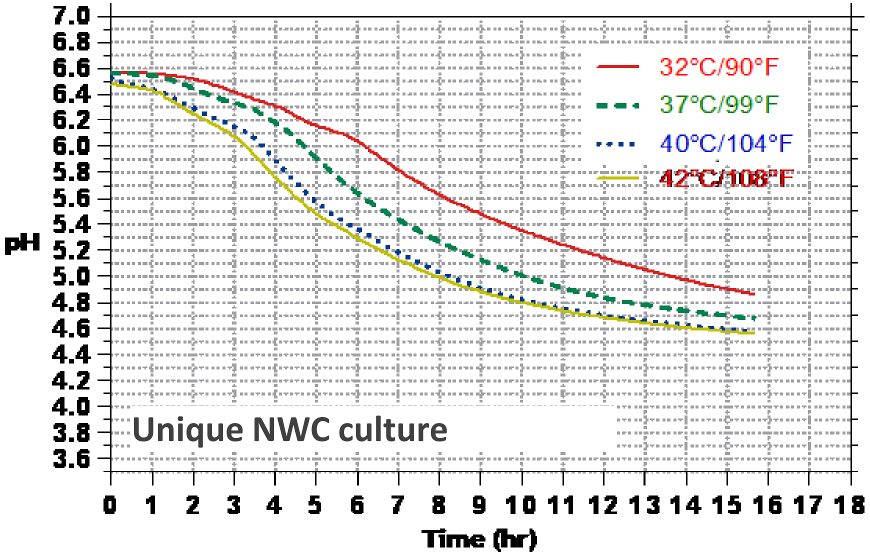
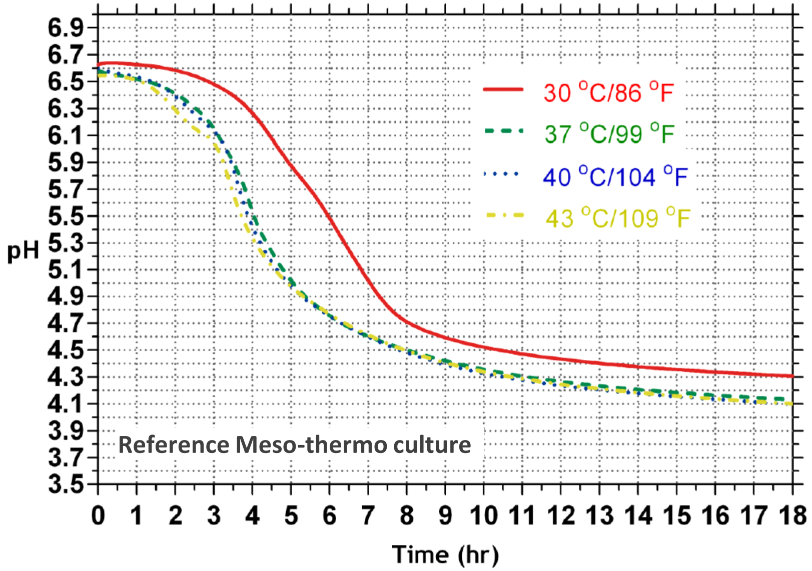
Slower acidification profile enabled by the NWC culture provides the pH kinetics required to control post-acidification







Comparing acidification profile between Unique culture & references

- Mesophilic reference: fast acidification at 30 and 37°C
- Meso-thermo reference: fast acidification from 37 to 43°C
- Unique non-washed curd (NWC) culture: Slower acidification at all temperatures, faster above 40 °C

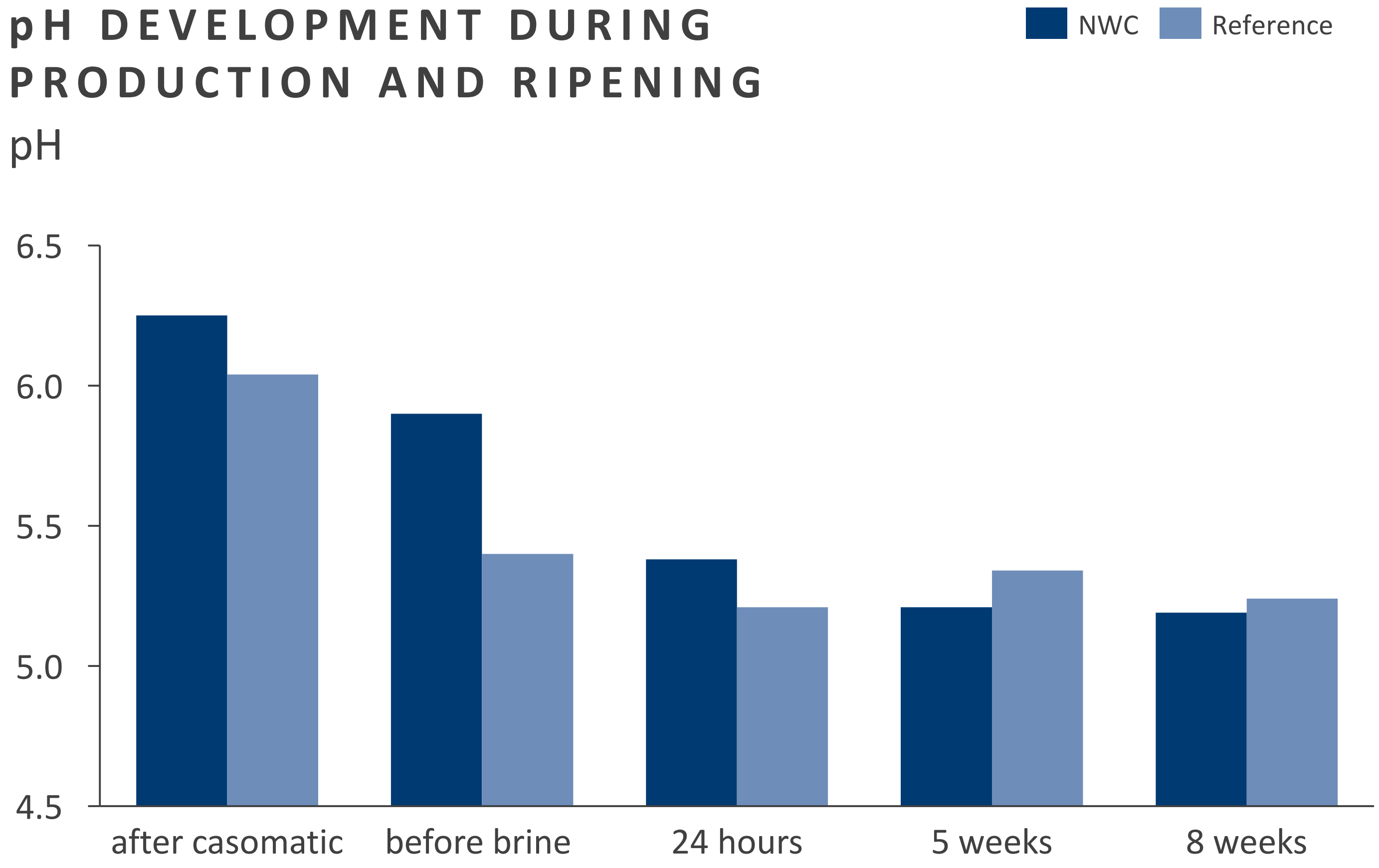
Slower acidification → higher buffer capacity → limits the risk of post-acidification.

NWC could be of interest if producers are looking for a slower acidifying culture.

The pH kinetics during production and ripening are controlled by the unique design of the NWC culture

The pH development is critical to control the flavor and texture of the cheese

pH DEVELOPMENT DURING PRODUCTION AND RIPENING



- Cheese produced using NWC cultures are generally higher in pH during cheese production, but reach similar pH levels after 5-6 weeks
- Slower acidification in cheese production is needed to control the final pH of cheese

Customer field trial 2019

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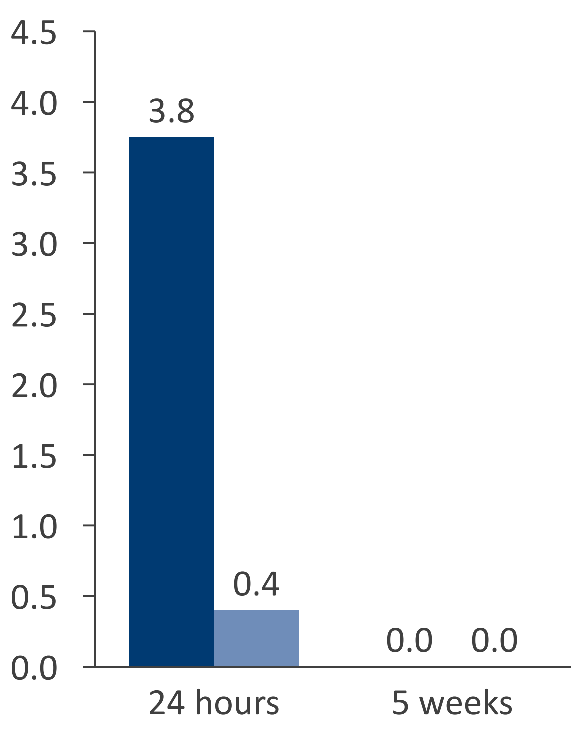
The residual sugars in the cheese are transformed into carbohydrates within the first five weeks

The transformation of residual sugars (lactose and galactose) is critical to control the flavor and texture of the cheese

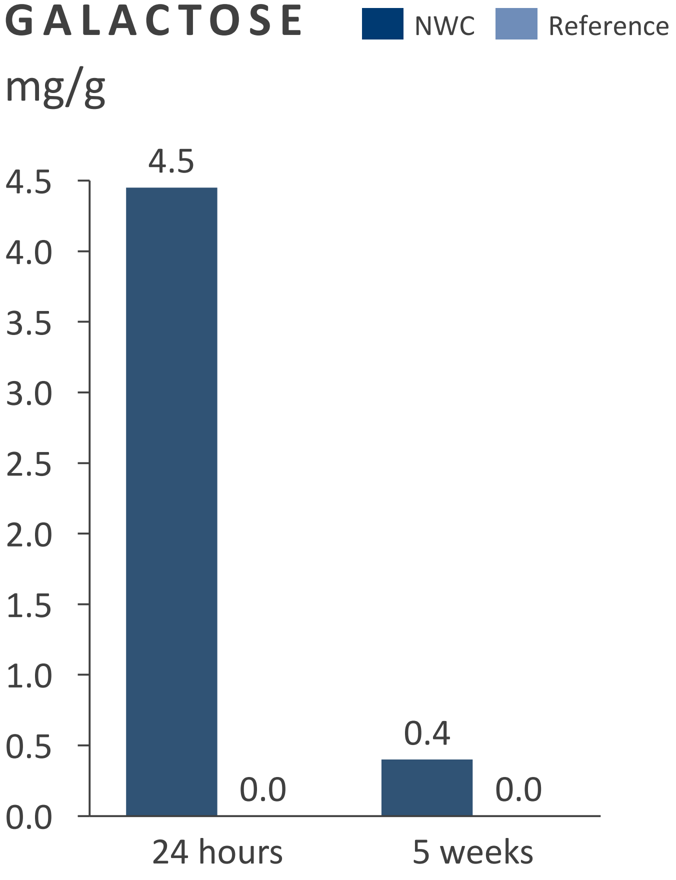
LACTOSE

mg/g



GALACTOSE

mg/g



- The high content of lactose in NWC cheese at 24 hours is a result of slower acidification
- The lactose is completely consumed by the mesophilic lactic bacteria within 5 weeks of ripening
- Galactose content NWC cheese at 24 hours is due to the STs in the culture blend, but they are consumed by the mesophilic part of the culture during ripening

Customer field trial 2019

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Field trials confirm better fat and protein retention in the cheese along with more concentrated whey when not washing the curd and using NWC cultures

	VAT			WHEY-OFF 1					WHEY-OFF 2				
	Milk protein (%)	Milk fat (%)	pH renneting	Protein (%)	Fat (%)	Total Solid (%)	Lactose (%)	pH	Protein (%)	Fat (%)	Total Solid (%)	Lactose (%)	pH
Reference	3.29	2.88	6.54	0.68	0.26	6.21	4.81	6.56	0.50	0.17	4.7	3.73	6.59
NWC	3.28	2.87	6.53	0.66	0.24	5.93	4.60	6.59	0.64	0.24	6.08	4.77	6.50

- Reference process has higher dry matter in whey at the first whey-off. This is the result of pre-stirring of the curd before water addition and scalding, resulting in more mechanical stress.
- At second whey-off, the dry matter in whey when using NWC is 22% higher than the reference because of no addition of wash water.

	CHEESE							
	pH cheese after Casomatic	pH cheese before brine	pH 24h	pH 5w	pH 8w	Fat (%)	Protein (%)	Moisture (%)
Reference	6.04	5.40	5.21	5.34	5.24	24.75	23.68	45.66
NWC	6.25	5.90	5.38	5.21	5.13	25.25	24.74	44.61

- The following is needed to make NWC work: a higher pH after Casomatic/pre-press and before brine and subsequently a higher pH after brine
- 0,5% higher fat and 1% higher protein retention are observed with NWC

Customer field trial 2019

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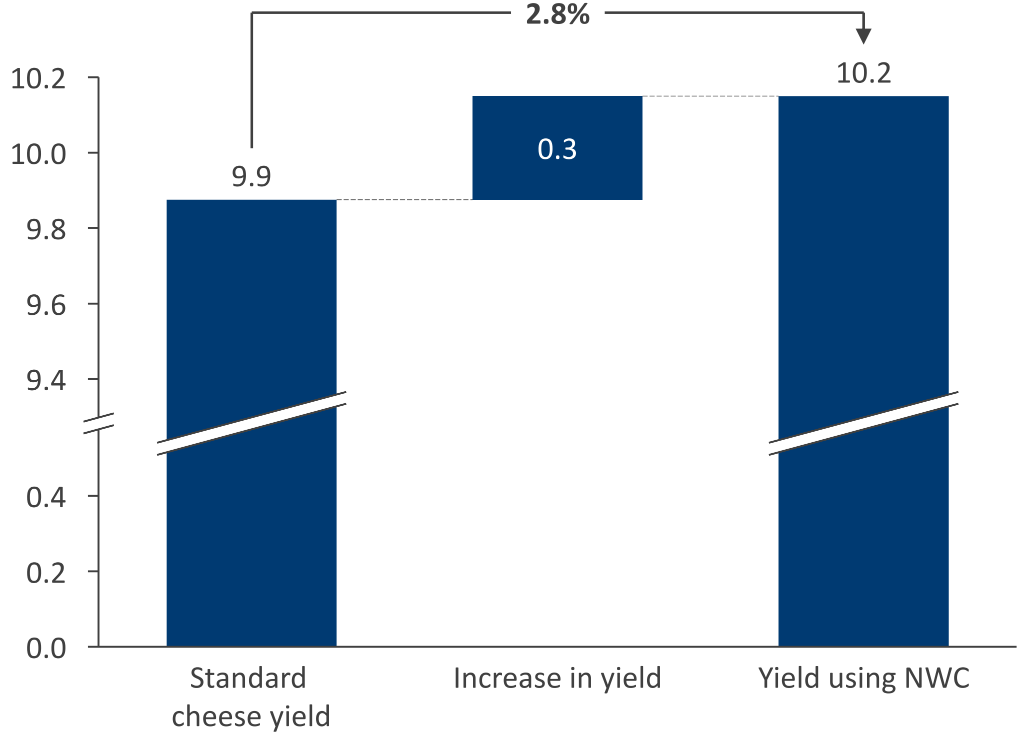
NWC technology has been seen to increase cheese yield with fewer steps, all without compromising on functionality

OVERALL CHEESE YIELD

Yield (moisture-adjusted kg of cheese per 100 kg of milk)



Applying NWC technology to the modern cheesemaking process has been shown to deliver up to a **3% yield increase** at our pilot plant and up to a **2% yield increase** when tested with our field trial partners.

This additional yield is comprised of the following:

- Protein: 25%
- Fat: 25%
- Carbohydrates and biomass: 50%

Trials at Chr. Hansen's pilot facilities.

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Pathway to successful cheesemaking using NWC technology and cultures

PRODUCTION PARAMETERS

Critical

Milk pasteurization (critical)	Pasteurize milk to minimum 72°C for 15s. Higher heat treatment can be applied. Important to know the quality of the milk.
Nitrate, Afilact® BioSafe® addition	Add as normal. NWC cultures work well with both Nitrate, Afilact® and BioSafe®
Pre-ripening (critical)	Shorter than normal - between 5 to 10 min. at 30 – 32 °C
Renneting	Time of renneting is generally between 25 and 35 min. Functionalities of the cheese can be changed with use of different coagulants.
Cutting	Target same gel firmness at cutting as standard recipe
Stirring – whey-off (critical)	Lower the amount of whey taken out in the first stage, and take more in the second stage instead. Recommended whey-off around 20% of the total milk volume.
Scalding – stirring (critical)	Heating using only jacket. Recommended temperatures 38.5 – 42°C
Molding	We recommend to keep the same parameters for the following steps as usually applied
Pressing	pH at molding is higher than normal, between 6.3 to 6.1 after pre-press
Brining	pH at after pressing is higher than normal. Target value is 5.9 – 5.7 before brine. Cool cheese quickly in either water or brine
Ripening (critical)	We recommend to ripen the cheese below 12°C

CRITICAL PARAMETERS

Milk quality	Issues with NSLAB or Biofilm in the pasteurizer, could potentially create a problem during acidification in vat and cheese ripening. Residual lactose combined with galactose and glucose (From *Streptococcus Thermophilus* part of culture) in cheese at 24h, introduces the risk of growth of unwanted bacteria.
Pre-ripening	For NWC cultures, the aim is to have a higher pH at molding, after pressing and before brine, in order to better control final pH. A higher pH at molding and before brine will help to obtain a higher buffer capacity of cheese (more Calcium Phosphate).
Stirring – whey-off	Less whey is drained in the first stage than in a "standard" process (as no water is added), to prevent the upper level of curd and whey being below the axis of the stirrer in vat. There is still a need to take out some whey, so that the amount of whey to be taken out before pump-over will not be too much causing slowing of the process and the cheese grains getting lumped together. Optimal ratio between curd and whey is needed to ensure good molding without mechanical openings
Scalding	Heating in jacket to 38.5 – 42°C We have seen good results by using a higher scalding temperature (40°C) to help control acidification. If higher scalding temperature is used, monitor the Delta T, to keep the right moisture content.
Ripening	Due to residual lactose in cheese at 24h, we recommend to ripen the cheese below 12°C. This is recommended in order to inhibit the growth of unwanted bacteria. Adjust the ripening temperature according to the milk quality and ripening time

Size of cheese block will impact the cooling time. Smaller block equal to faster the cooling.

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Skipping the curd washing step could enable you to get more out of less

UP TO 2% MORE YIELD

€400-600.000
worth of additional cheese yield for a dairy producing 10,000 tons of cheese per year

20% HIGHER WHEY CONCENTRATION CAPACITY

€80-100.000
worth of additional value driven by an increased whey concentration capacity due to the absence of wash water

SIGNIFICANT WATER AND ENERGY SAVINGS

€40-50.000
worth of savings per year from reduced wash water, energy consumption from pumping water, and concentrating whey

Taken together, these savings offer a dairy producing 10,000 tons of cheese annually approx. €600k – 800k in total additional value every year

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Thank you from the Chr. Hansen Team

COMMERCIAL DEVELOPMENT

Devdutt Rajan
Global Commercial Development Manager

dkdera@chr-hansen.com

GLOBAL APPLICATION

Peter B. Poulsen
Application Scientist

dkpepo@chr-hansen.com

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