Working together to produce more cheese from milk

Daryl Craven – 10th May 2019

CHR. HANSEN
Improving food & health

Chr. Hansen in brief

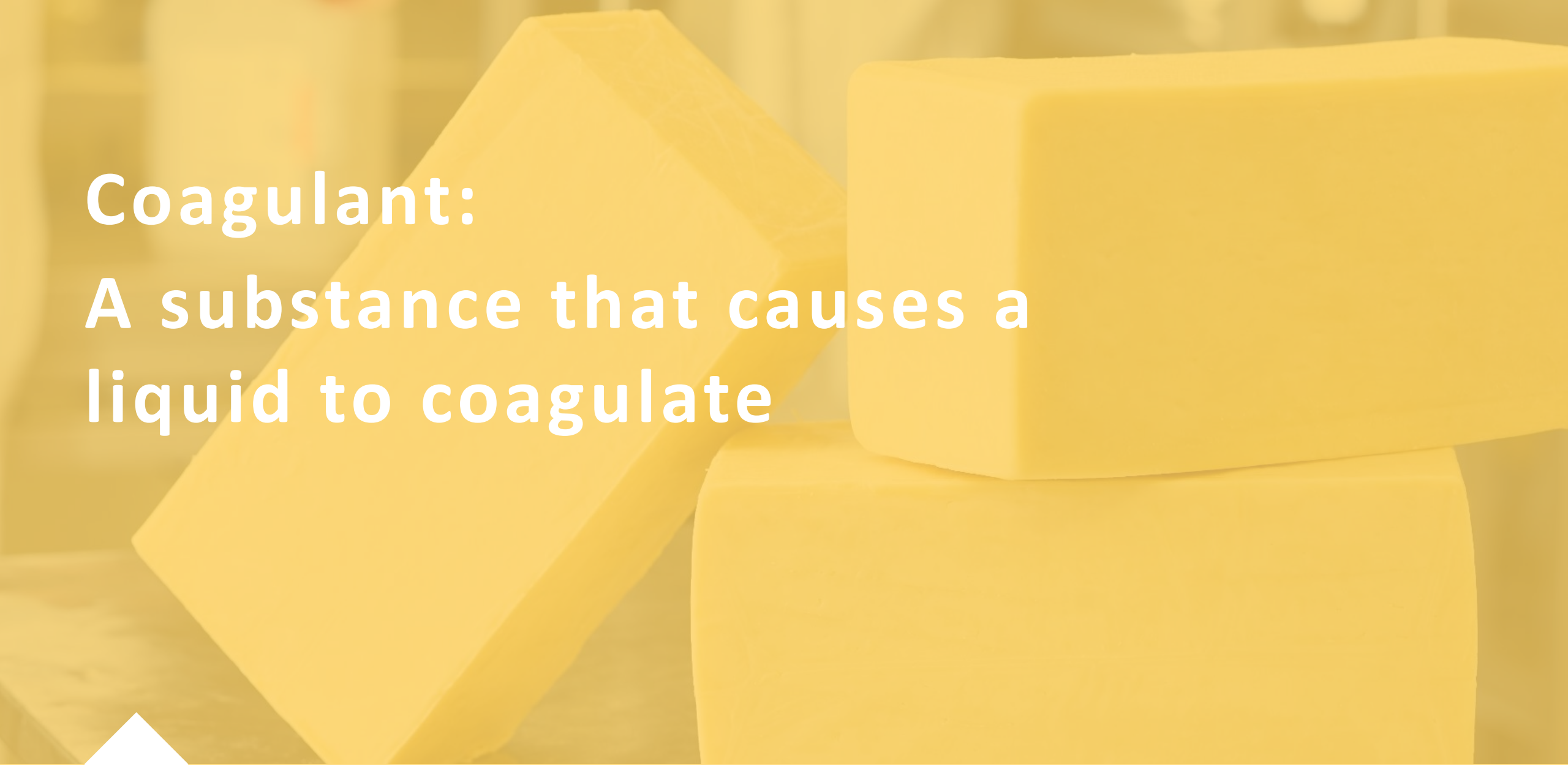
- Founded in 1874 in Copenhagen by Danish pharmacist Christian D.A. Hansen
- A global supplier of bioscience based ingredients to the food, health, pharmaceutical and agricultural industries
- More than 3400 employees
- We mainly produce cultures and dairy enzymes, probiotics and natural colours

CHR. HANSEN
Improving food & health

Agenda

- ROLE OF COAGULANTS IN CHEESE MAKING
- CHY-MAX SUPREME
- COAGUSENS
- QUESTIONS AND ANSWERS

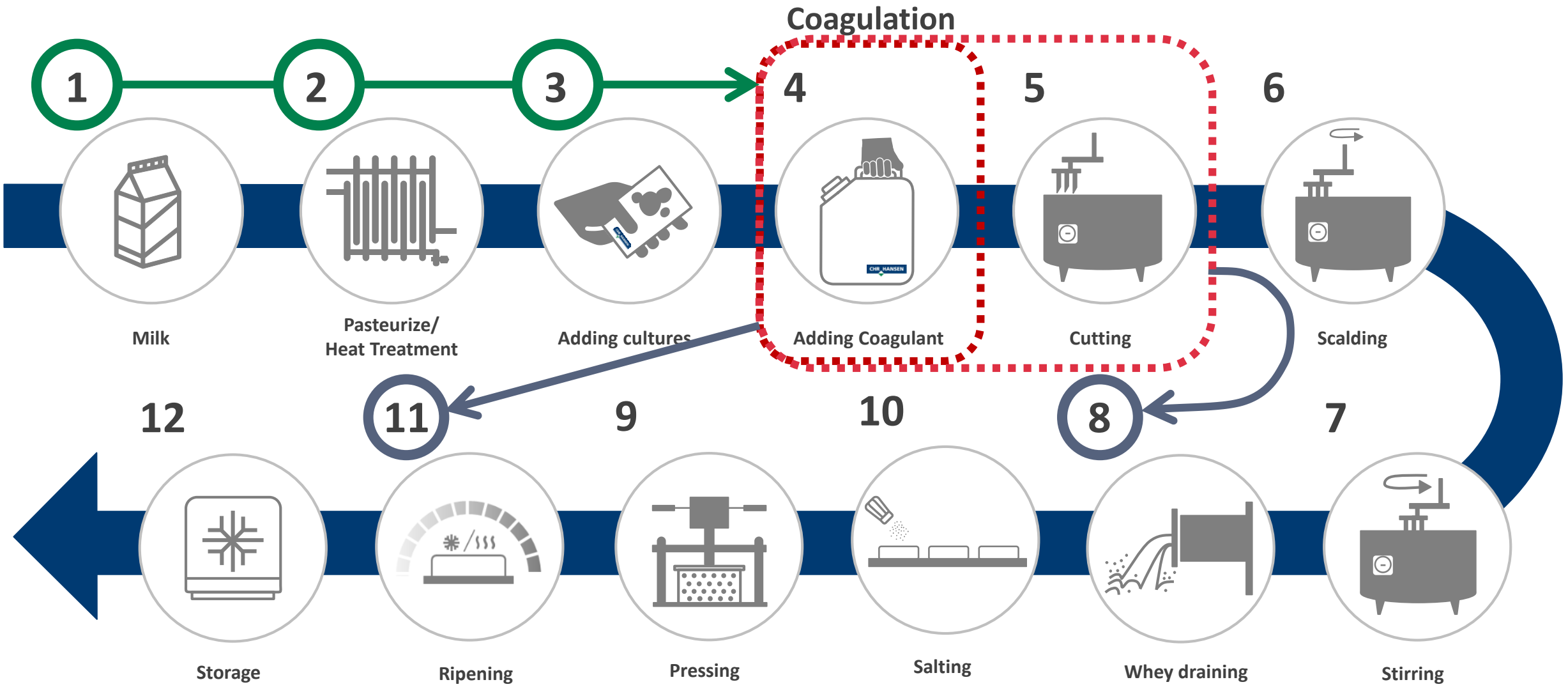
CHR. HANSEN
Improving food & health



Coagulant:
A substance that causes a liquid to coagulate

CHR. HANSEN
Improving food & health

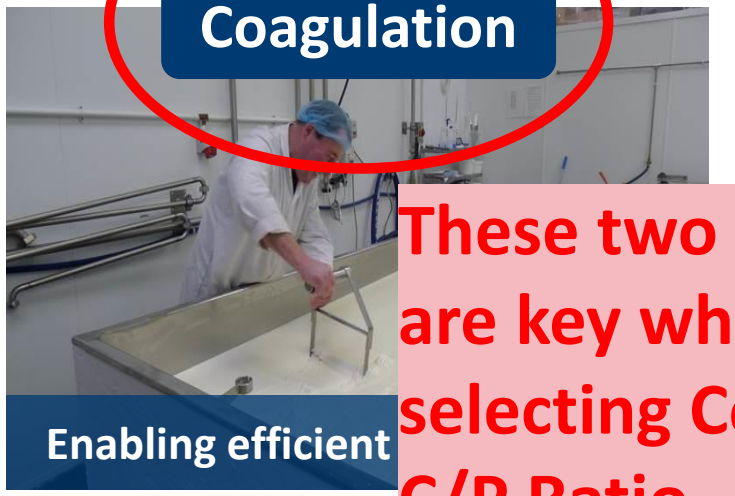
Cheese Making Process



CHR. HANSEN
Improving food & health

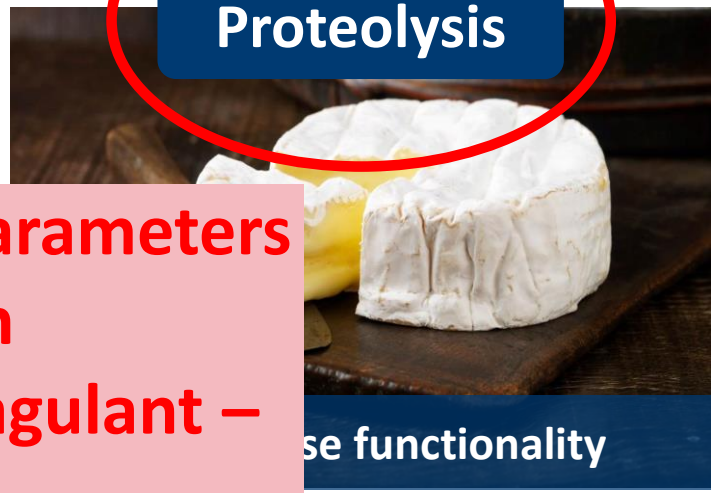
The role of coagulants in cheese making

Coagulation



Enabling efficient

Proteolysis



se functionality

Whey

No longer a bi-product

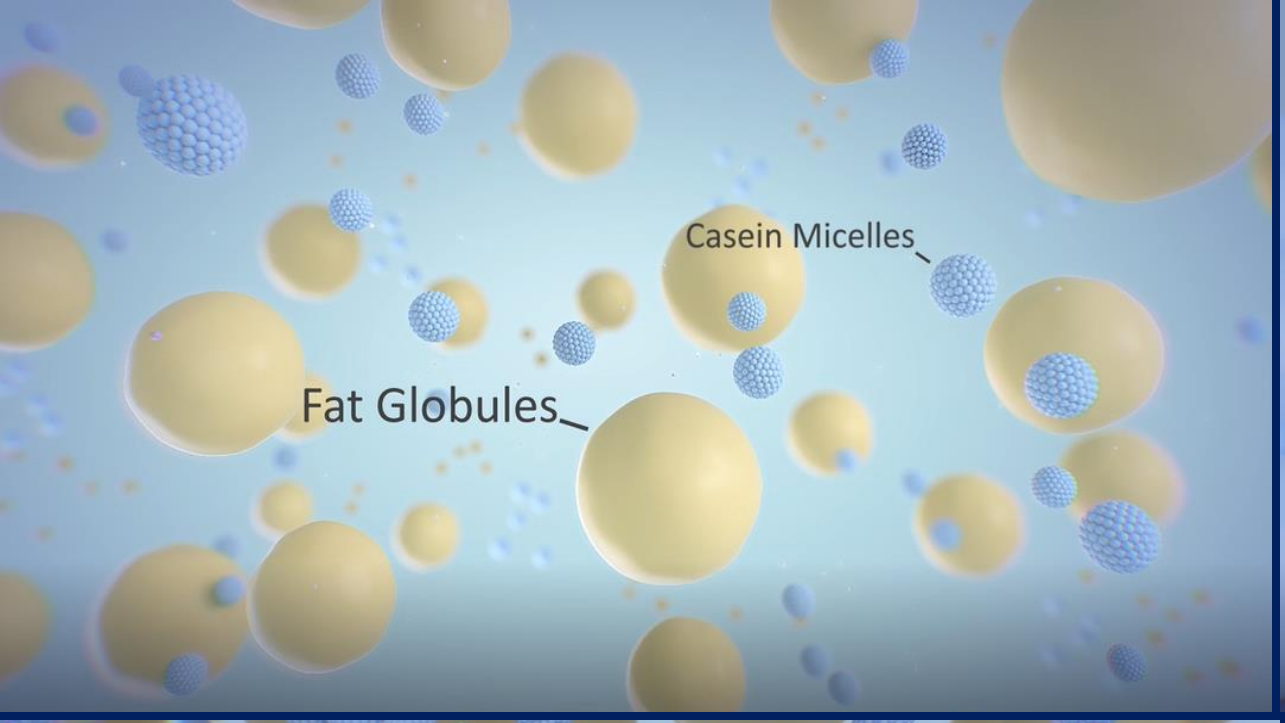
These two parameters are key when selecting Coagulant – C/P Ratio

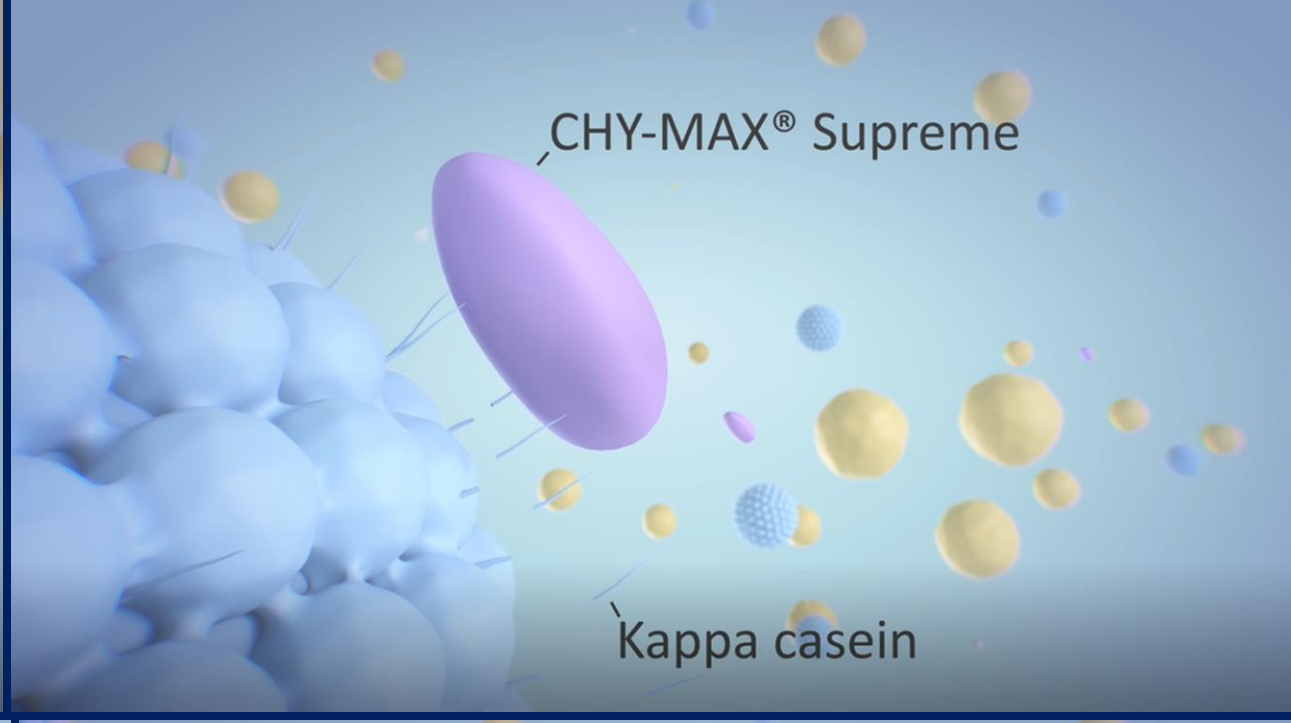
- Coagulation is impacted to a large extent by the specific coagulant

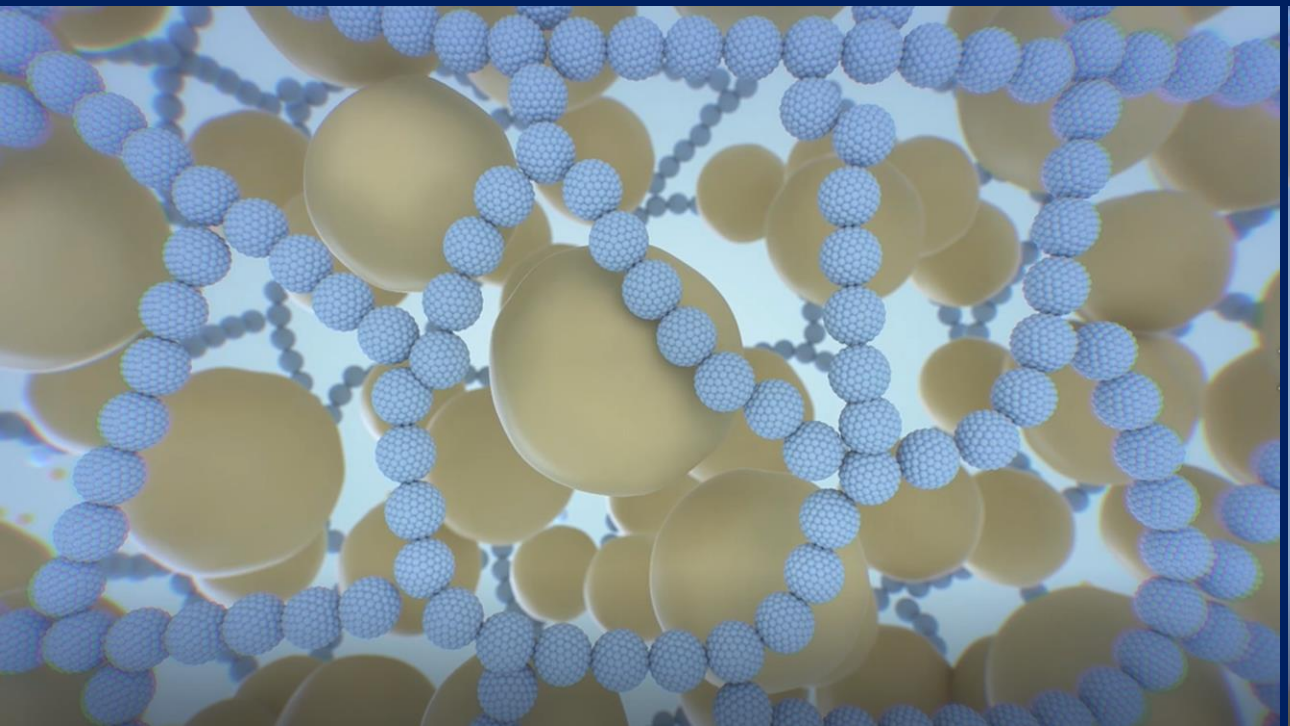
- Choice of coagulant plays a role in the ripening of the cheese.
- Level of proteolysis delivered by the coagulant impacts flavour and texture development as well as other key functionalities.

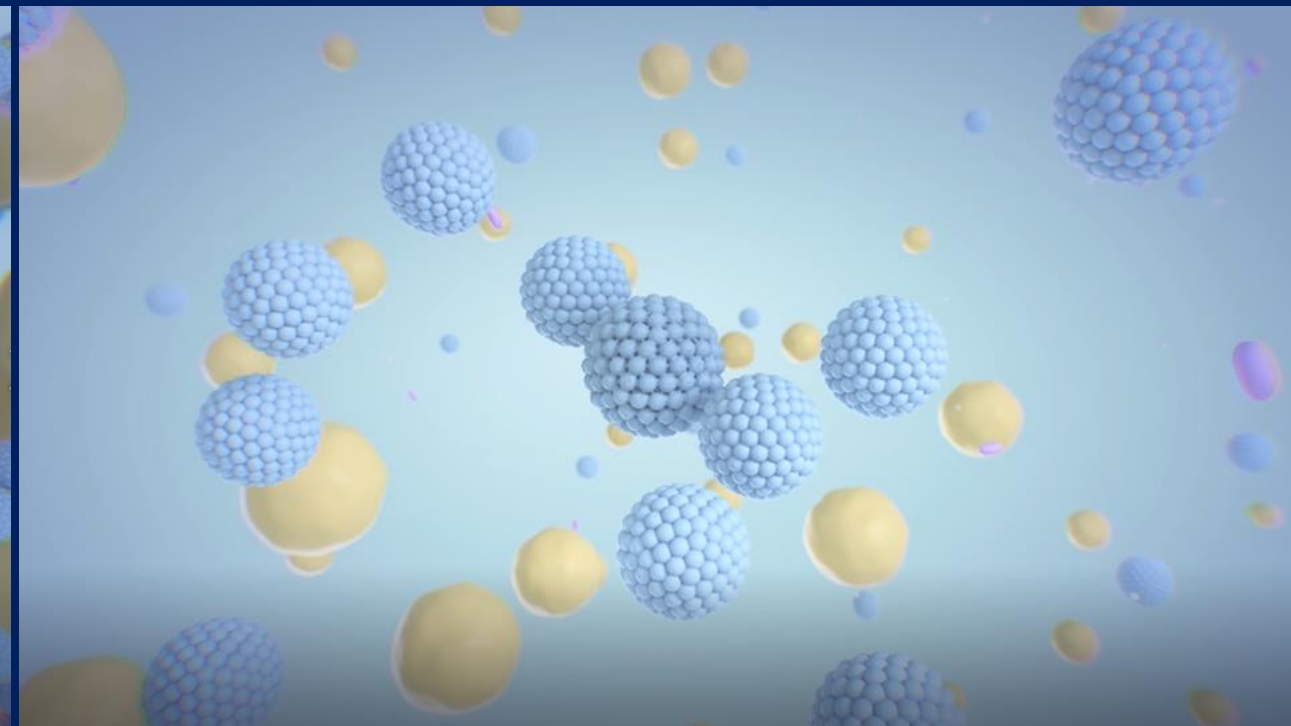
- Choice of coagulant impacts the peptide fractions in the whey.
- The ability to inactivate the coagulant is important.

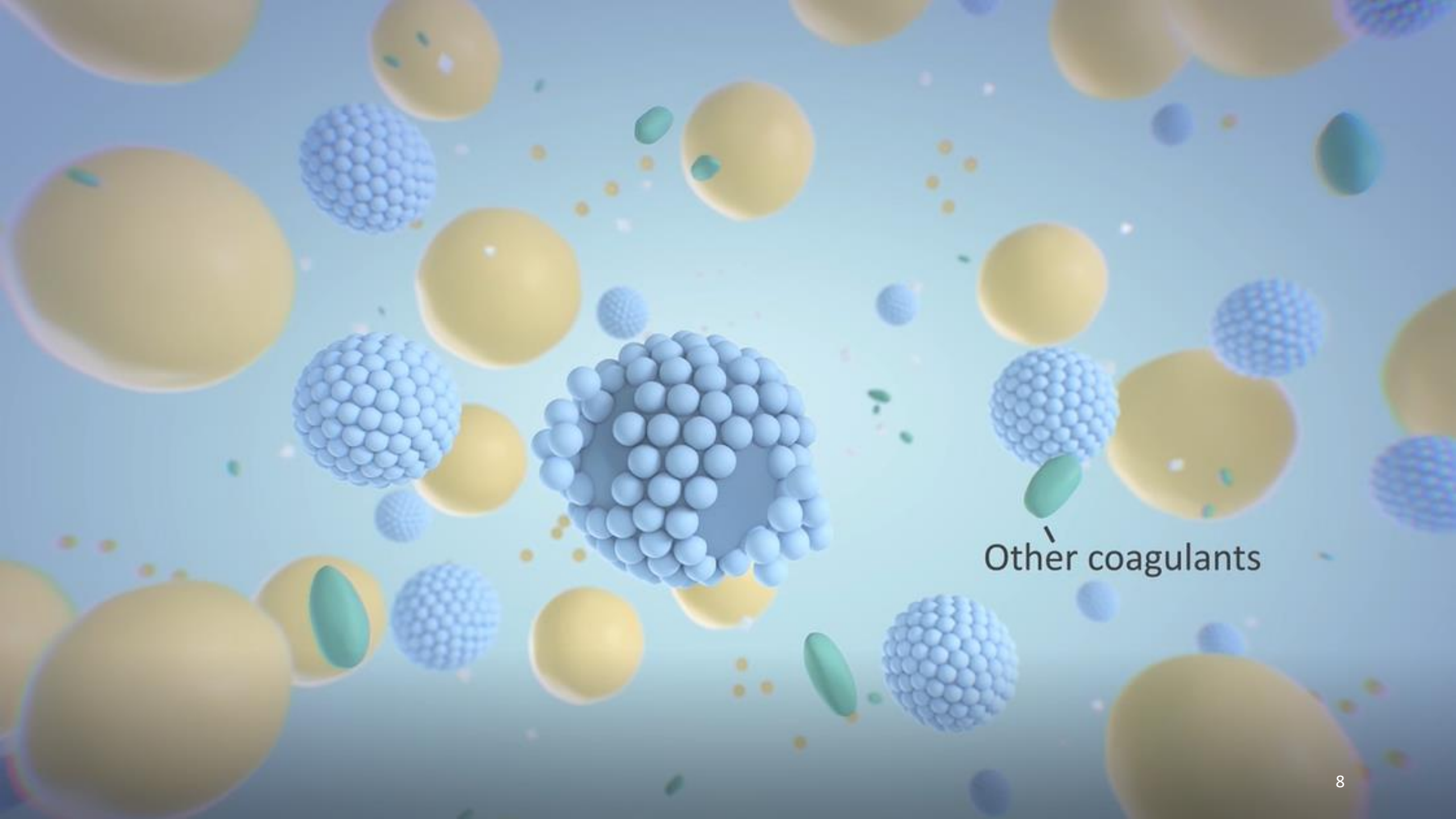
CHR HANSEN
Improving food & health


Casein Micelles
Fat Globules


CHY-MAX® Supreme
Kappa casein






Other coagulants

Specificity is affected by the C/P ratio

THE C/P RATIO[1]	CASEIN SUBSTRATE	ANALYSIS METHOD
C Clotting activity	K	› 50 IMCU / liter of milk at pH 6.50
P General proteolytic activity	α, β	› Curd simulation › Peptides extraction

[1] C/P is the ratio between specific clotting activity (IMCU/ml) and general proteolytic activity. Reference method by E045

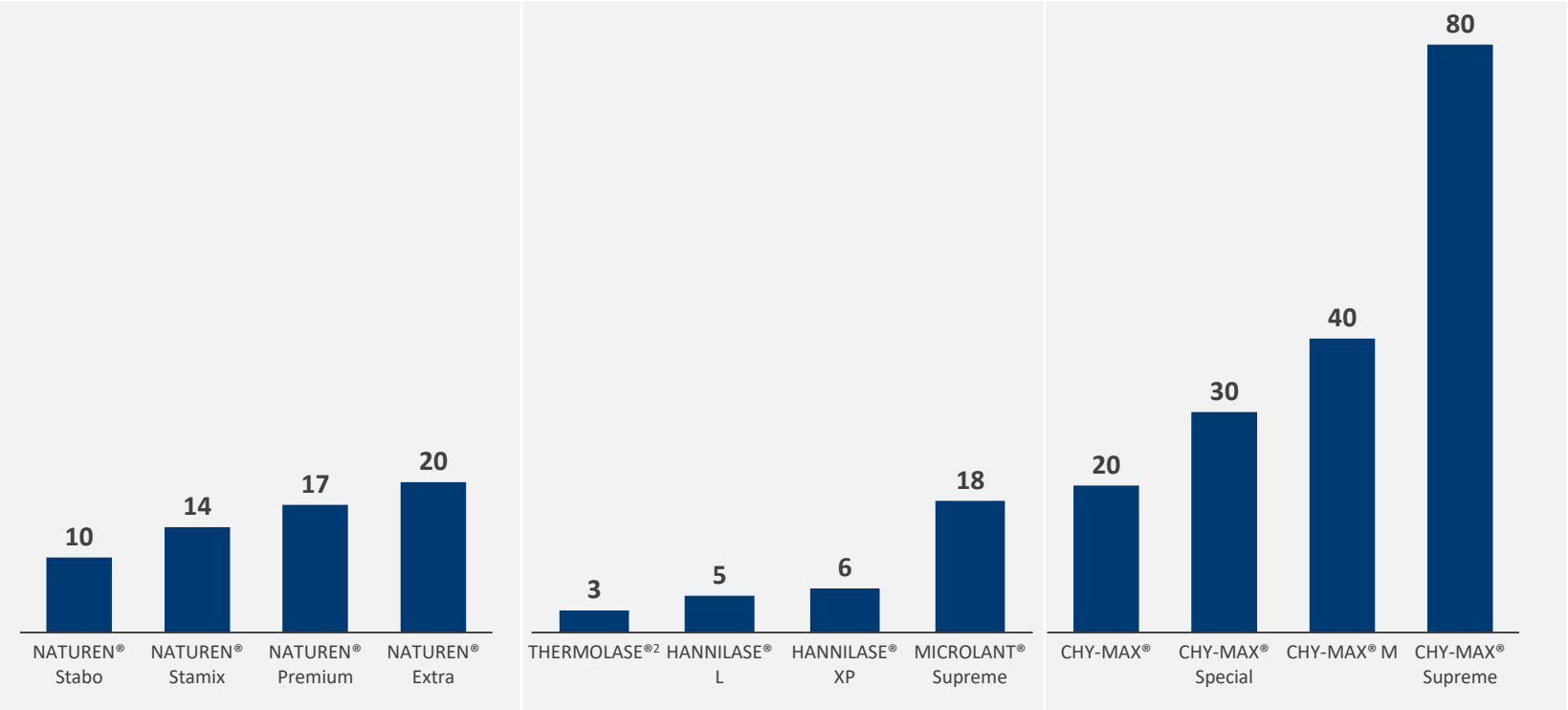
CHR. HANSEN
Improving food & health

The three families

Reduced proteolysis comes when you have a higher C/P ratio, indicating greater specificity during coagulation

SPECIFICITY (C/P)[1]

ANIMAL	MICROBIAL	FPC
Keeping traditions alive	Making organic possible	For the modern cheesemaker



[1] C/P is the ratio between specific clotting activity (IMCU/ml) and general proteolytic activity

[2] Thermolase is generally not compatible with organic cheese production

CHR. HANSEN
Improving food & health

Constantly raising the bar in coagulant performance, we kicked off our quest for the next best coagulant in 2014

OUR GOAL

To deliver a superior chymosin for tomorrow's cheesemaker

- Better cheese
- Less waste – getting the most out of milk

CRITERIA

- **Increase C/P ratio**
  Indicator for higher yield
- **Decrease β-casein cleavage**
  Indicator for less bitterness
- **Decrease α-casein cleavage**
  Indicator for higher firmness
- **Increase yield by 0.2%**

LEARNING

Inspired by nature and applying cutting edge scientific methods and machine learning, we analyzed over 500 enzyme variants. Learning from observation, we were able to then refine and pinpoint the enzymes with the strongest proteolytic profiles

DEVELOPMENT

Prime candidates were chosen for application trials and many trials later the superior enzyme was chosen

CHR HANSEN
Improving food & health

Introducing
CHY-MAX® Supreme

Small change, big difference

At Chr. Hansen we are committed to raising the industry standard for coagulant performance. By making a small but crucial change to our CHY-MAX® enzyme, we are making a big difference across cheese production and functionality

DELIVERING BIG RESULTS

- **Higher yield**
- **Faster and more precise production**
- **Superior functionality**

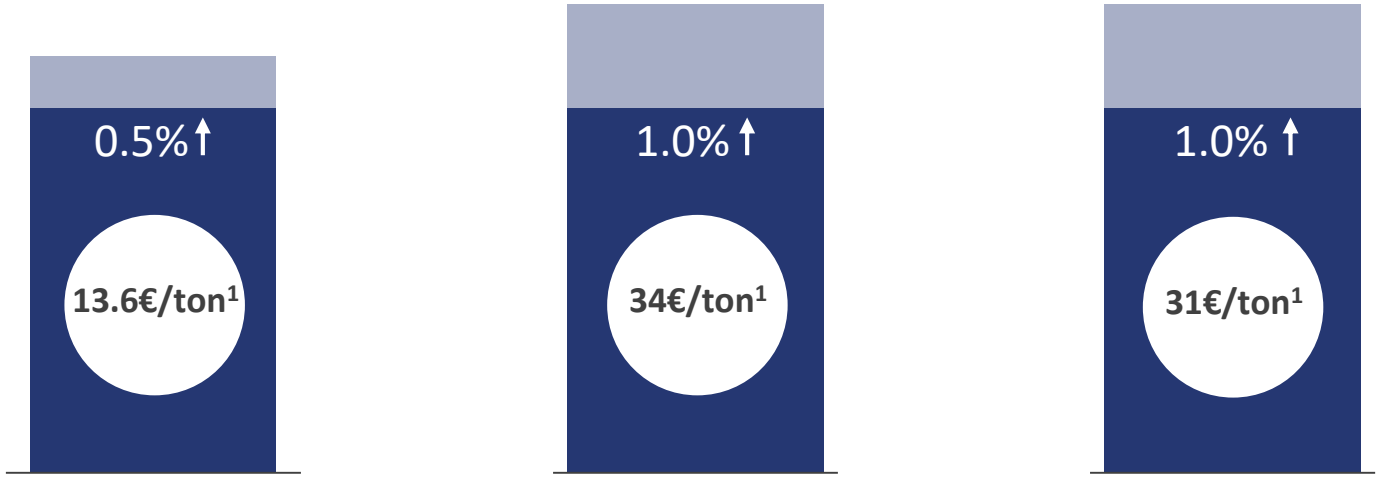
It’s a small change that can make a big difference to your business

CHR. HANSEN
Improving food & health

Maximizing value

More yield, longer shelf life, and less giveaways mean greater profits – effectively paying for itself

YIELD AND PROFIT INCREASES IN DIFFERENT CHEESE TYPES USING CHY-MAX® SUPREME



CHEDDAR
FPC 1st gen vs.
CHY-MAX® Supreme

PASTA FILATA
FPC 2nd gen vs.
CHY-MAX® Supreme

CONTINENTAL
FPC 2nd gen vs.
CHY-MAX® Supreme

Trial results reveal:

- CHY-MAX® Supreme is the outstanding performer in the market-leading CHY-MAX range
- Yield increase of 0.5-1% on average per ton[2]
- More product from less milk delivering a higher profit margin

[1] Based on latest cheese prices informed on September 17, 2018. Pasta Filata prices for Poland (3.4 EUR/kg), Cheddar for US (3.1 EUR/kg) and Continental in Germany (3.1 EUR/kg).
[2] All factors the same using recommended dosage of coagulant

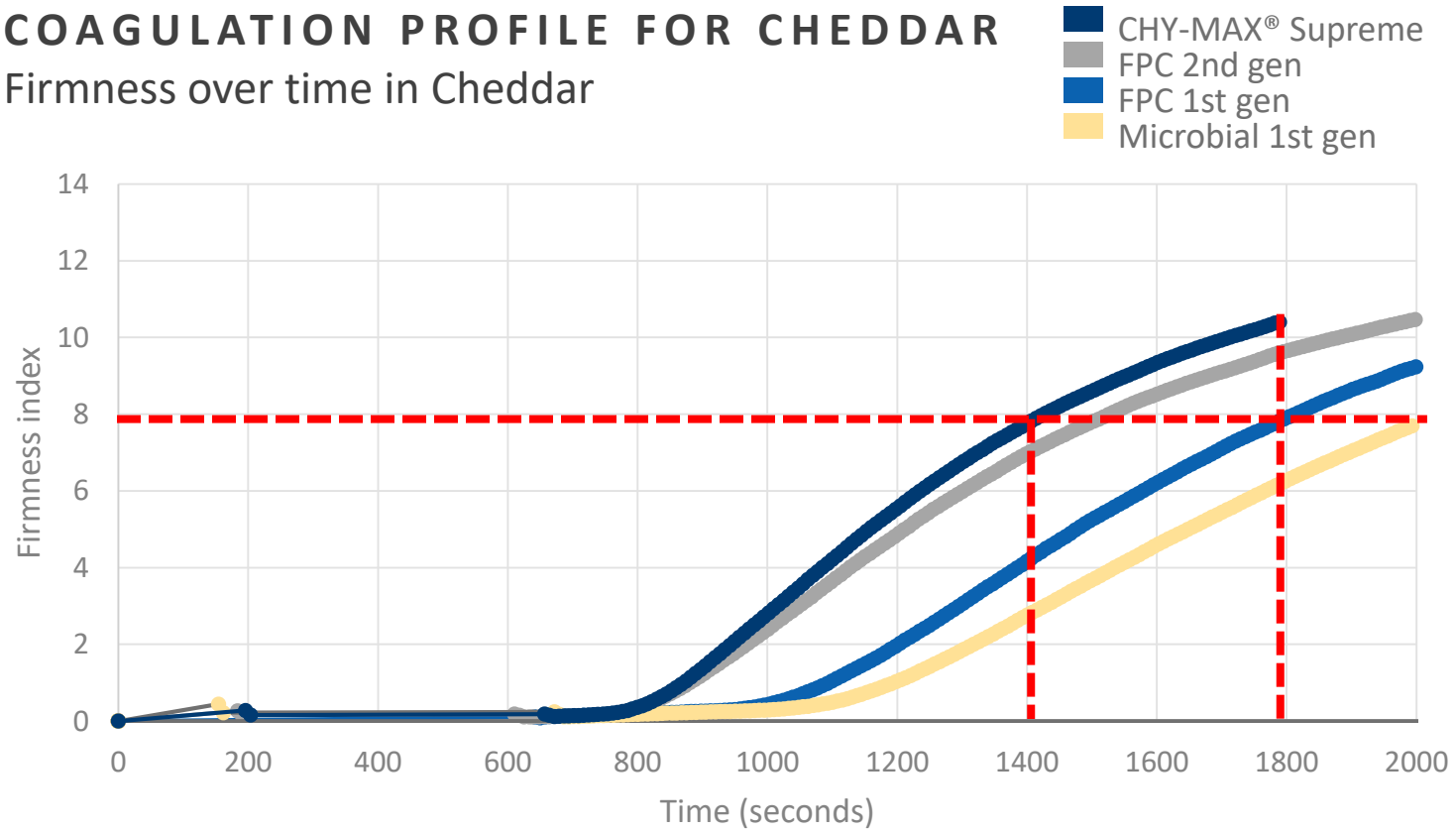
CHR. HANSEN
Improving food & health

CHY-MAX® Supreme is able to reach the ideal firmness, much faster while obtaining maximum yield

When dosed properly, CHY-MAX® Supreme can save time and increase yield

COAGULATION PROFILE FOR CHEDDAR

Firmness over time in Cheddar

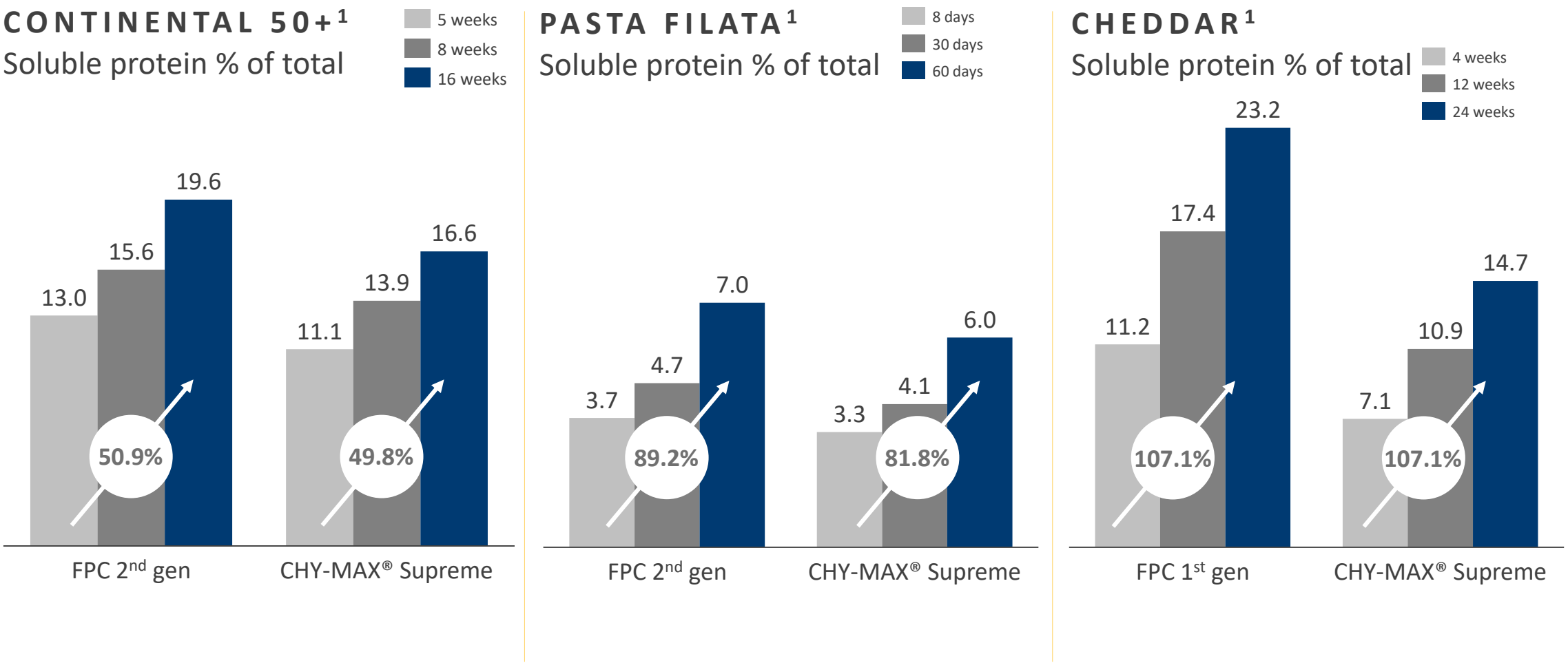


Because of the high specificity, the coagulation profile for CHY-MAX® Supreme using the same IMCU dosage is much faster than the market leading references so it is necessary to adjust the cutting time to produce the same cheese (cut at the same firmness)

CHR. HANSEN

Improving food & health

CHY-MAX® Supreme is less proteolytic during ripening than market leading coagulants



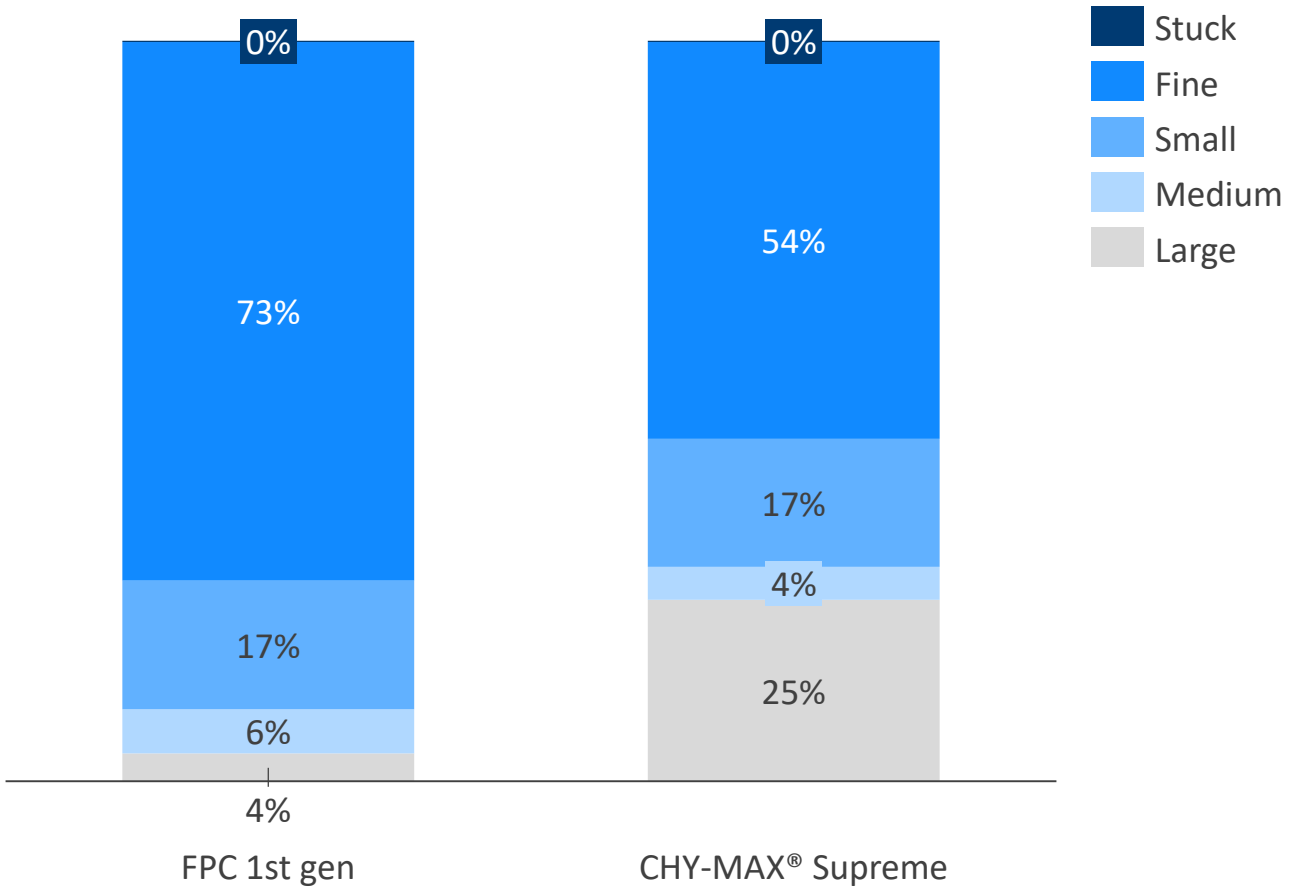
[1] Chr. Hansen trials, 2018. Continental findings verifies by 2018 Nizo study.

CHR. HANSEN
Improving food & health

We see a difference between trial and control cheese when evaluating the shredability of cheddar

SHREDABILITY AFTER 2 MONTHS[1]

Customer cheese internal evaluation



TRENDS OF CHY-MAX® SUPREME:

- >25% less fines
- 5 times more large shreds

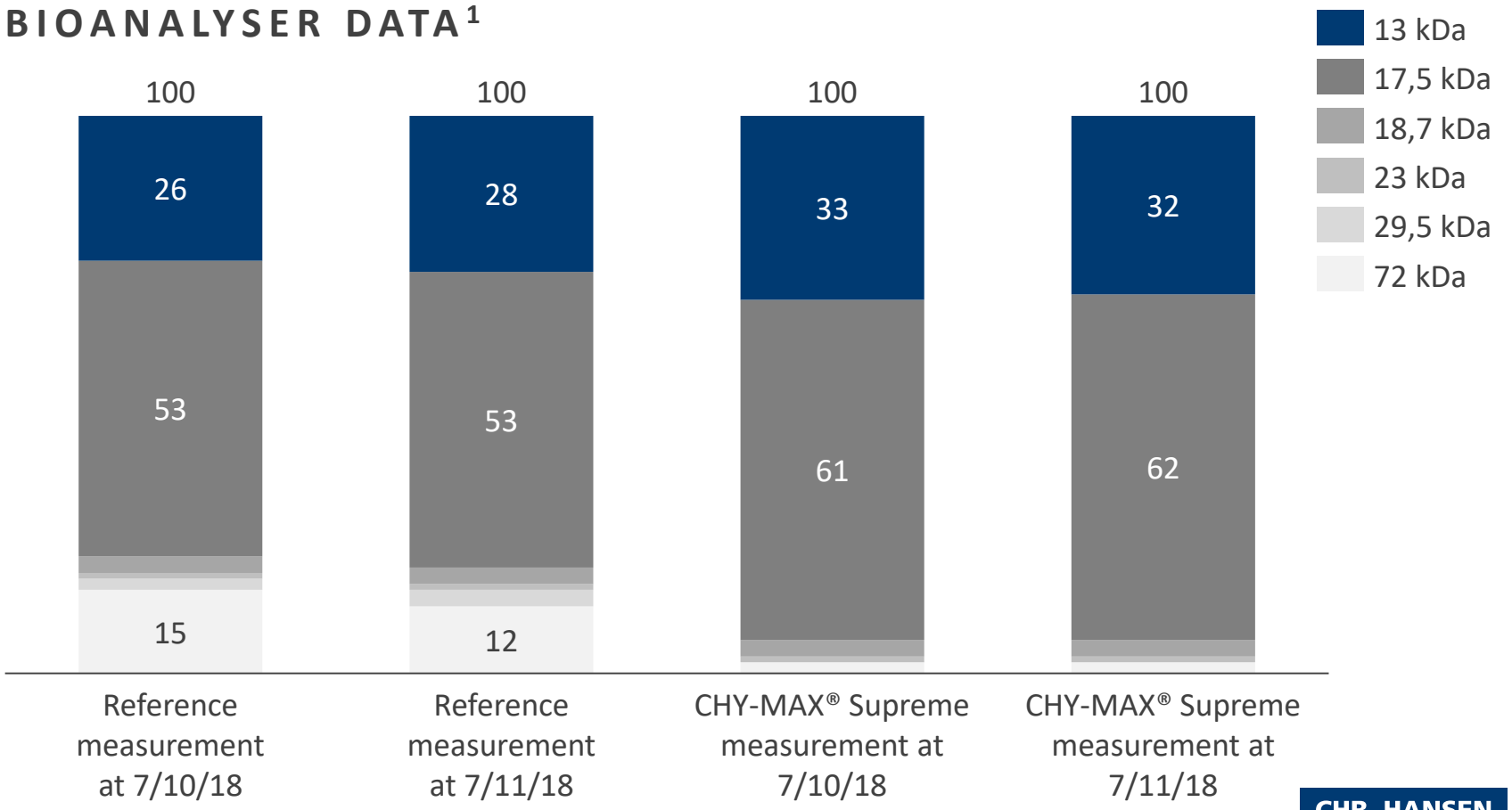
[1]Shredding evaluation performed at Chr. Hansen using cheese produced at customer. These are average values of two trials

CHR. HANSEN
Improving food & health

Trials reveal an positive impact on the whey quality

Analysis show an increase in valuable whey proteins (α- lactoglobulin and β- lactoglobulin) and less large molecular weight (kDa) residual of caseins with CHY-MAX® Supreme, leading to slightly improved whey quality

BIOANALYSER DATA[1]



[1]Customer trial, 2018

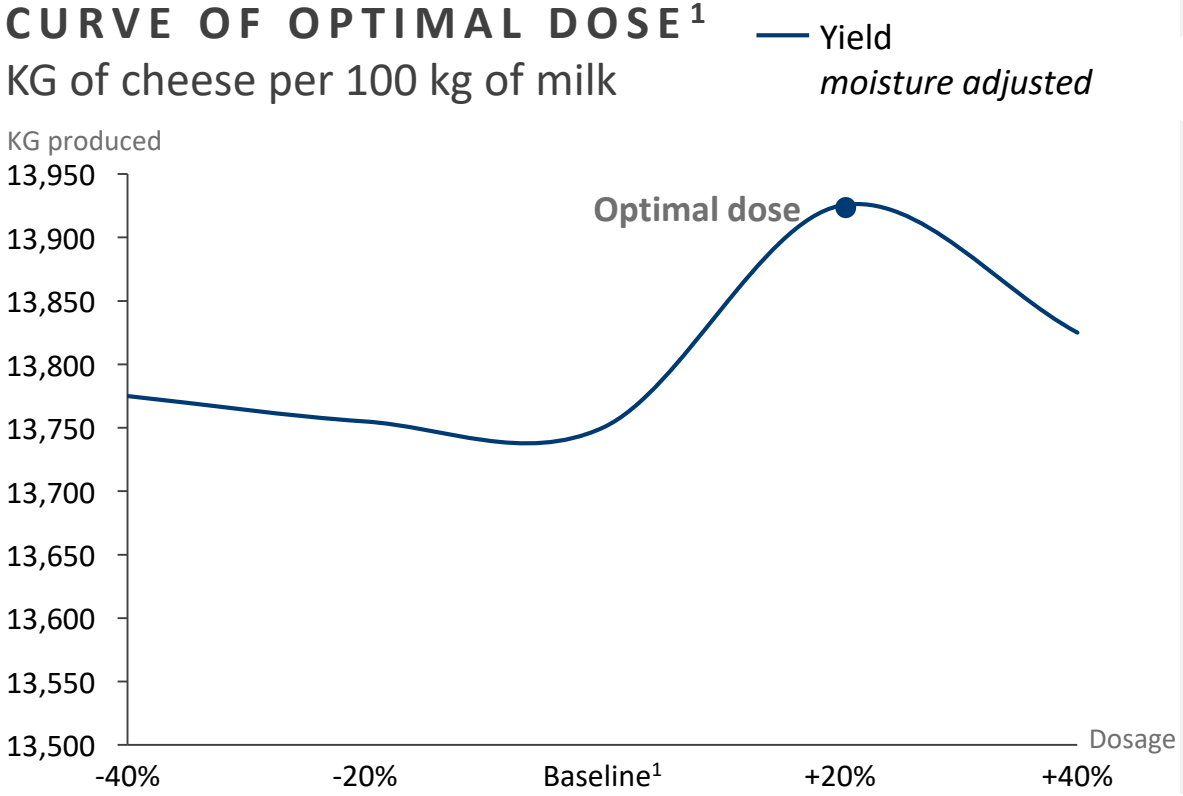
CHR. HANSEN
Improving food & health

Proper dosing can enable higher yield on top of CHY-MAX® Supreme gains

Our trials indicate that there is an optimal dosage of coagulant. Obtaining the optimal dose can help you achieve a higher yield, on top of the increased yield from CHY-MAX® Supreme, increasing the value well beyond the cost of the coagulant at proper dose

CURVE OF OPTIMAL DOSE[1]

KG of cheese per 100 kg of milk



- The optimal dose generates a higher yield compared to a non-optimal dose
- Using the latest technology to measure flocculation and our extensive coagulant knowledge, our expert team can help you identify the optimal dosage for your target firmness

[1]ATC trials, US Long Make Cheddar, May 2018. Milk protein 4.15%.

[1]Actual dosage depends on volume and process

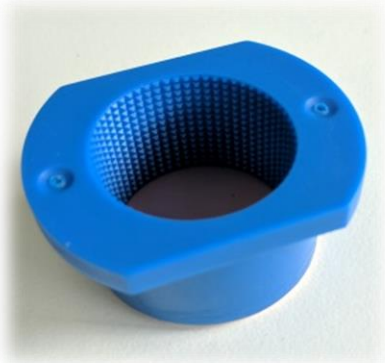
CHR. HANSEN
Improving food & health

The equipment

The CoaguSens™ system is composed of the CoaguSens unit and the sample holders.

CoaguSens™

Tool to monitor the coagulation process



Sample Holder

Specific surface design and flexible membrane

CHR. HANSEN

Improving food & health

From coagulation to data analysis

The CoaguSens™ provides a real-time measurement of the coagulation process.
This allows the cheese maker to control the variation of this step.

STARTING UP

A cheese recipe is configured.
A new measurement is initiated.

ADDING SAMPLE

A sample of the coagulating milk is transferred to the CoaguSens™

REAL TIME MEASUREMENT

The coagulation process is displayed real-time.
Cutting firmness is recorded.

DATA ANALYSIS

Coagulation data is analyzed for variance.
Next steps suggested and agreed.

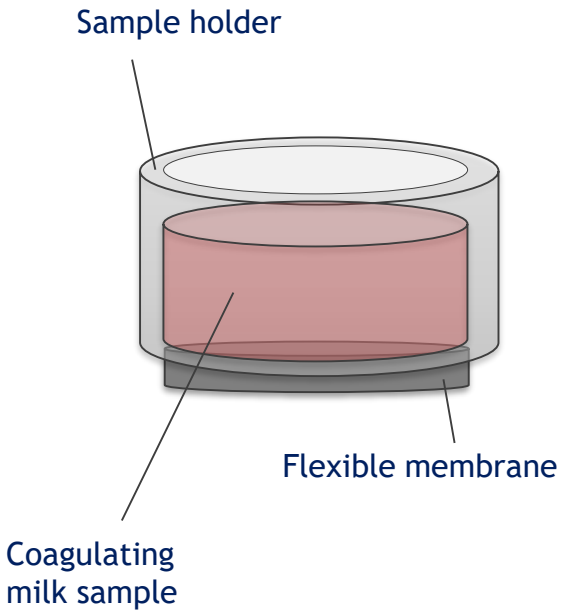
CHR HANSEN
Improving food & health

How does the CoaguSens™ measure a sample?

It measures firmness development by a contactless, non-destructive vibration measurement

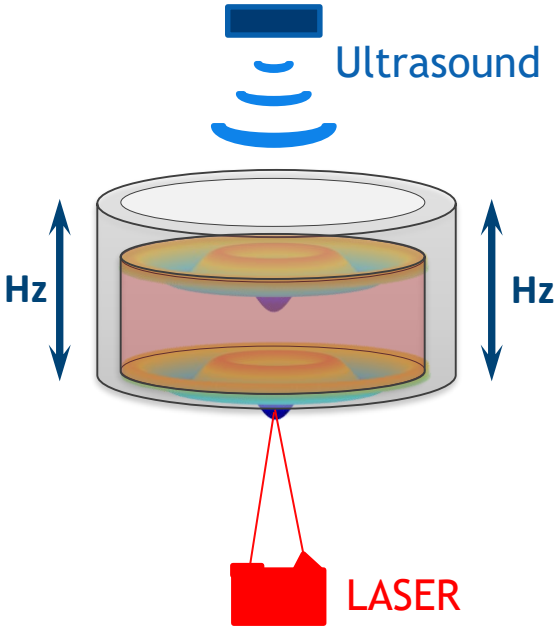
1

Filling the sample holder



2

Vibration



3

Measurement

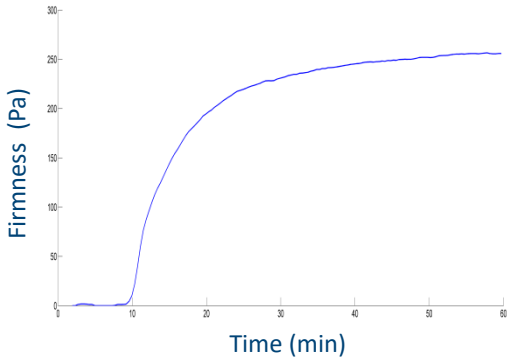
Contactless non-destructive measurement

↓

Signal processing

↓

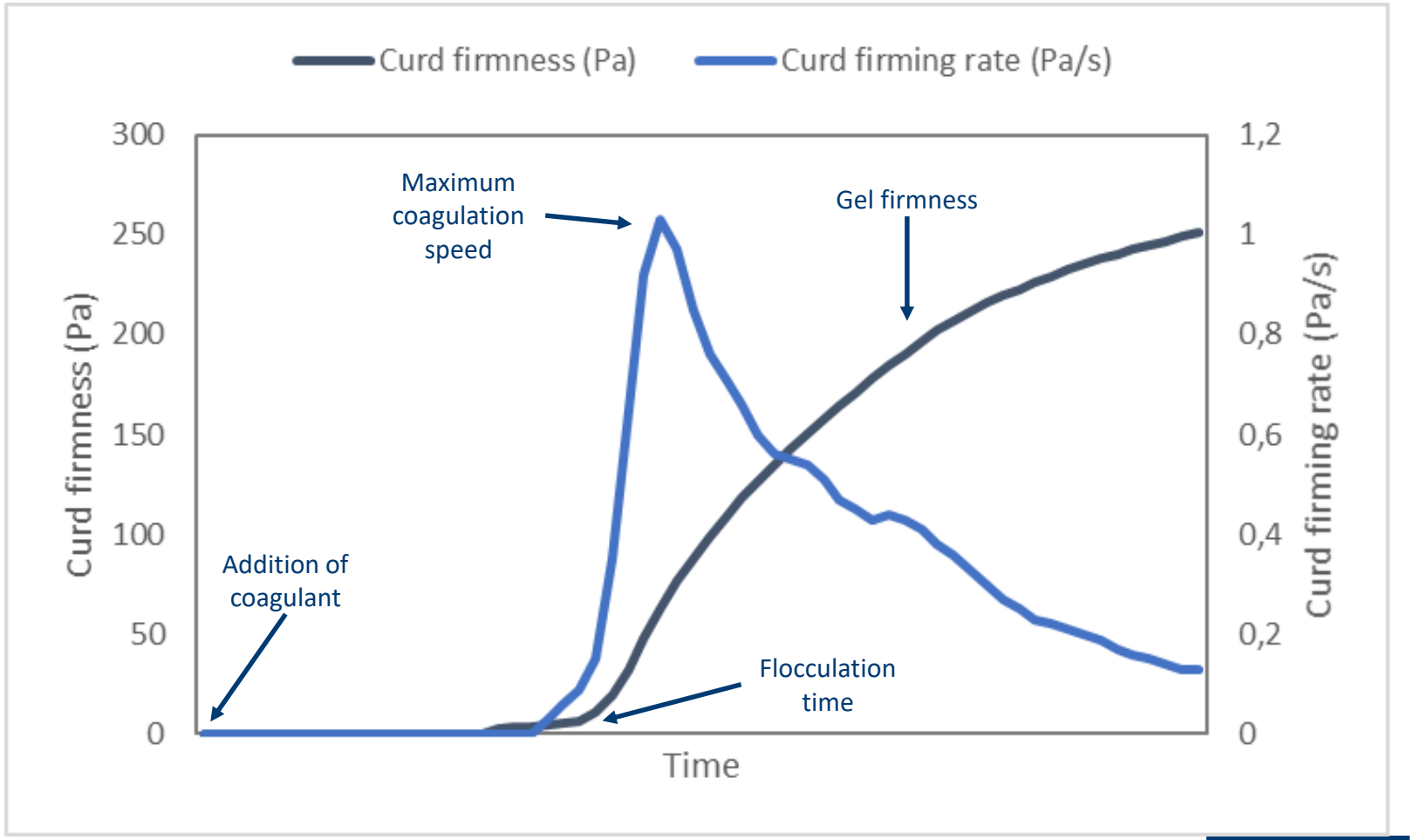
Coagulation kinetics



CHR. HANSEN
Improving food & health

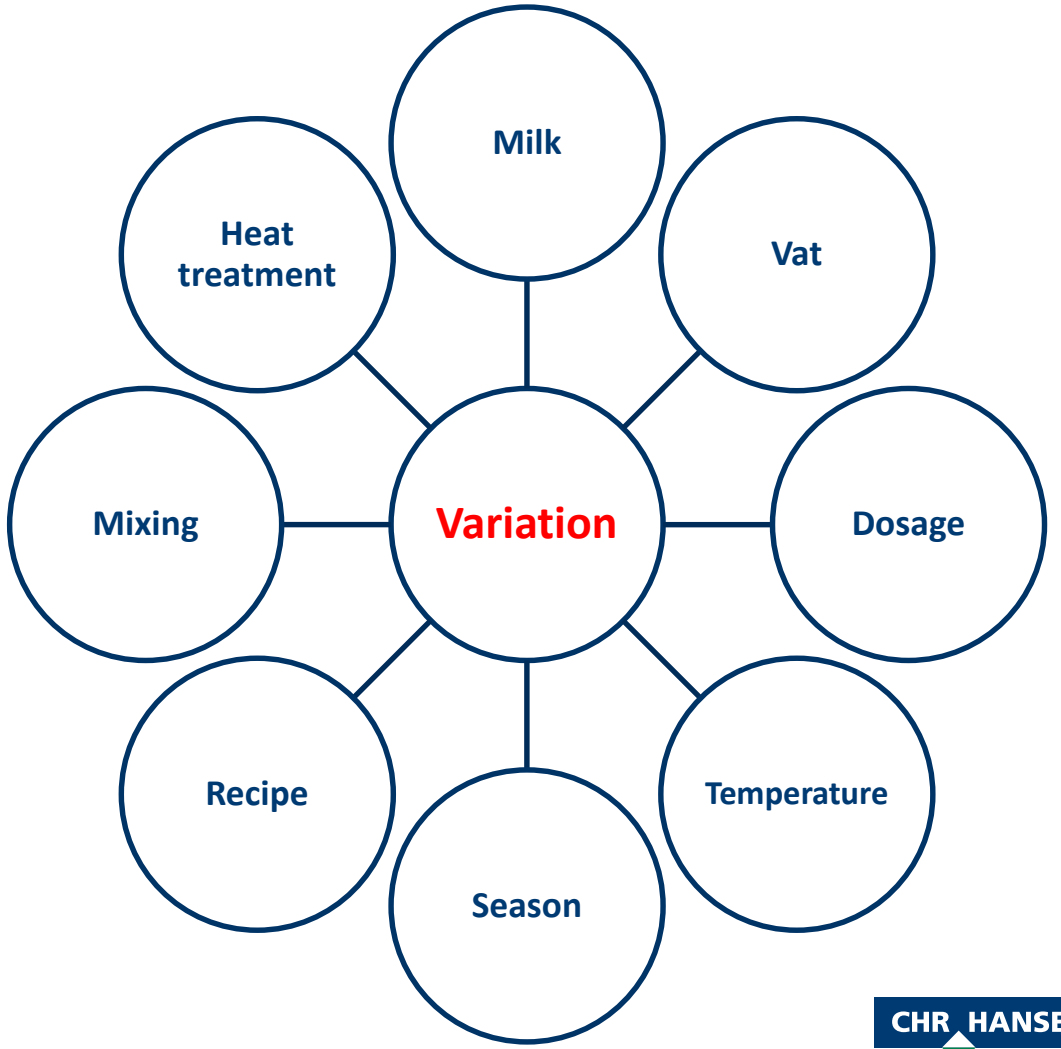
Parameters measured by CoaguSens™

The CoaguSens™ effectively measures the gel firmness as a function of time.
The slope of the firmness curve provides additional information.



CHR HANSEN
Improving food & health

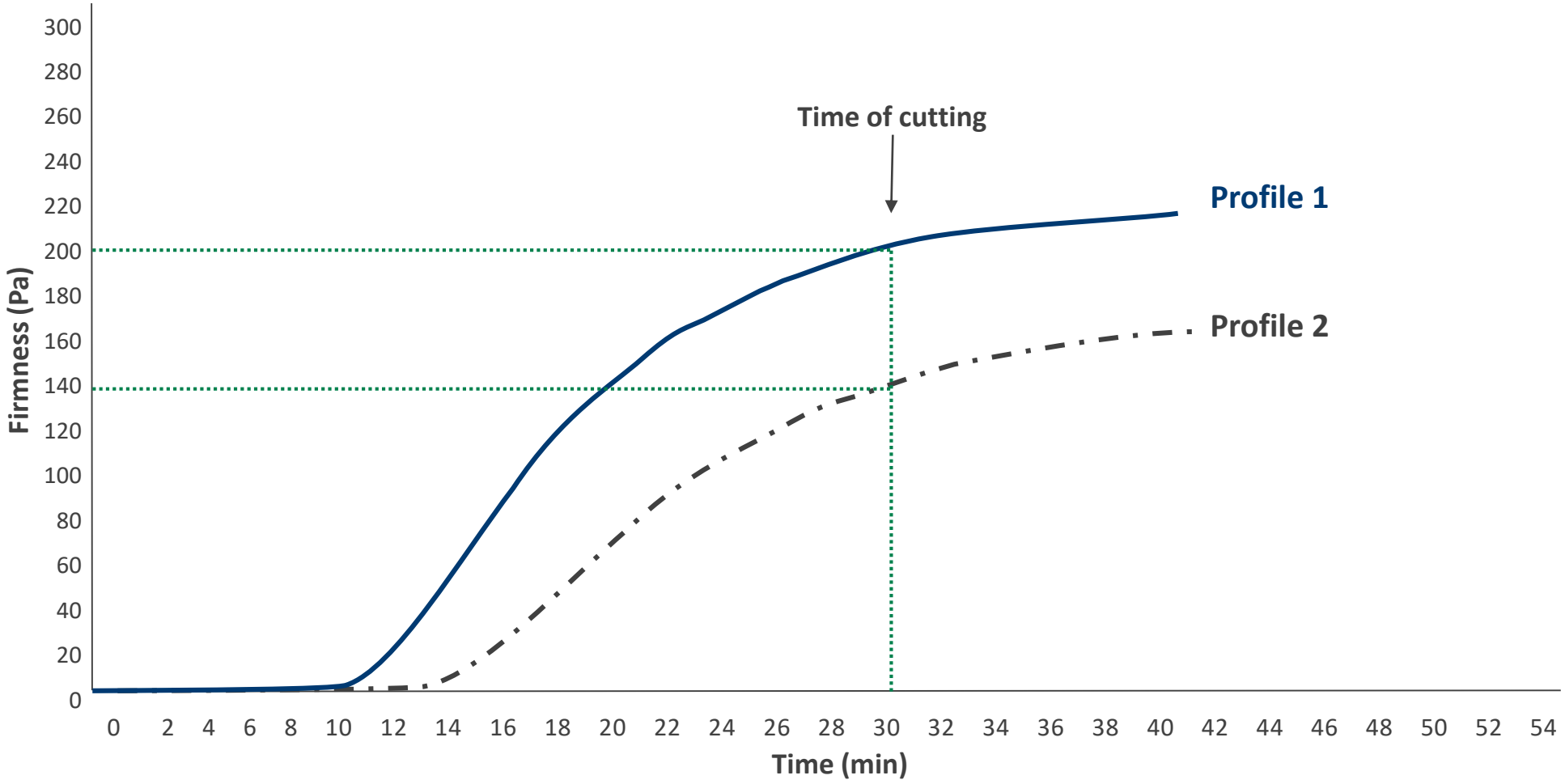
Sources of coagulation variance in a cheese plant



CHR. HANSEN

Improving food & health

Effect of process variance during the coagulation step



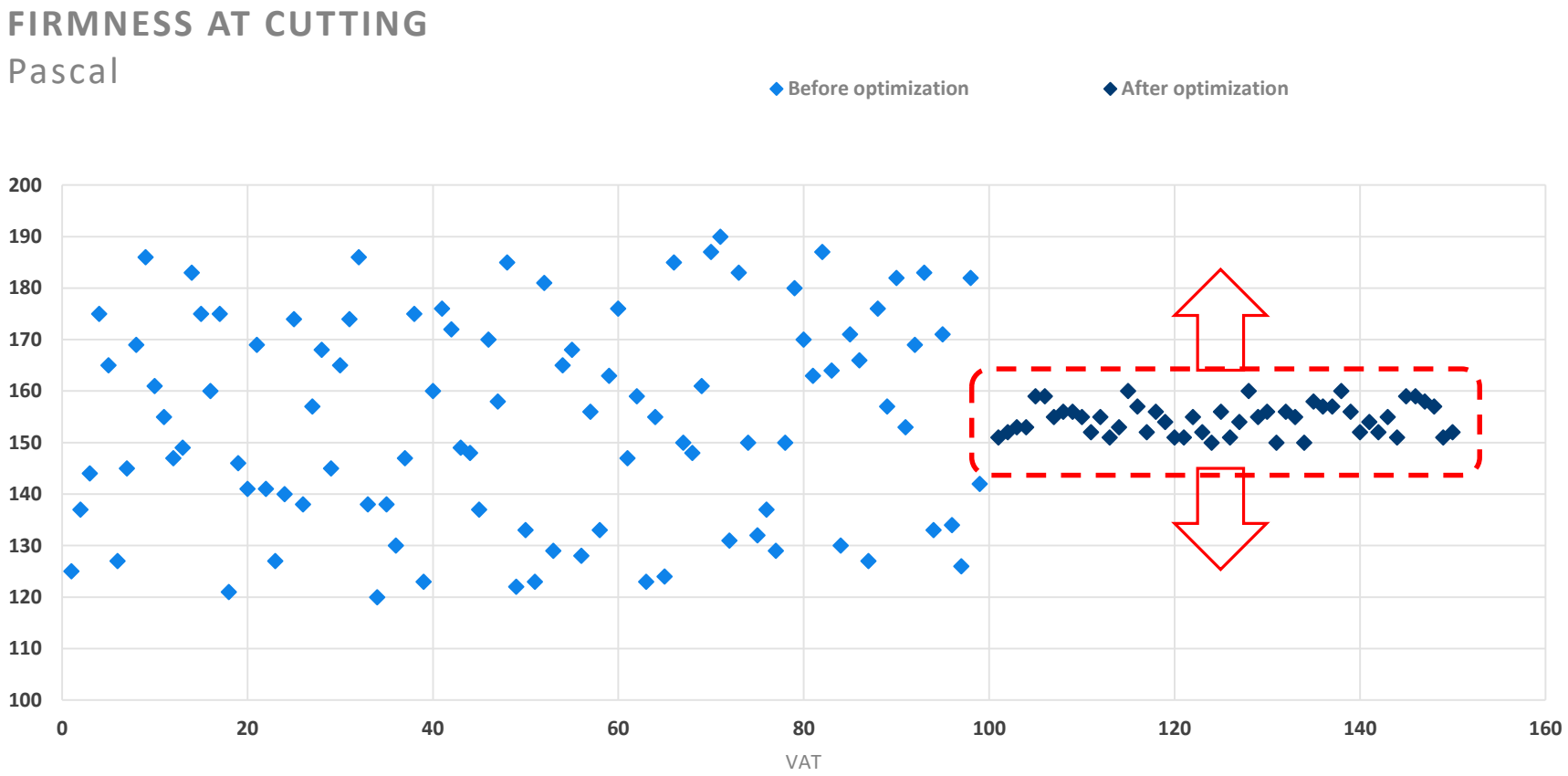
Different coagulation profiles gives **different firmness at cutting**

Coagulation profile is correlated to **retention of moisture and solids**

CHR. HANSEN

Improving food & health

Improve the process by establishing the optimum



CHR HANSEN
Improving food & health

Summary

How can more cheese be produced from milk?

1. Select a coagulant with higher C/P ratio – increase yield
2. Faster coagulation
3. Firmer body
4. Optimise the coagulation using the CoaguSens

CHR. HANSEN
Improving food & health

Thank you

44 7914 678 191

GBDACR@CHR-HANSEN

CHR-HANSEN.COM

CHR HANSEN

Improving food & health