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Role of milk protein fractions on coagulation, curd firming and syneresis

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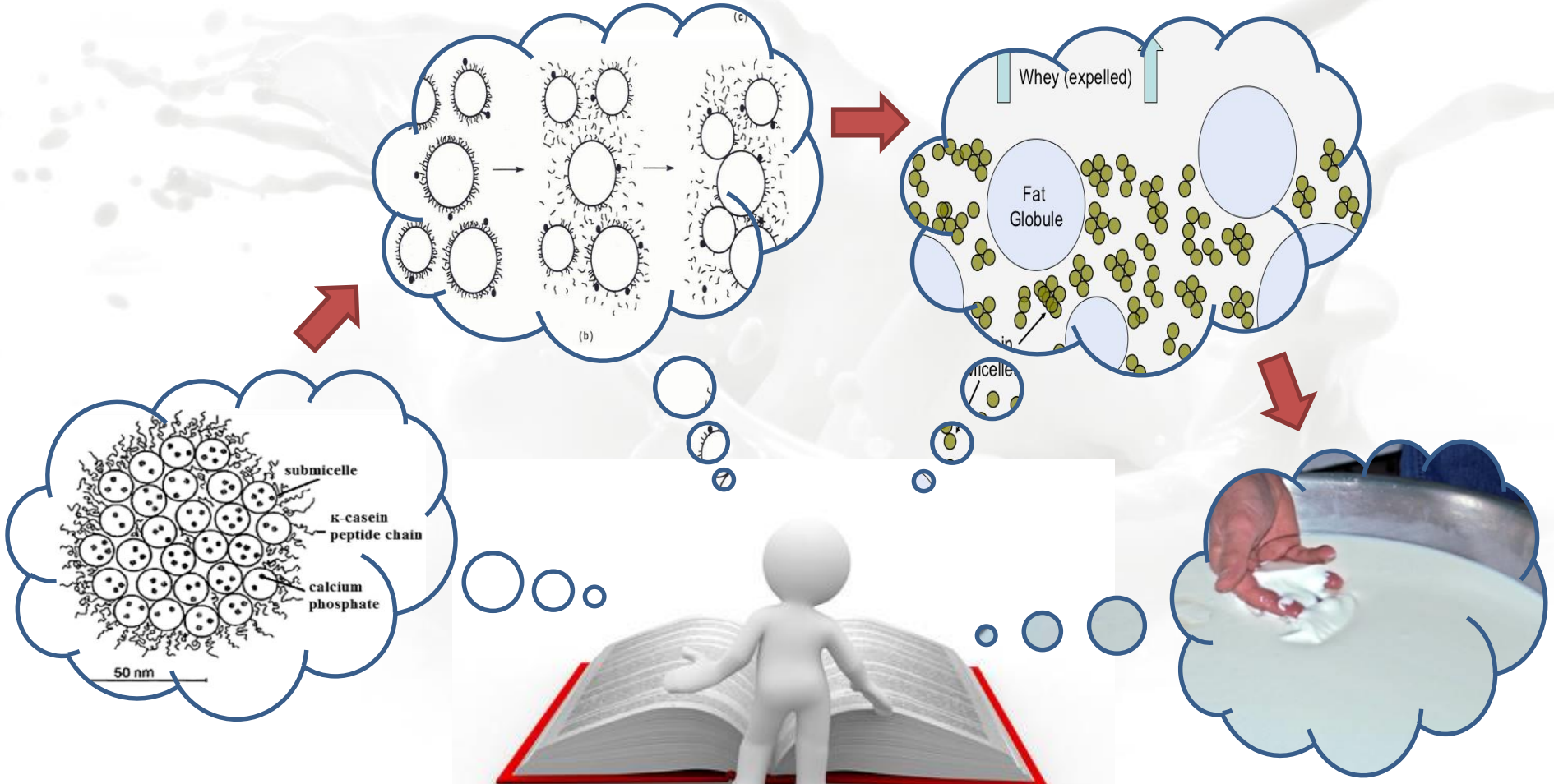
Coagulation process



Actual bibliography:

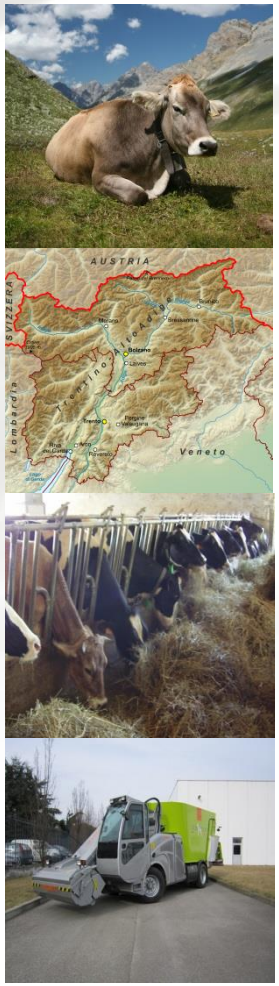
- Many studies on the effects of the genetic variants of different protein fractions on coagulation process
- Fewer studies on the effect of the concentrations of different protein fractions in the milk
- Even fewer studies on the effect of both the amount and the genotype of each protein fraction

The aim of the present work was to study the influence of individual milk protein fractions concentration on:

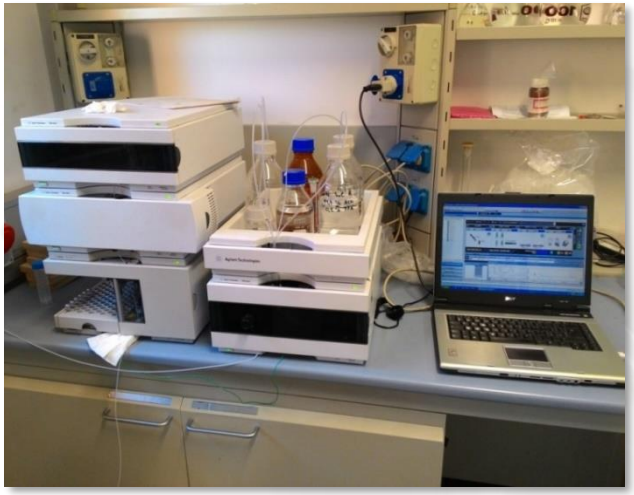
- traditional coagulation properties
- curd firming over time (CF_t) model parameters

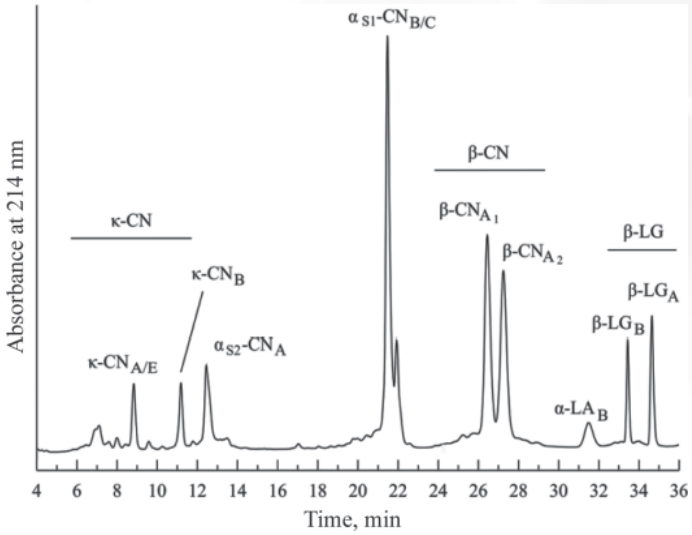
Experimental design

- **1271** Brown Swiss cows
- **85** herds in Trento Province (Northeast Italy)
- **4** farming systems
  - ✓ Traditional system
  - ✓ Modern system with traditional feeding methods
  - ✓ Modern system with silage-based TMR
  - ✓ Modern system with silage-free TMR



Reversed-Phase High-Performance Liquid Chromatography





Bonfatti et al., 2011

Proteins from 500 µL of individual cow milk

+

Gradient elution

+

Reversed-phase analytical column C8 with a silica-based packing (3.5m, 300A˚ , 150×4.6 I.D.)

=

Identification and quantification of milk single protein fractions and genetic variants

Traditional milk coagulation properties

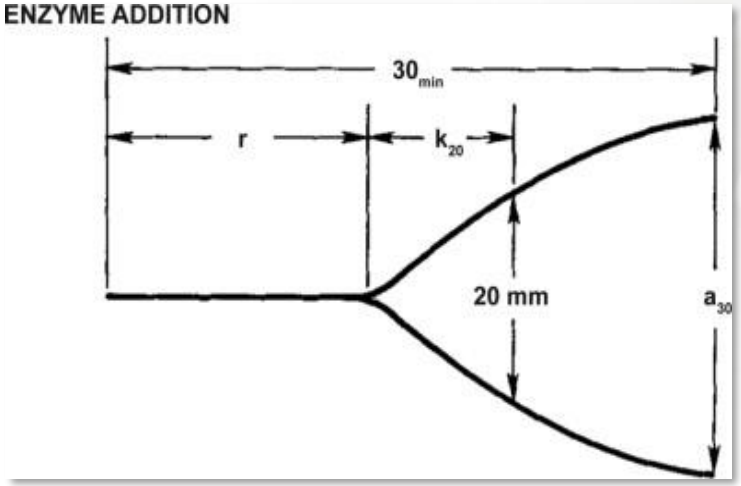
10 mL of individual cow milk

+

Rennet solution (51 IMCU/ L of milk)

=

Lacto-dynamographic curve

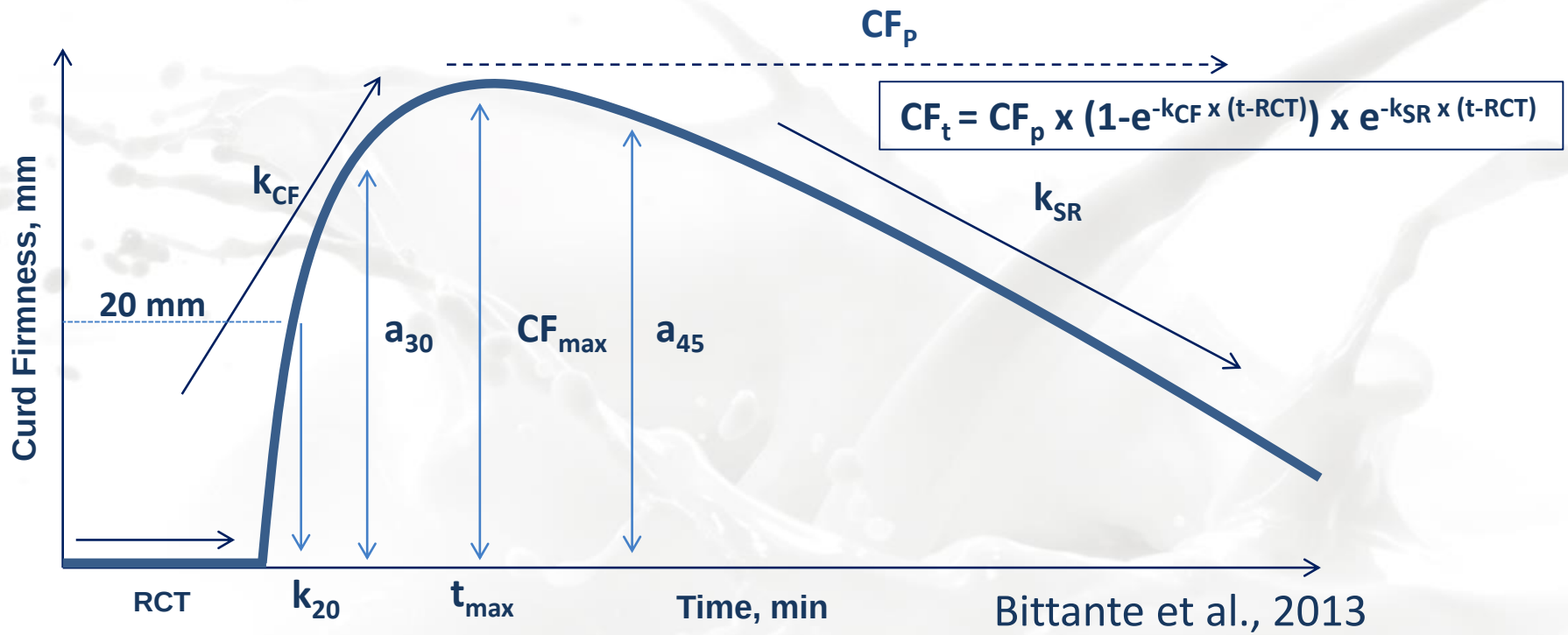


McMahon and Brown (1982)

Traditional MCPs:

- **RCT**: rennet coagulation time (min)
- **k_{20}**: time to curd firmness of 20mm (min)
- **$a_{30,45}$**: curd firmness at 30 and 45 min (mm)

Modeling CF and syneresis



Bittante et al., 2013

RCT_{eq}: rennet coagulation time estimated from equation (min)

CF_p : asymptotic potential maximum value of CF at infinite time (mm)

k_{CF} : curd-firming instant rate constant (% × min^{-1})

k_{SR}: syneresis instant rate constant (%× min^{-1})

CF_{max}: maximum curd firmness value obtained by the curd(mm)

t_{max}: time taken to reach the CF_{max} (min)

Statistical analysis

M-g/L model:

$$y_{fghijklmnopqrstuv} = \mu + \text{dairy system}_f + \text{herd}_g(\text{dairy system})_f + DIM_h + \text{parity}_i + dMY_j + \beta\text{-CN-GT}_k + \kappa\text{-CN-GT}_l + \beta\text{-LG-GT}_m + \alpha_{S1}\text{-CN}_n + \alpha_{S1}\text{-CNph}_o + \alpha_{S2}\text{-CN}_p + \beta\text{-CN}_q + \kappa\text{-CN}_r + \alpha\text{-LA}_s + \beta\text{-LG}_t + \text{pendulum}_u + e_{fghijklmnopqrstuv}$$

- Protein fractions expressed in grams per liter of milk

M-%cas model:

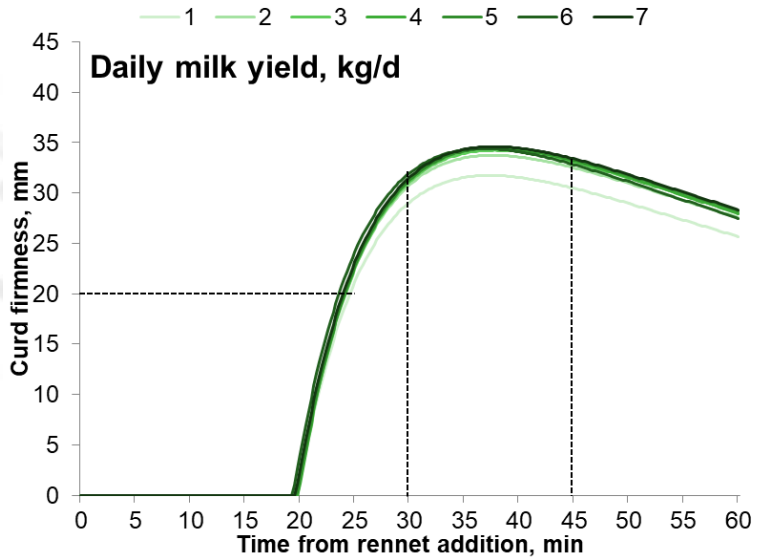
$$y_{fghijklmnopqrstuv} = \mu + \text{dairy system}_f + \text{herd}_g(\text{dairy system})_f + DIM_h + \text{parity}_i + \text{casein}_j + \beta\text{-CN-GT}_k + \kappa\text{-CN-GT}_l + \beta\text{-LG-GT}_m + \alpha_{S1}\text{-CN}_n + \alpha_{S1}\text{-CNph}_o + \alpha_{S2}\text{-CN}_p + \beta\text{-CN}_q + \kappa\text{-CN}_r + \alpha\text{-LA}_s + \beta\text{-LG}_t + \text{pendulum}_u + e_{fghijklmnopqrstuv}$$

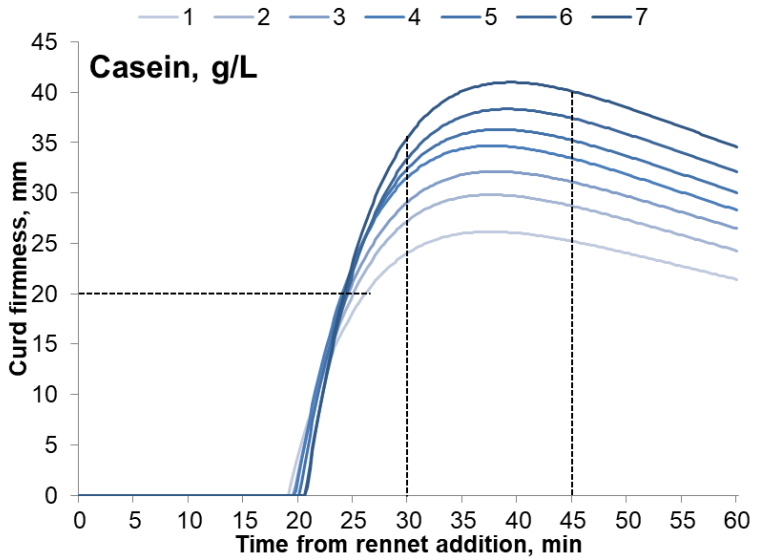
- Protein fractions expressed in % on total casein content

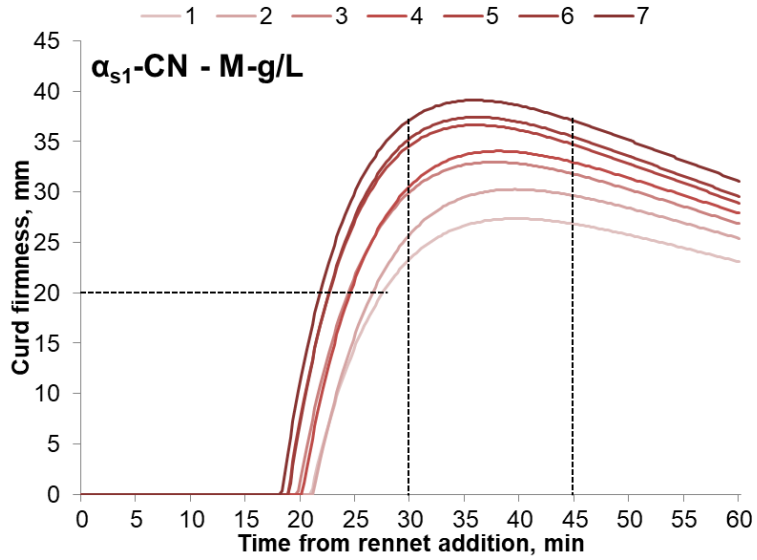
N.B. The interval of the classes of protein fractions was half a standard deviation of the trait distribution

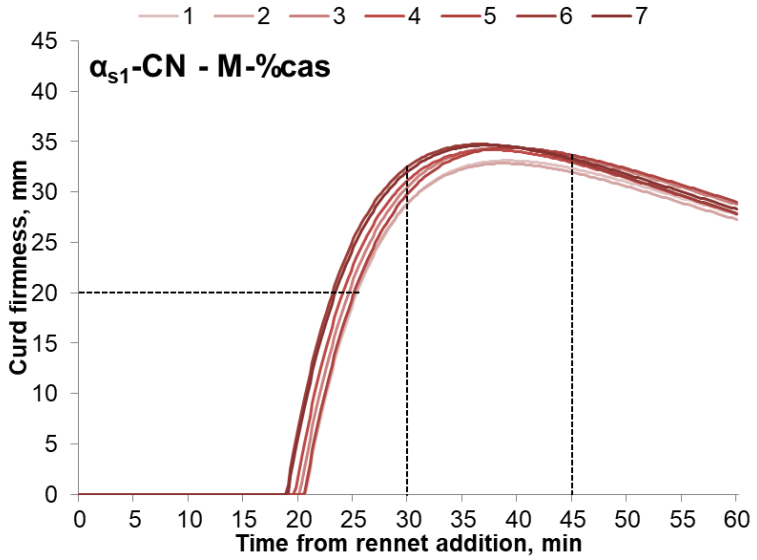
Results

Effect of total casein content and α_{S1}-CN on coagulation

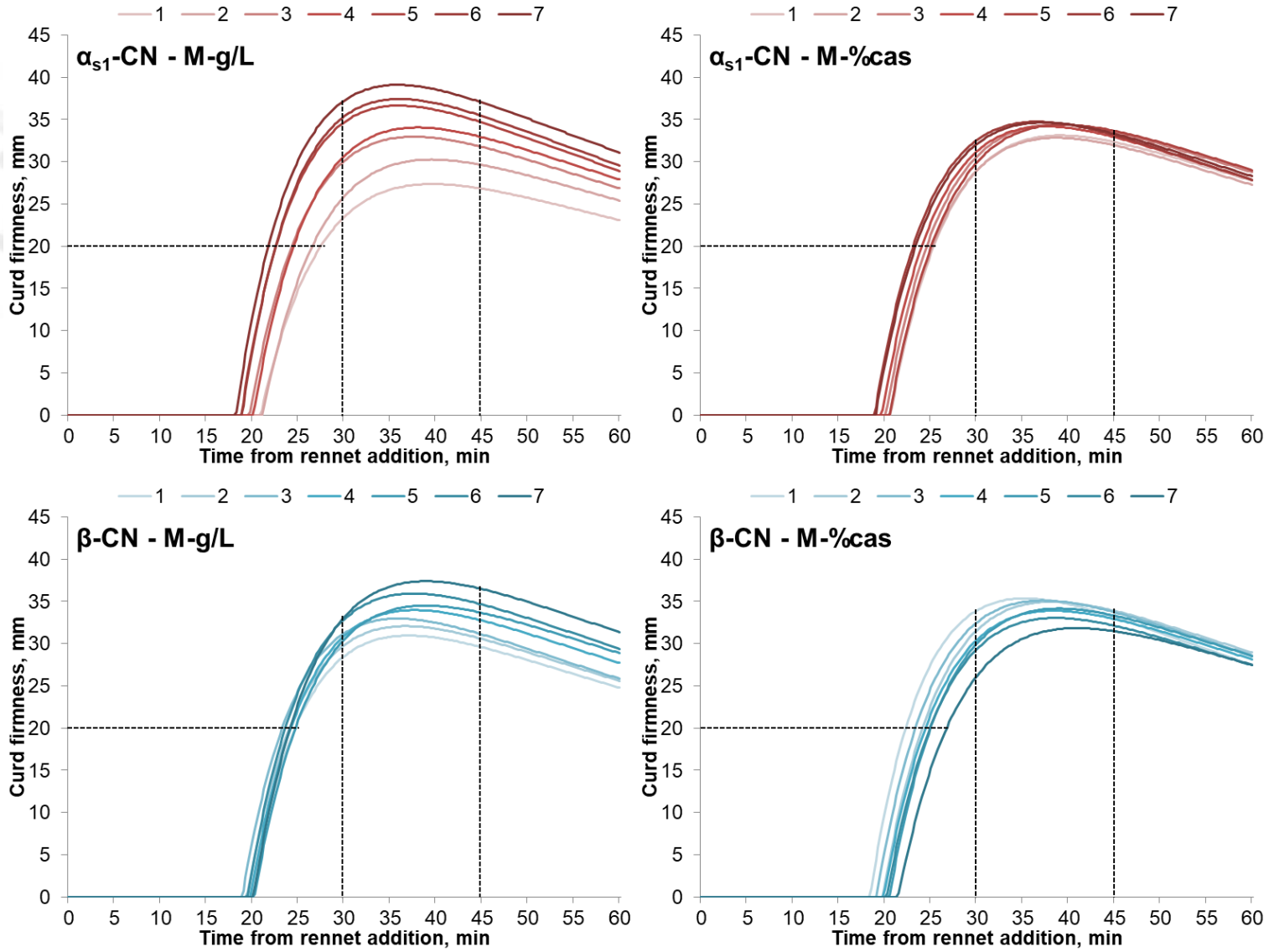




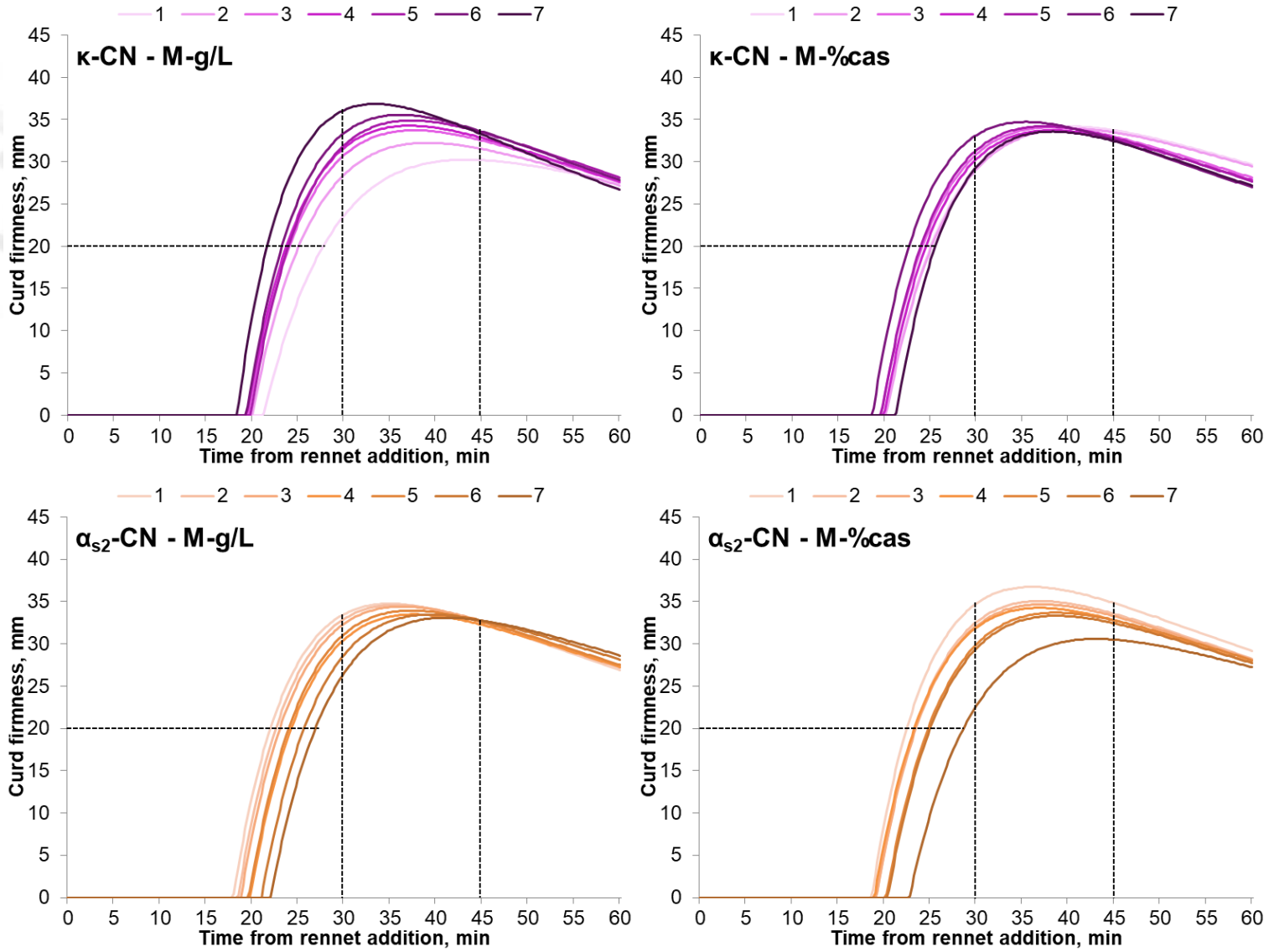




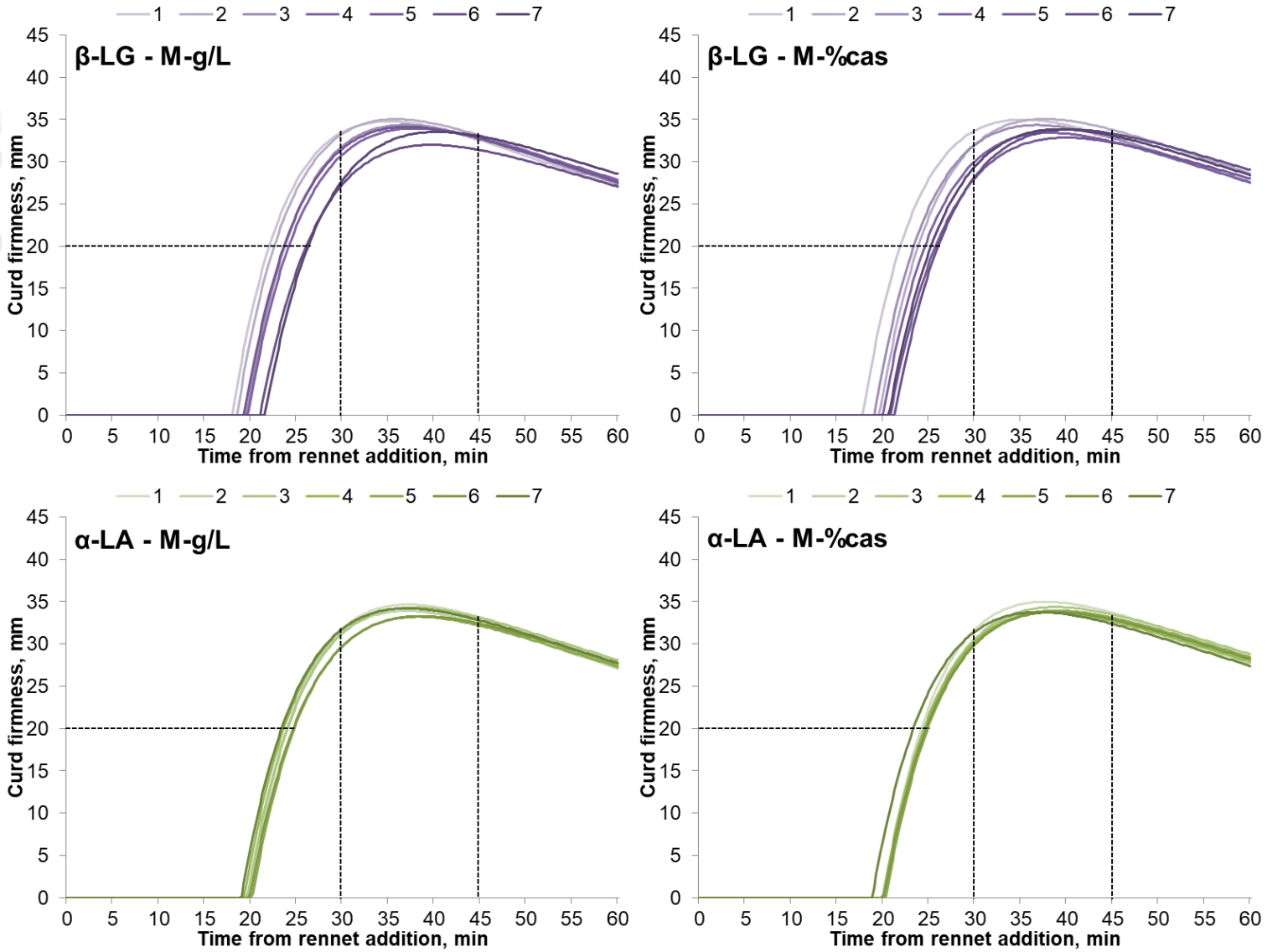
Effect of α_{S1}-CN and β-CN on coagulation



Effect of κ-CN and α_{S2}-CN on coagulation



Effect of β-LG and α-LA on coagulation



In conclusion

Fractions	RCT	Curd-firming	Curd firmness	Syneresis
α_{s1}-CN	↑	–	↑↑↑	↑
α_{s2}-CN	↓↓↓	- / ↓	↓↓	- / ↓
β-CN	–	–	↑/↓	–
κ-CN	↑	↑↑↑	↑↑	↑↑↑
β-LG	↓↓	↓	↓↓↓	–




Applications:

- Selection criteria for more specific genetic improvement of the traits relevant to cheese production
- Improvement of the Quality Payment criteria

Thanks for your attention