World´s leading cheese coagulant portfolio from Chr. Hansen

August 2021

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Improving food & health

The right coagulant is crucial for optimal cheesemaking

COAGULATION

ENABLING EFFICIENT CHEESE PRODUCTION

The coagulant impacts the **time to coagulate** and the **yield** in the final cheese so by selecting a specific coagulant the process can be fully optimized.

RIPENING

OBTAINING THE DESIRED FUNCTIONALITY

The coagulant plays a key role in the ripening of the cheese. This links to the level of proteolysis delivered by the coagulant.

Proteolysis **impacts flavor, texture** and **functionality** of the final cheese.

WHEY

INCREASING THE VALUE OF CHEESEMAKING

Whey brings high value to the process and the choice of coagulant impacts the **quality**.

Whey processors generally look for a **cleaner whey** with less sediments and fat. The ability to **inactivate** the enzyme is important for some whey producers as they bring the whey to a higher value (e.g. infant formula).

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Trends in the market

YIELD AND FUNCTIONALITY

- Continuous focus on maximizing value of milk through higher cheese yield and better whey quality
- Increasing demand for cheese as an ingredient and convenient formats call for functionality improvements during production[1]

PRESERVATIVE-FREE AND ORGANIC

- Big surge towards preservative-free coagulants globally
- Increasing consumer interest for organic and more natural foods with fewer ingredients[2]

SUSTAINABILITY

- UN global goals as a proactive tool to measure business impact. For instance ensuring sustainable consumption and production patterns

1 Euromonitor 2017 - 2020 2 Mintel GNPD 2017 - 2020

World´s leading cheese coagulant portfolio since 1874

ANIMAL RENNET

NATUREN® & BIOREN®

Keeping traditions alive

- Traditional cheese coagulant. Great choice for high quality cheese with flavor intensity
- Preferred range for DOP, AOC or other labeling requirements for traditional products
- Range includes **NATUREN®, BioRen®, BioRen® Paste and Dried vells**

MICROBIAL COAGULANTS

MICROLANT®

Making organic possible

- The ideal alternative, when there is a need to combine the demands for organic and vegetarian.
- This multi-purpose range is suitable for sensitive markets where special labeling is required.
- Range includes **MICROLANT® Basic, MICROLANT Classic, MICROLANT® Supreme and THERMOLASE®**

FERMENTATION PRODUCED CHYMOSIN

CHY-MAX®

For the modern cheese maker

- Most used cheese coagulant
- Delivers consistency and high cheese quality, higher cheese yield and improved functionality and whey quality
- Suitable for vegetarian
- Range **includes CHY-MAX®, CHY-MAX® Special, CHY-MAX® M and CHY-MAX® Supreme**

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Chr. Hansen's Animal Rennet builds on pure tradition

NATUREN® & BIOREN® KEEPING TRADITIONS ALIVE

NATUREN®	Chymosin	Pepsin	Characteristics
NATUREN® Extra	>95%	<5%	Long-ripening and firmer texture
NATUREN® Premium	83%	17%	A balanced flavor development
NATUREN® Stamix	50%	50%	Fast-ripening with a strong flavor impact
NATUREN® Stabo	<30%	>70%	Fast-ripening with a bold flavor impact
NATUREN® Cordero[1]	75%	25%	Medium-ripening with a unique flavor impact
BioRen®	**Chymosin**	**Pepsin**	**Characteristics**
BioRen® Premium	95%	5%	Long-ripening and firmer texture
BioRen® Classic	80%	20%	A balanced flavor development
BioRen® Paste	75-85%	15-25%	A characteristic flavor development
Dried Vells	>75%	<25%	Fast ripening with a strong flavor impact

- Preferred range for **traditional products**, incl. **DOP, AOC** or other labeling requirements.
- Great choice for **high quality cheese** with **flavor intensity**
- Approximately 15% of cheese is produced with animal rennet
- The **higher chymosin** level, the **higher the yield**. Different **chymosin / pepsin ratios** are available.
- Main markets for animal rennet are: Italy, France and Russia/Belarus

REGISTRATIONS

1) Lamb rennet

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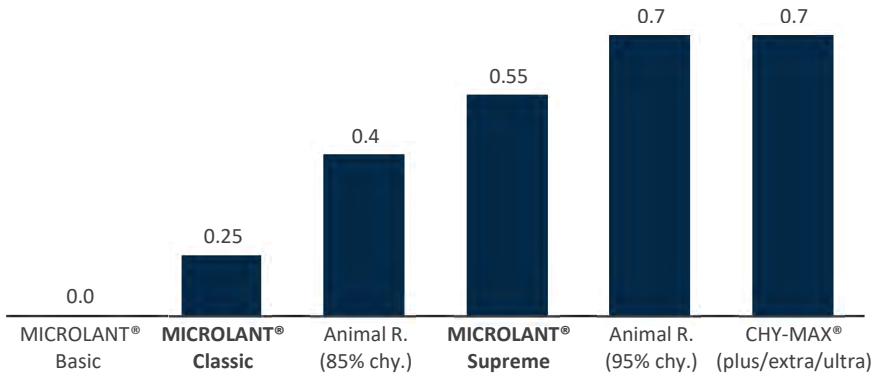
Our microbial coagulants meet the needs from versatile lifestyle, ethnic segments and certifying NGO´s

MICROLANT® MAKING ORGANIC POSSIBLE

	Reference	Heat-labile[1]
MICROLANT® Supreme	2nd Generation Mucor/Microbial	Yes
MICROLANT® Classic	1st Generation Mucor/Microbial	Yes
MICROLANT® Basic	1st Generation Mucor/Microbial	No
THERMOLASE®[2]	1st Generation Cryphonectria	Yes

% CHEESE YIELD



- Introduced in the 1960s
- Allowing **organic, vegetarian, halah, kosher, VLOG** and **NGOs**- labelling
- Microbial coagulants are generally known for lower cheese yields and high level of proteolytic activity
- Proteolytic activity impacts both **flavor, texture** and **functionality** of the cheese
- **MICROLANT® Supreme** is the newest best-in-class microbial coagulant. It is **highly purified** and delivers **0.3% more cheese yield** and is **15% less proteolytic** compared to 1st gen. mucor on the market

REGISTRATIONS

1 Heat-labile means enzyme is fully inactivated by pasteurization
2 THERMOLASE® is generally not compatible for organic cheese production

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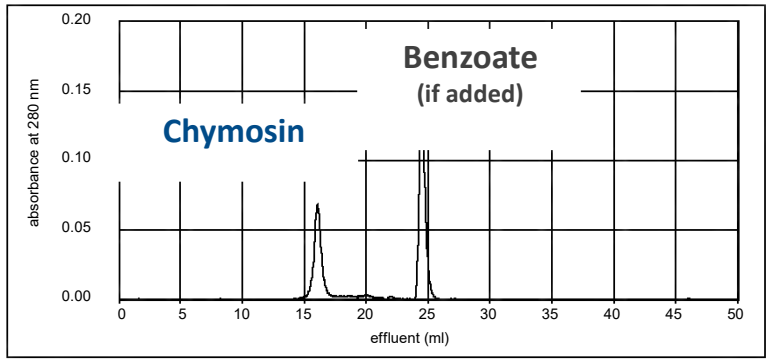
Wide range of FPCs[1] delivering superior properties for cheese and whey

CHY-MAX® FOR THE MODERN CHEESE MAKER

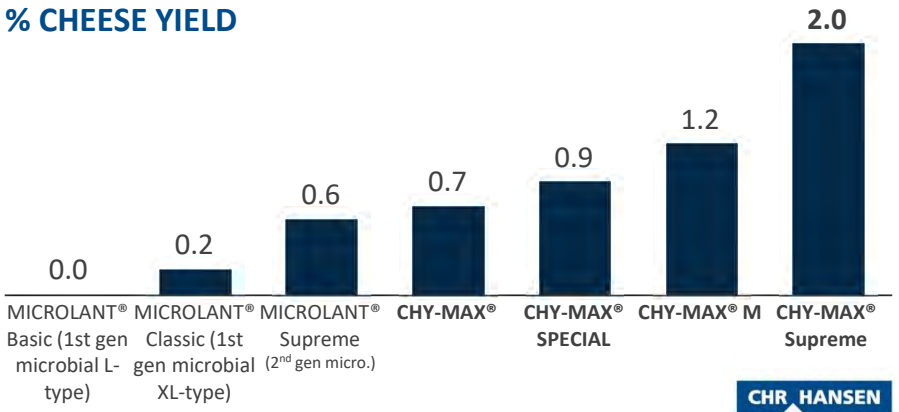
CHY-MAX®	C/P ratio	Reference	Since
CHY-MAX® Supreme	80	3rd gen. FPC	2019
CHY-MAX® M	40	2nd gen. FPC	2009
CHY-MAX® Special	30	2nd gen. FPC	2015
CHY-MAX® Plus/Extra/Ultra	20	1st gen. FPC	1989

CHY-MAX®- PUREST ON THE MARKET



- CHY-MAX® is **100% chymosin** and an **ideal milk-clotting** enzyme
- FPC is widely accepted as the **best coagulant** for cheese making
- 55% of all cheese globally are produced by the use of FPC
- Suitable for **vegetarian** and **Halal- and Kosher approved**
- The CHY-MAX® range is the **purest FPC** on the market
- CHY-MAX® Supreme is the most precise coagulant and delivers **superior performance** compared to other FPC's on the market. Delivers up to **2% more yield** compared to 1st gen Mucor

% CHEESE YIELD



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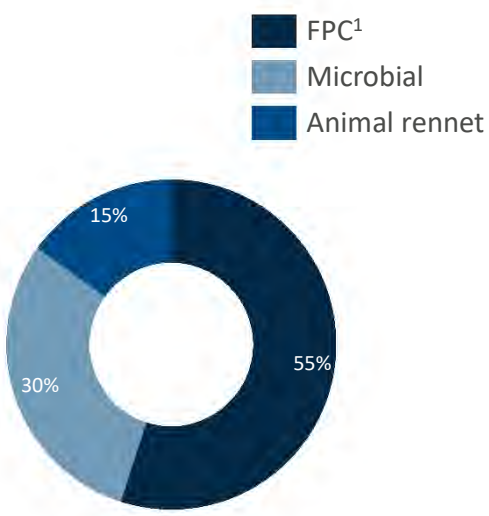
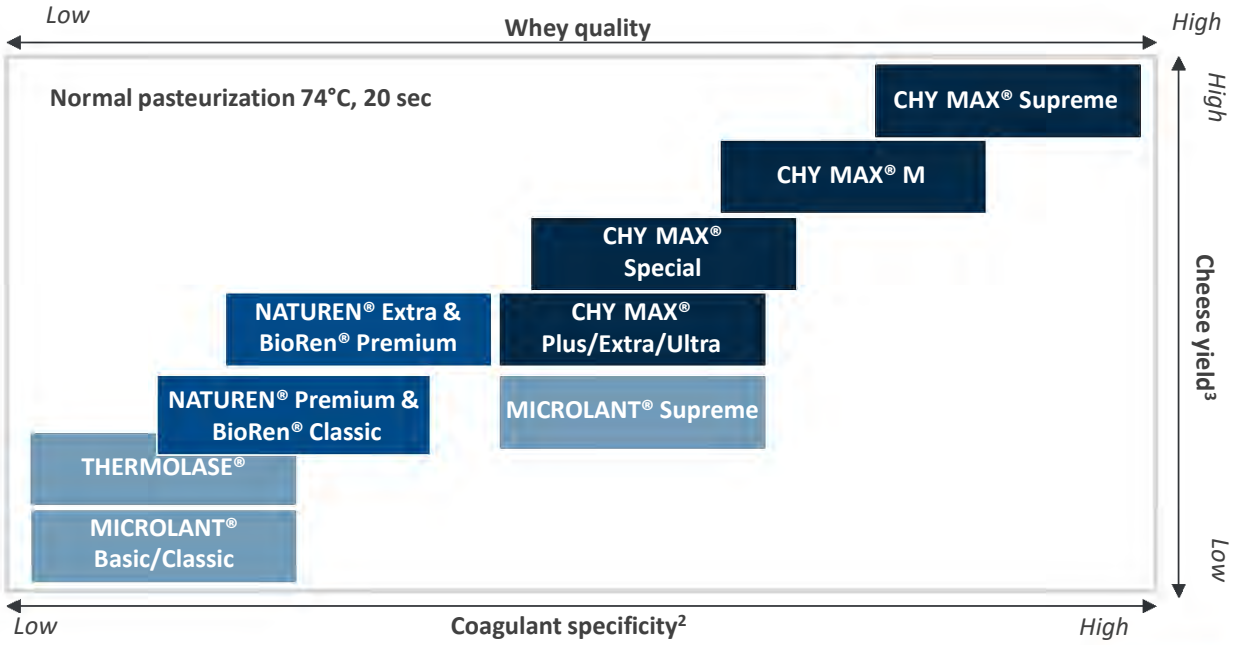
1 FPC = Fermentation-produced chymosin

Providing the world's market leading coagulant portfolio

Chr. Hansen offer the most extensive range of superior coagulants which can fulfill every need of a cheesemaker whether it requires traditional cheesemaking, organic production or is for the modern industrial cheese production.

VOLUME SHARE OF GLOBAL COAGULANT USE





1 Fermentation Produced Chymosin
2 Coagulant specificity is the ratio between desired and undesired protein breakdown. High specificity leads to firmer texture and reduced bitterness and vice versa.
3 Yield variates depending on the cheese process incl the temperature of pasteurization

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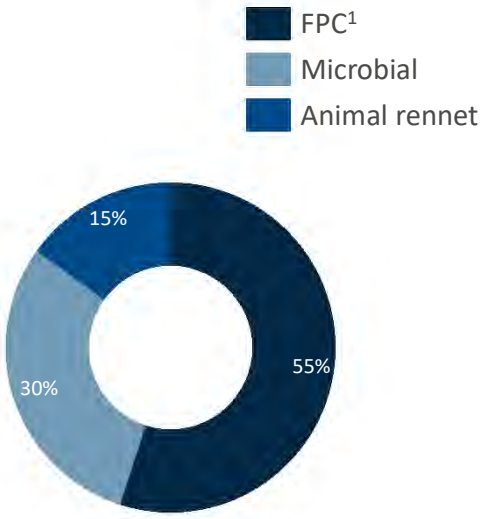

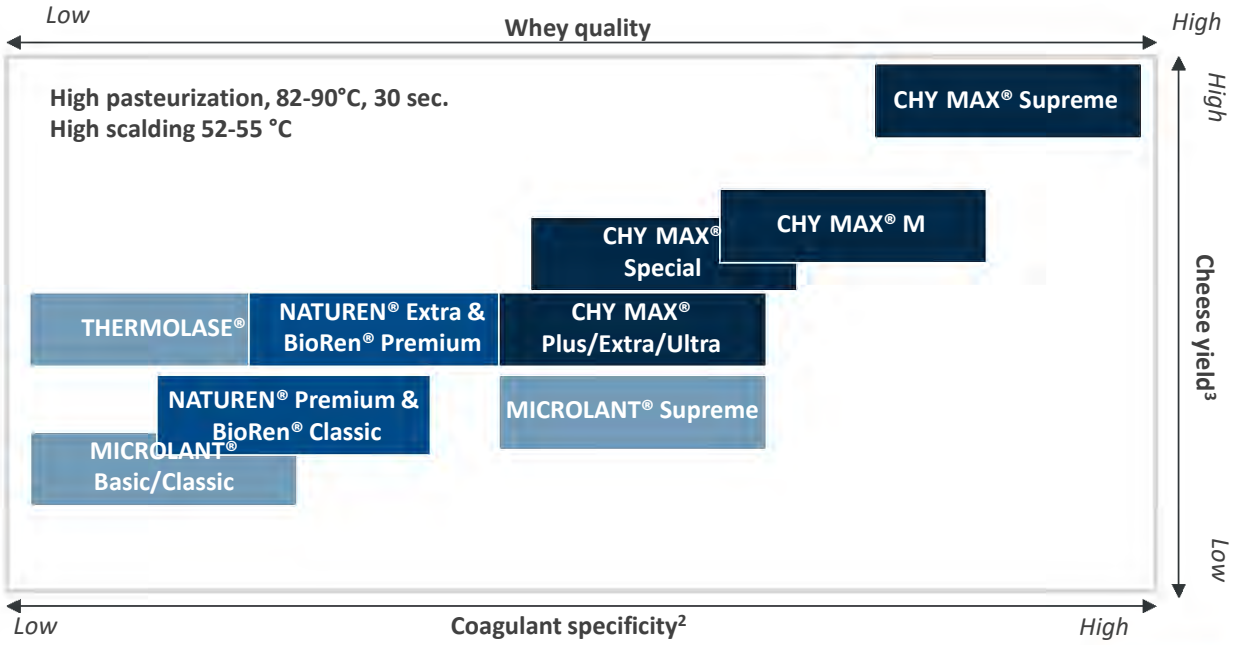

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Specificity (C/P-ratio) of coagulants matters as it disclose the performance

THE C/P RATIO[1]	CASEIN SUBSTRATE	EFFECT	IMPACT
C Clotting activity[1]	K	• The higher clotting activity the more precise cutting of Kappa Casein and ability to form strong casein network	• Use of a coagulant with a high C/P ratio results in a stronger casein network and fat and proteins are kept in the cheese • Cheese yield is directly linked to the C/P ratio of the coagulants
P General proteolytic activity	α, β	• The proteolytic activity impacts the speed of breakdown of casein in bigger and smaller peptides (fast speed gives bitter taste)	

[1] C/P is the ratio between the specific clotting activity and general proteolytic activity. Reference method by E045
1 Analysis method = 50 IMCU/L Milk, pH 6.5. 3 Analysis method = Curd simulation & peptides extraction

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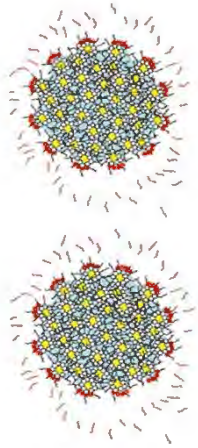
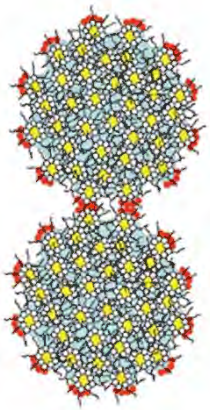
A more specific coagulant enables precise cutting of the kappa casein and allow strong network formation

SPECIFICITY

What is specificity?

- Specificity is the degree of precision which the Kappa caseins are cut during coagulation
- The specificity varies dependent on the type and generation of coagulant

	INSTABILITY	COAGULATION
SPECIFIC CLEAVING		
	Coagulant is added, CMP released after cleaving Kappa casein	Casein network formed as destabilized micelles aggregate into curd

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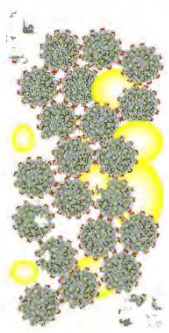
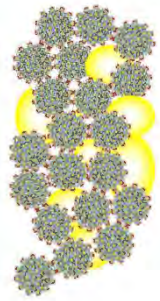
Higher specificity (C/P ratio) leads to faster coagulation and higher yield

BETTER NETWORKS, HIGHER YIELD

Influence of specificity

- The more precise the micelles are cut, the better networks they form and the more you keep what you need in the cheese without affecting the quality of the whey
- Using a coagulant with high C/P-ratio gives a superior network capturing fat and retaining intact proteins – producing a significantly higher yield

LOW C/P RATIO	HIGH C/P RATIO
Broken proteins Lost fat 	
Casein network is weaker due to unintended cleaving, losing fat and bits of broken protein to the whey	Casein network is strong and captures optimal levels of fat with minimal protein breakdown

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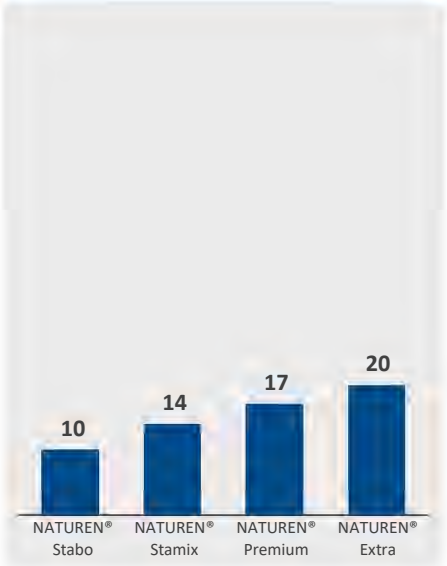
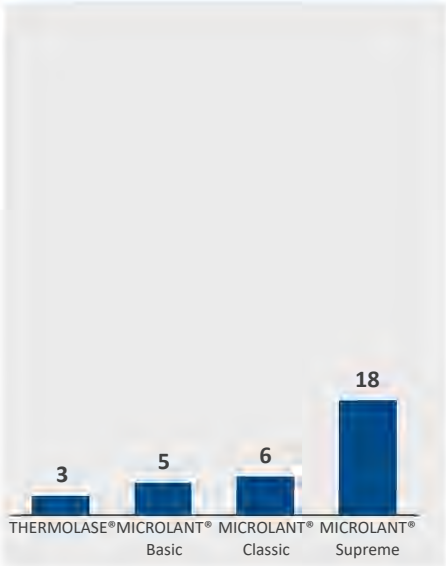
Our range includes different ratios of specificity and fulfill the desired outcome of individual cheese productions

SPECIFICITY (C/P)[1]

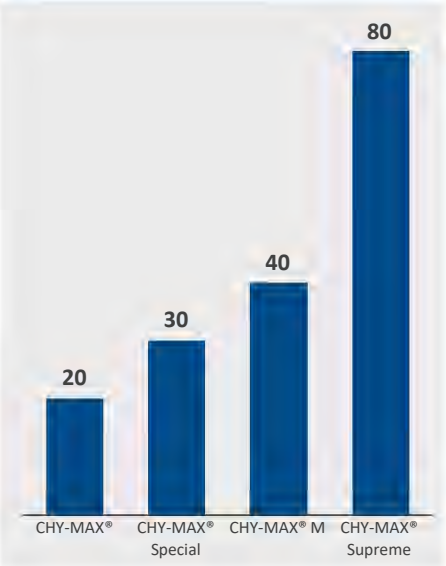
NATUREN®
Keeping traditions alive



MICROLANT®
Making organic possible



CHY MAX®
For the modern cheesemaker



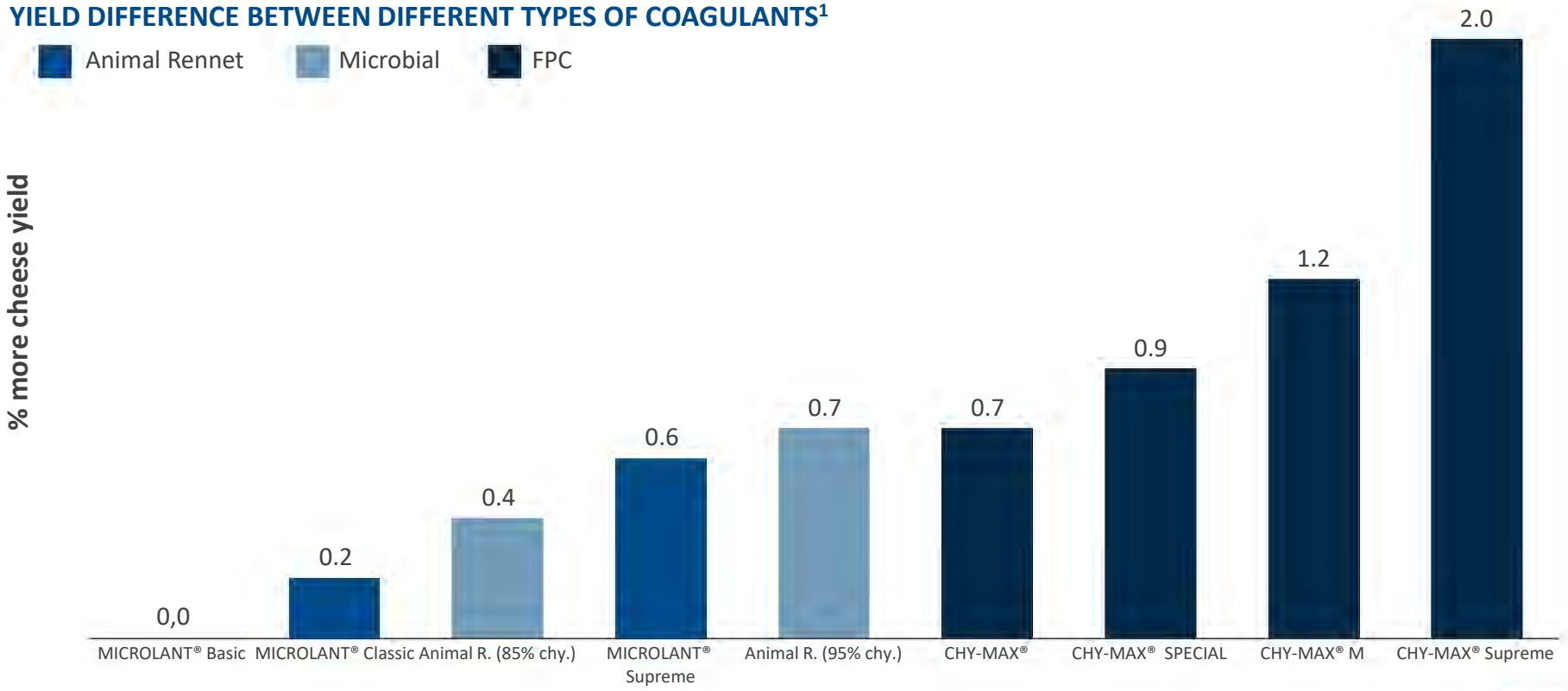
Parameters to consider when selecting:

- More yield vs. cost
- Strong flavor impact and bitterness
- Desired functionality (sliceability, melta-bility, shelf-life etc.)
- Better whey quality

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

CHY-MAX® Supreme outperforms all other coagulants in the market when comparing cheese yield

YIELD DIFFERENCE BETWEEN DIFFERENT TYPES OF COAGULANTS[1]



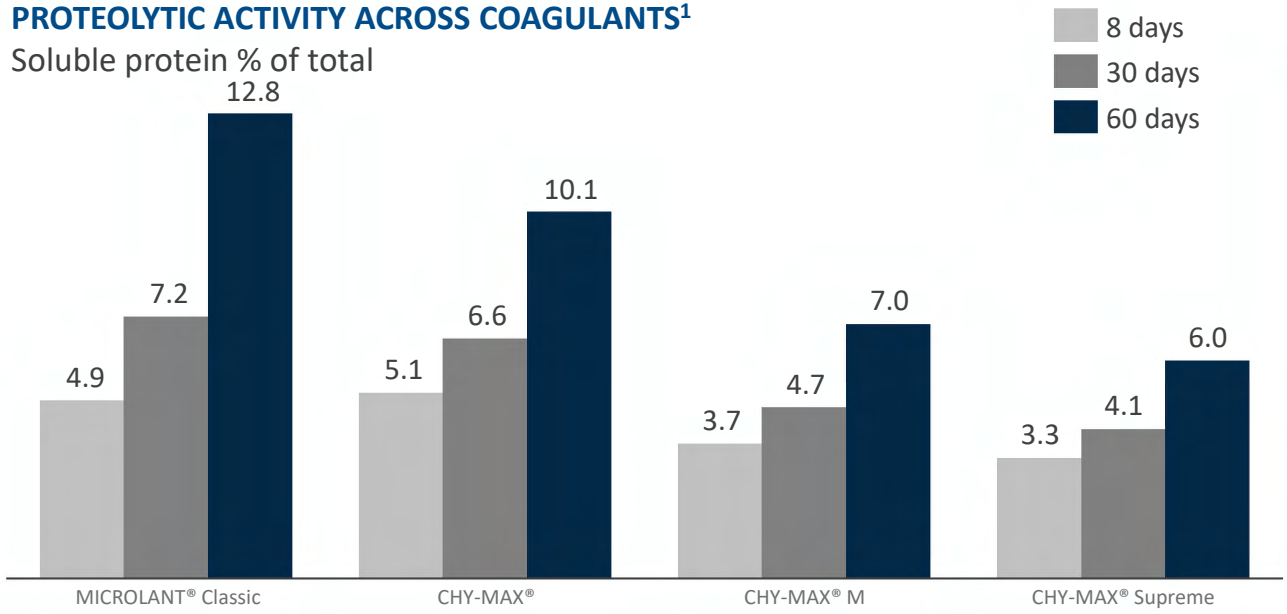
[1] Average moisture-adjusted cheese yield across coagulant ranges. Yield difference may vary between cheese types, processes, milk quality.

Obtain the desired functionality in the cheese over time

Example for Pasta Filata cheese

PROTEOLYTIC ACTIVITY ACROSS COAGULANTS[1]

Soluble protein % of total



- Determine the desired functionality of the final cheese before deciding on the coagulant as this has influence on the breakdown of caseins meaning the **functionality** incl. **texture** of the cheese.
- If eg. slice-ability and shread-ability is important choose a coagulant with **lower proteolysis** as it provides an **optimal texture** for converting to other formats

[1] Trials in Chr. Hansen's facility.

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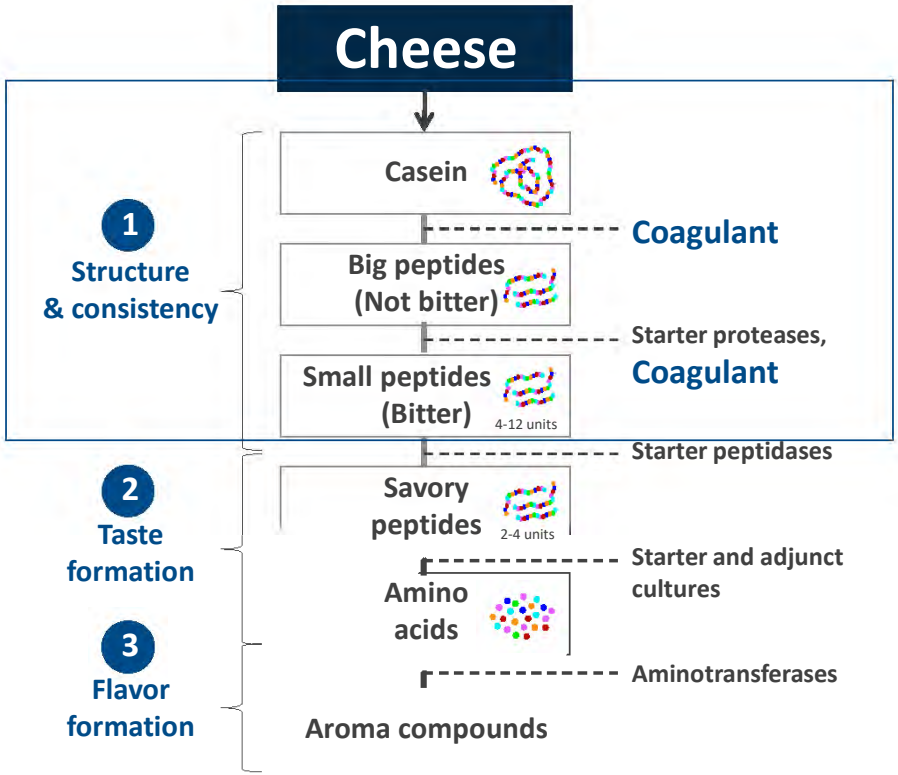
The coagulant is fundamental in the ripening process as it impacts the functionality and flavor



Coagulant affects the ripening by breakdown of the different types of caseins into small peptides

THE COAGULANT IMPACTS:

- Flavor
- Functionality
  - Texture (firmness, stickiness)
  - Shredability
  - Meltability
  - Sliceability
  - Browning
  - Oiling-off
  - Shelf-life

Starter- and ripening cultures and other enzymes also has an impact on ripening.

To produce a specific type of cheese the cheese producer needs to choose the right coagulant in combination with the culture.

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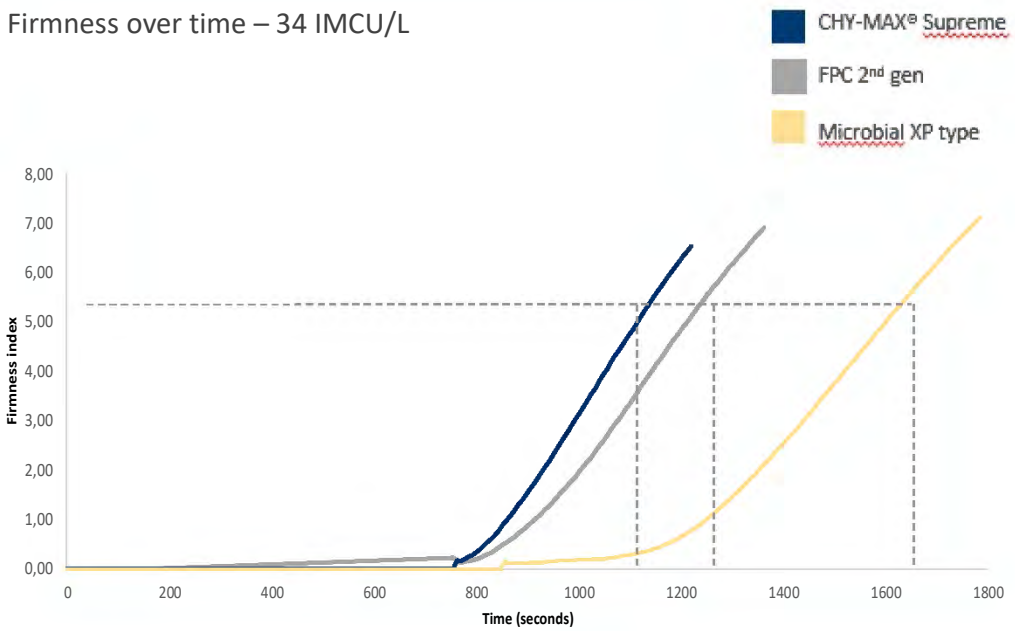
Reach the desired firmness faster by selecting a more specific coagulant when dosed at same level

COAGULATION PROFILE FOR PASTA FILATA[1]

Firmness over time – 34 IMCU/L



- To reach the desired firmness faster use a more specific coagulant as the coagulation **speed is higher** and the **flocculation time faster**. This enables a faster production time.
- It is necessary to **adjust the cutting** time so the curd is cut at the **same firmness**
- Same firmness at cutting enables **consistent quality** of the cheese
- **Note:** A lower dosage will have a negative impact on the network structure meaning it will be more difficult to reach the desired yield

1 Field trials, Aug. 2018

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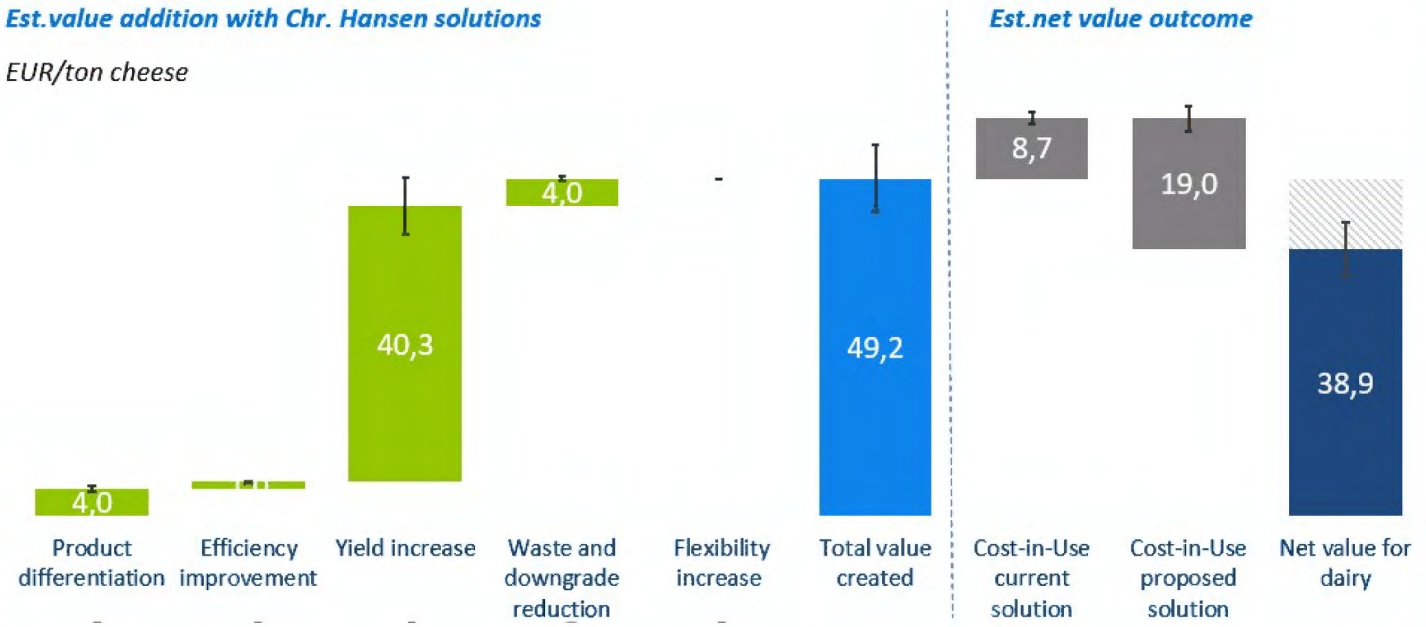
CHY-MAX® Supreme adds significant value through increased yield and better cheese functionality[1]

Example for Pasta Filata cheese

CHR. HANSEN VALUE CALCULATOR: SUMMARY OUTPUT



- By converting from 2nd gen FPC[2] to CHY-MAX® Supreme a mid-size cheese producer gains 38.9 EUR/ton of cheese
- The value is created by achieving a higher cheese yield and the firmer texture of the cheese enables less waste and more efficient production

[1] Chr. Hansen value calculator [2] Fermentation Produced Chymosin

Obtain the full value of Chr. Hansen's offerings

Chr. Hansen brings much more value into cheesemaking than the superior coagulants we offer. Our great services includes access to technical experts and support to maximizing your cheese production whether it is traditional cheese-making, organic production or if you want to maximize the yield.

OUR CORE COMPETENCY AREAS		YOUR VALUE CREATION AND BUSINESS IMPACT
Superior products	**The very best** Cheese cultures and enzymes portfolio	• Proven ingredients for any cheese applications - on specification • Solutions that secure your consistent delivery – risk management • Solutions that increase your output – yield optimization • Solutions that kick-start new business opportunities for you - growth
Superior services	**Proactive partnering** Co-development for value realization	• Innovation days and co-creation of new products • Market insights sparring, regulatory and market development • Employee training sessions and strategy outlooks • Connect to the world - Support from our local sales organization
	Engaged and strong application experts Technical support to tackle complex problems	• Full, best-in-class technical application and laboratory services • Ingredient customization to specific customer needs and products • Trials, production audits and trouble-shooting
	On-time delivery Global reach and compliant	• On-time delivery via global setup • Detailed, multi-language documentation and info • Local application/service support every day

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Thank you

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