Rheological evaluation of rennet-induced curdling of goat milks from different farming systems

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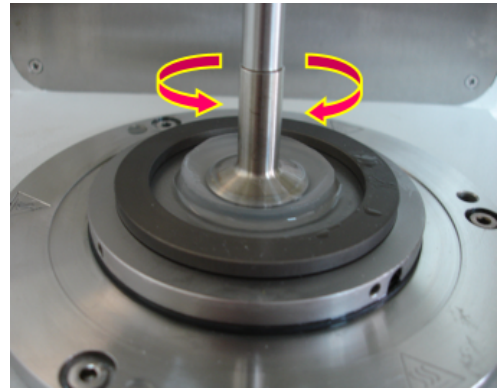
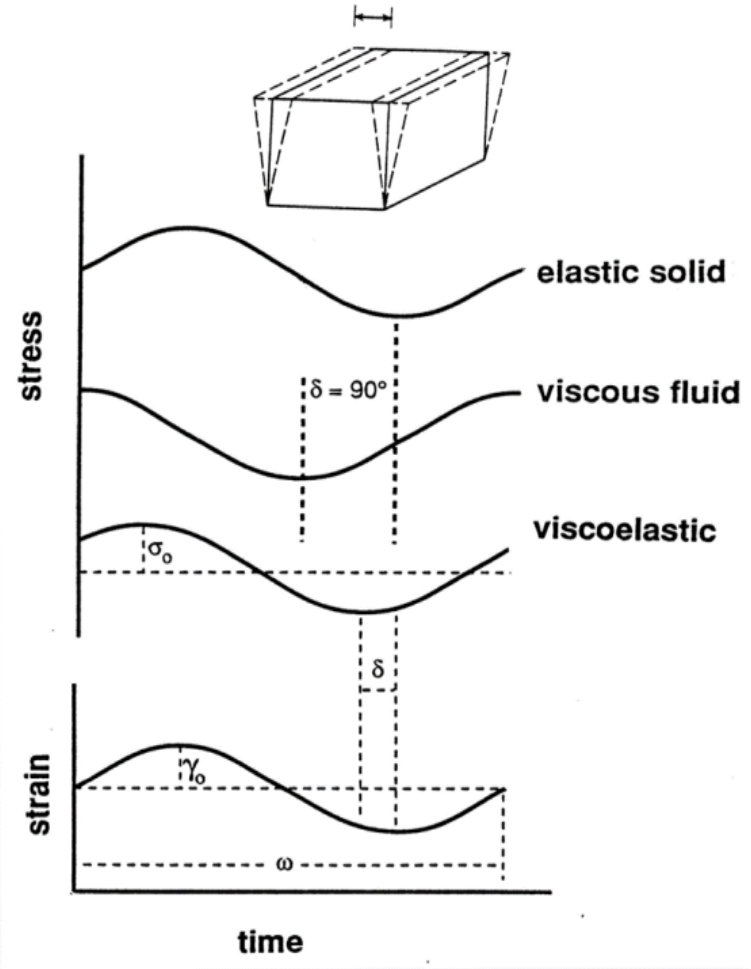
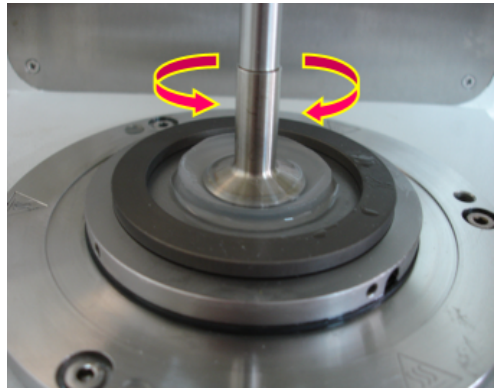
Rheology

- Most of food products, including dairy formulations, have both of elastic and viscous properties, that is, they are characterized as viscoelastic materials.
- Viscoelasticity of food materials is related to their textural properties and is often evaluated by rheological tests.
- Rheology, in general, is defined as the science of flow and deformation, describing the relationships between stress, deformation and time.
- The textural attributes of a food product play an important role in food stability on the shelf, sensorial attributes and consumer acceptability of the product.

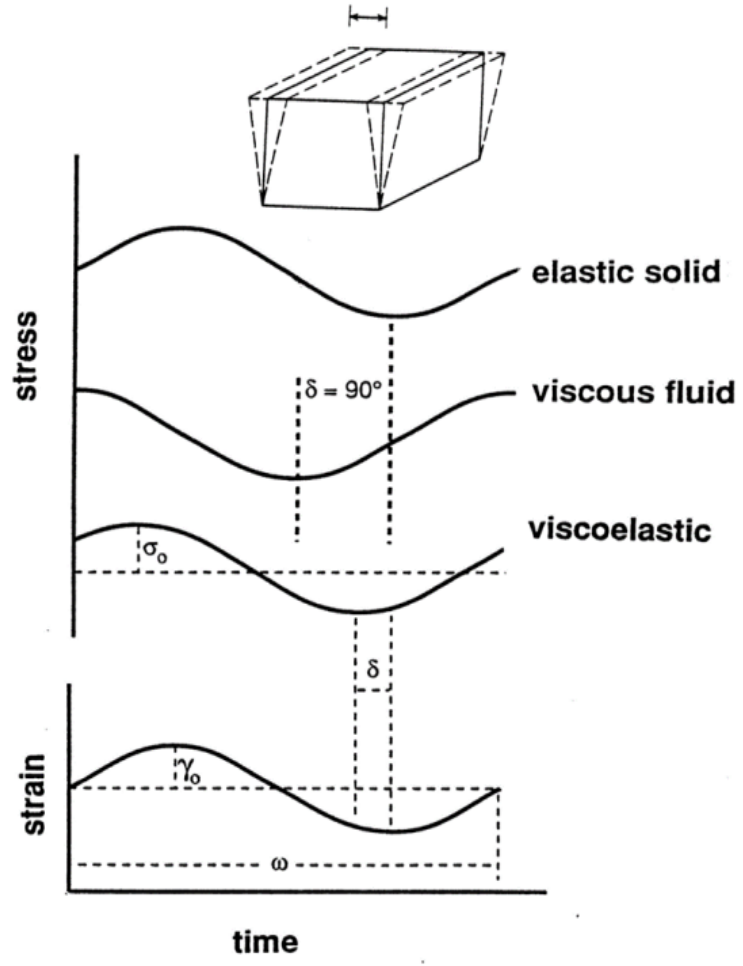




Rheology



Some of the rheological tests used in textural characterization of food products, like those of dairy items, involve small deformation testing to assess process and time related effects, like protein coagulation phenomena, as those found in cheese making. As a result, **material properties are being evaluated without affecting the structure of the product as it evolves.**



Objective

- The present study focuses on the rheological assessment of rennet-induced coagulation of milk from dairy goats of the Greek Skopelos breed

Rheological behavior of milk upon coagulation

Materials & methods

Goat milk samples:

Extensive farming system, n=32

Intensive farming system, n=40

⇩

Pasteurization (63 °C /15 min)

⇩

Addition of:

✓ $CaCl_2$ (15.0 g /100 L)

✓ Chymosin (0.96 g /100 L)

⇩

Evaluation of mechanical properties of milk upon coagulation

Rheological evaluation of milk coagulation

- ***Gelation kinetics (1st step)***
    1. 90 measuring points
    2. Measuring point duration: 0.5 min
    3. Constant Frequency: 1 Hz
    4. Constant strain: 0.5%

- ***Frequency sweep test (2nd step)***
    1. 30 measuring points
    2. *f* = 0.1–50 Hz
    3. Constant strain: 0.5 %

- ***Amplitude sweep test (3rd step)***
    1. 30 measuring points
    2. Strain: 0.1–500 %

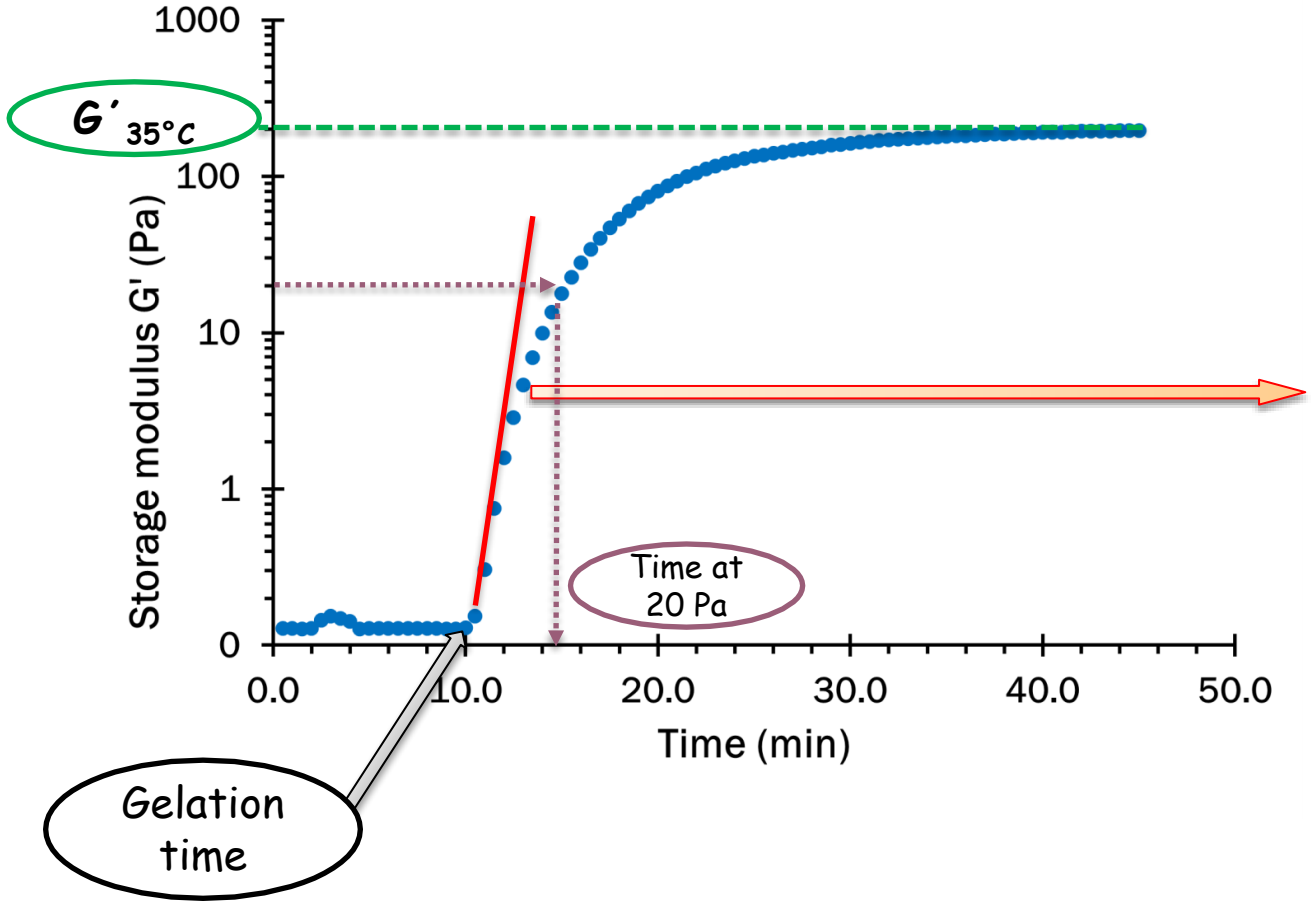
All measurements performed at 35 °C

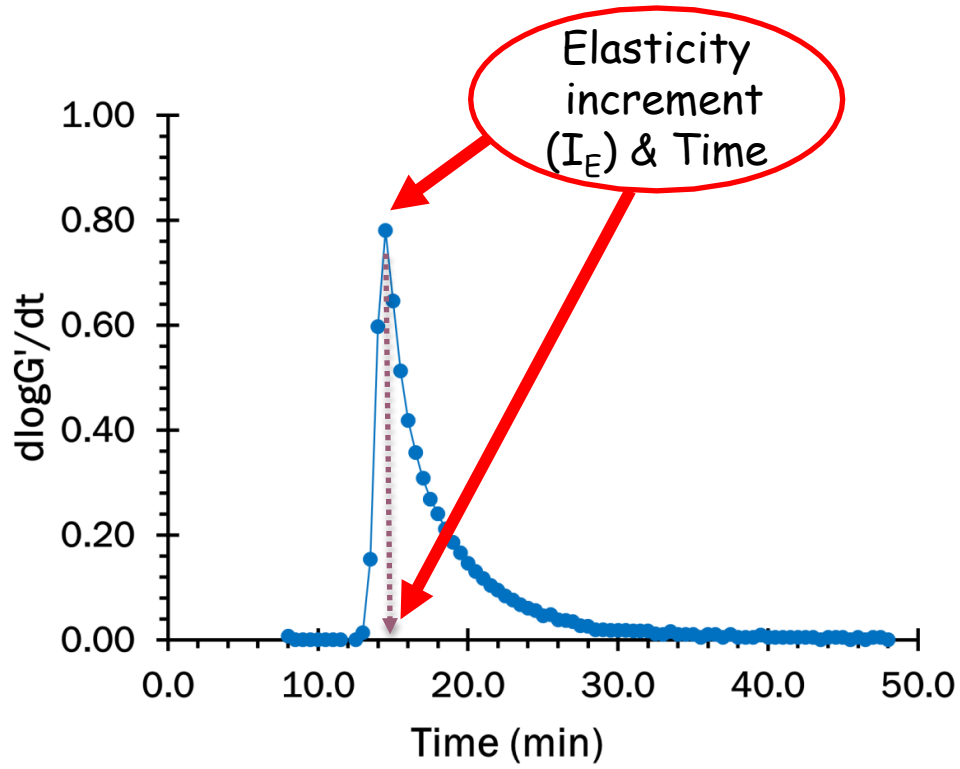
Rheometer MCR 300 (Stuttgart, Germany)

Measuring probe: Concentric cylinder - CC27

Results

Gelation kinetics - analysis

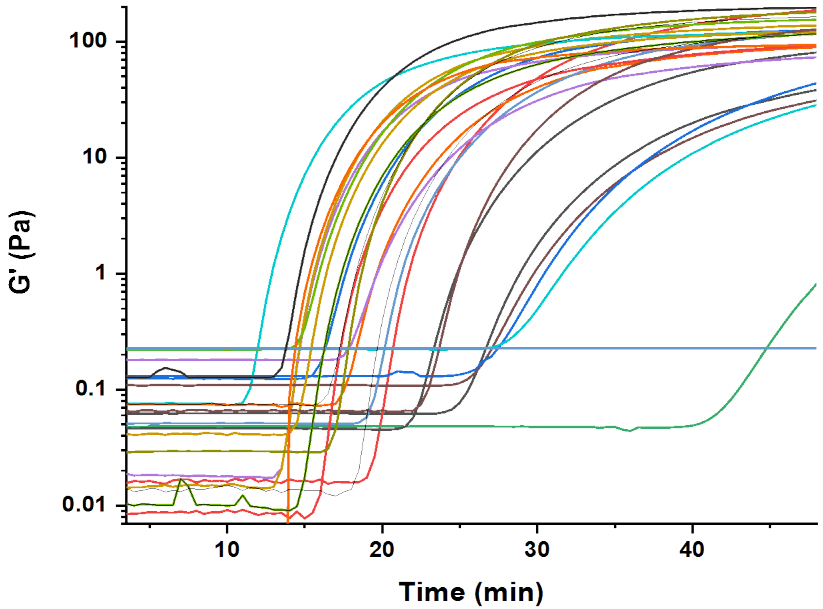


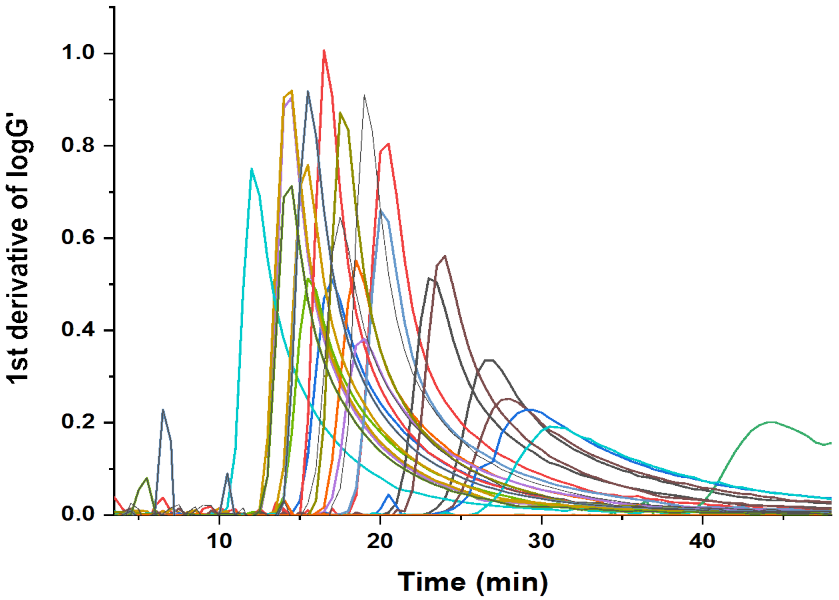


Gelation kinetics – raw data

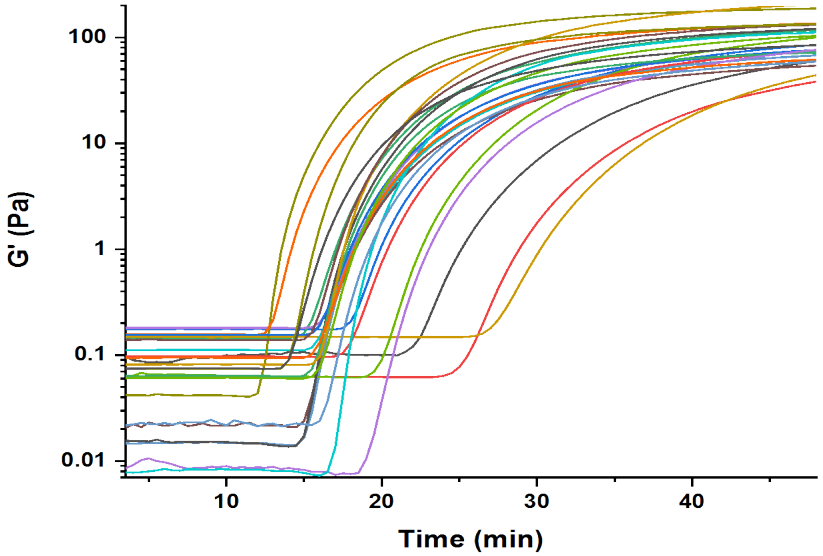
Results

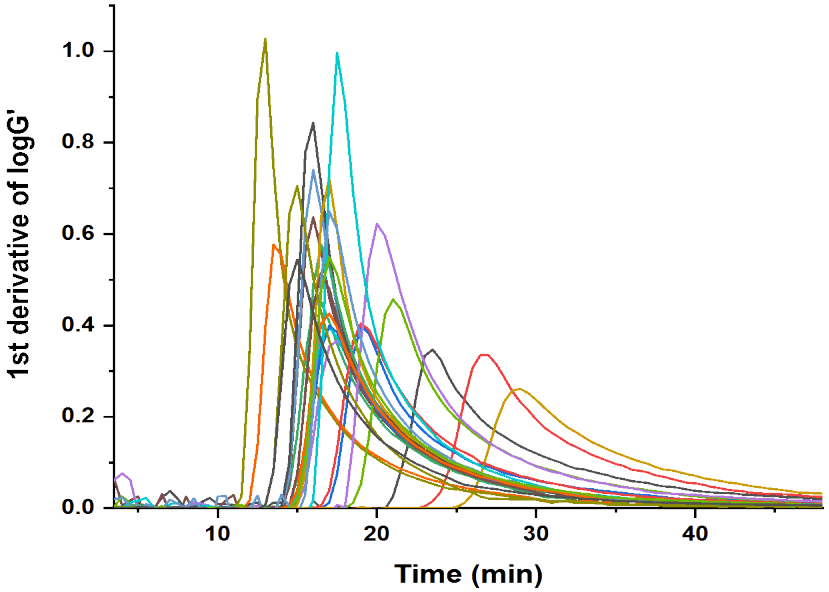
- Extensive farming system





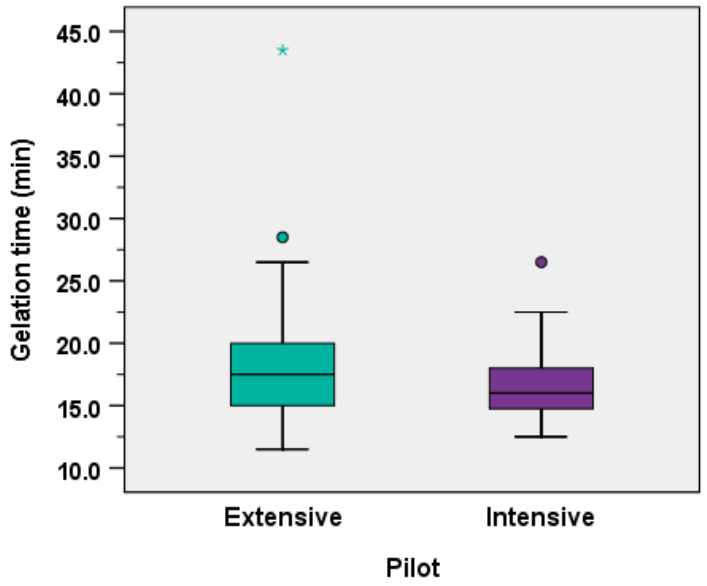
- Intensive farming system

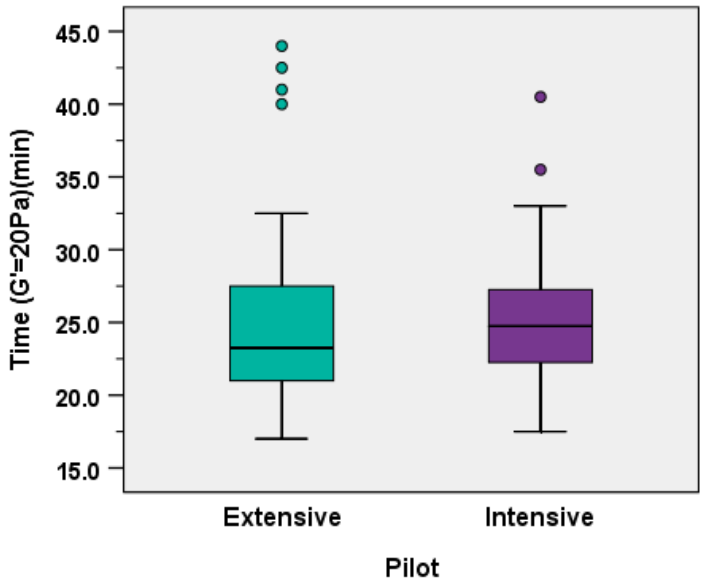


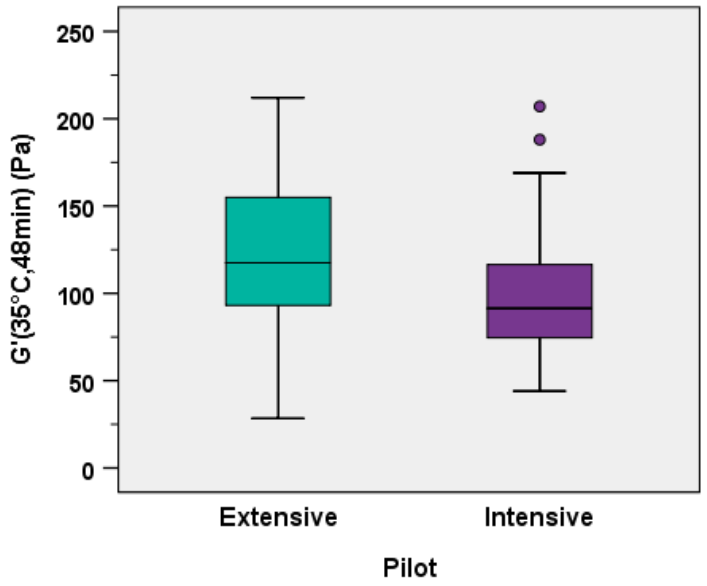


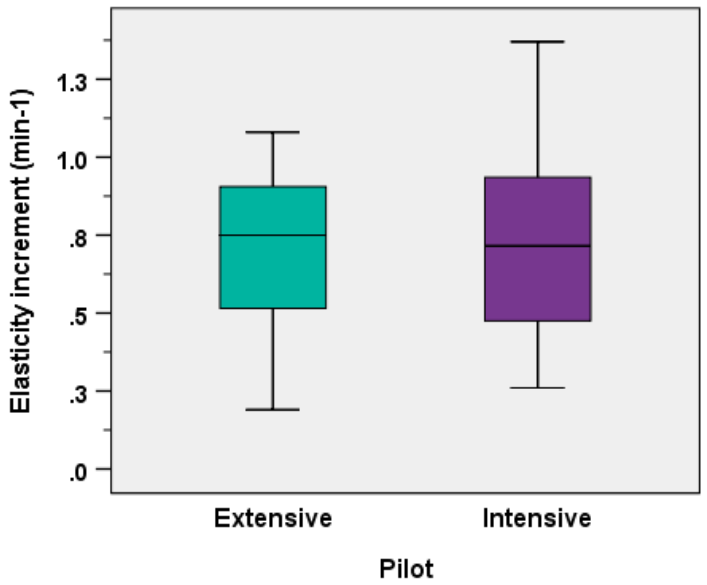
Gelation kinetics - analysis

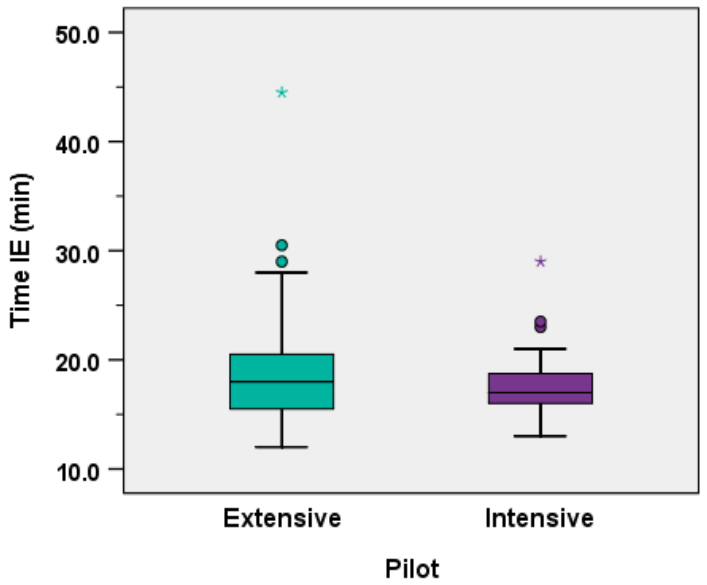
Results











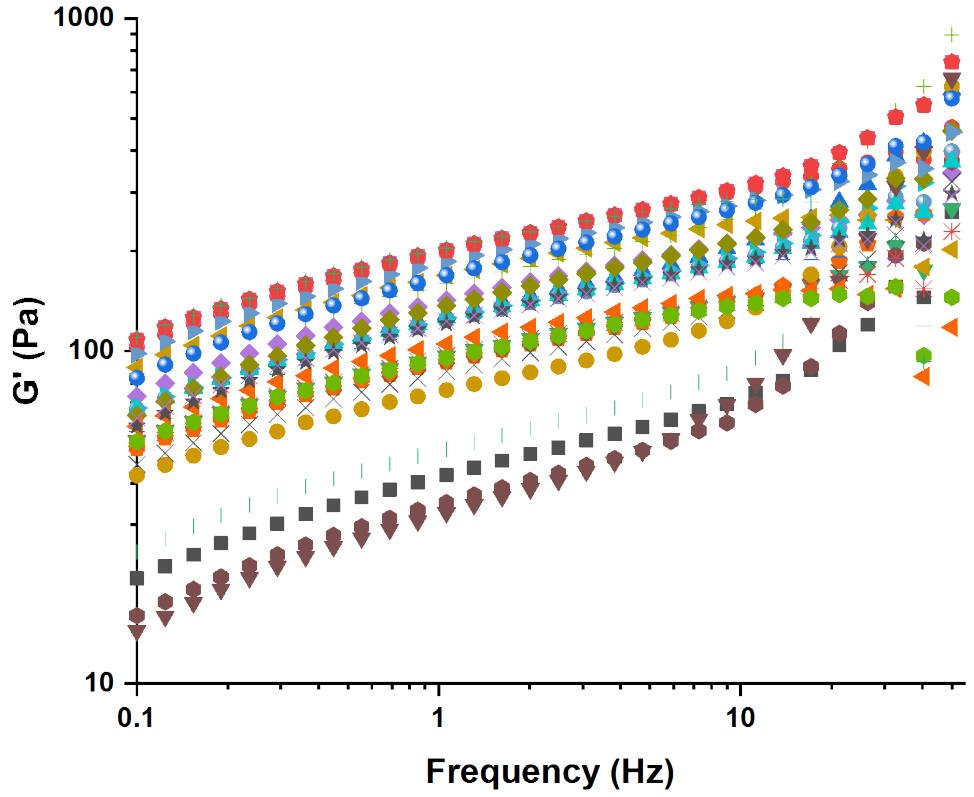
	Extensive	Intensive
Gelation time (min)	19.0 ^{b}	16.5 ^{a}
Time $_{G'=20Pa}$ (min)	26.1^{a}	25.2 ^{a}
G' $_{35°C,48min}$ (Pa)	119 ^{a}	100 ^{a}
Elasticity Increment (min^{-1})	0.69 ^{a}	0.73 ^{a}
Time IE (min)	19.7 ^{b}	17.4 ^{a}

Results

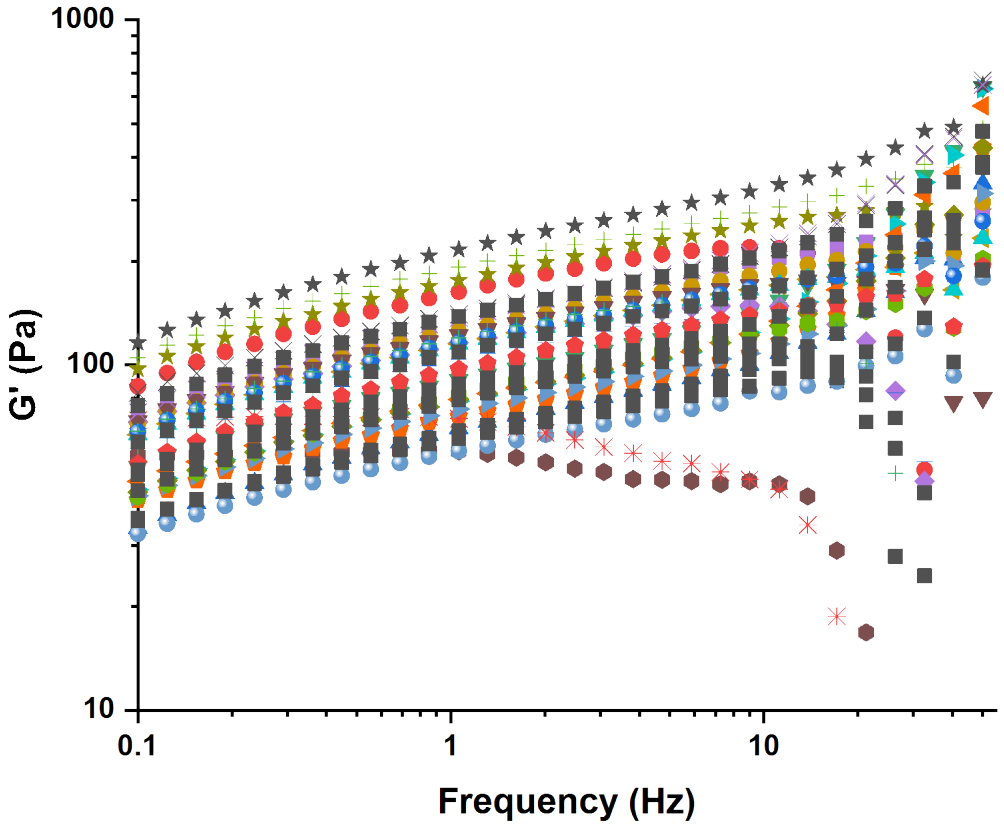
Frequency sweep – raw data

(γ= 0.5 %, 35 °C)

➢ Extensive farming system

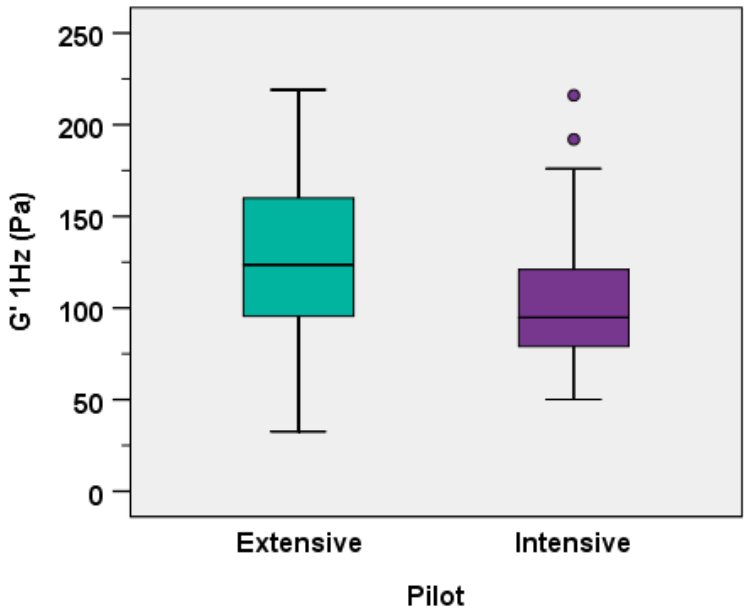


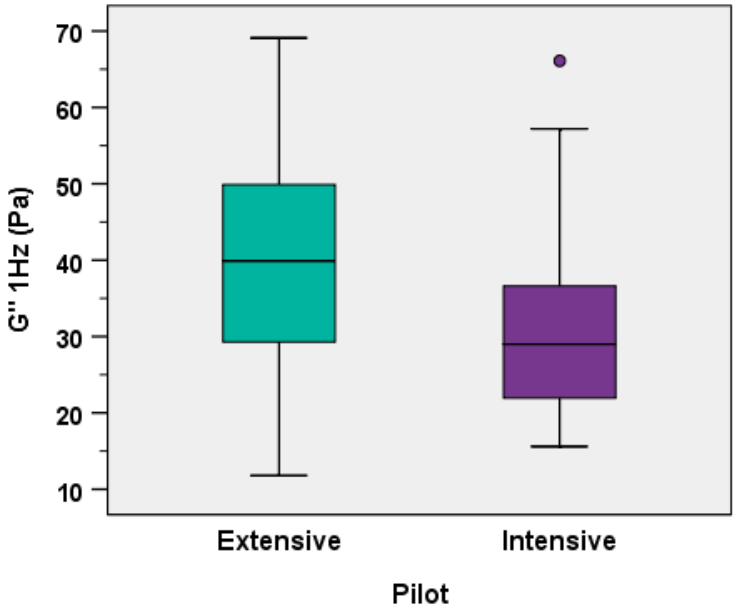
➢ Intensive farming system

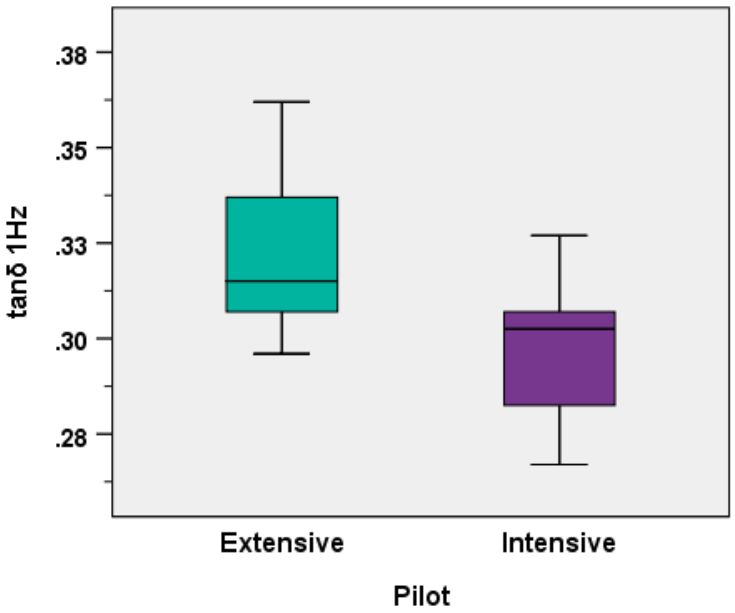


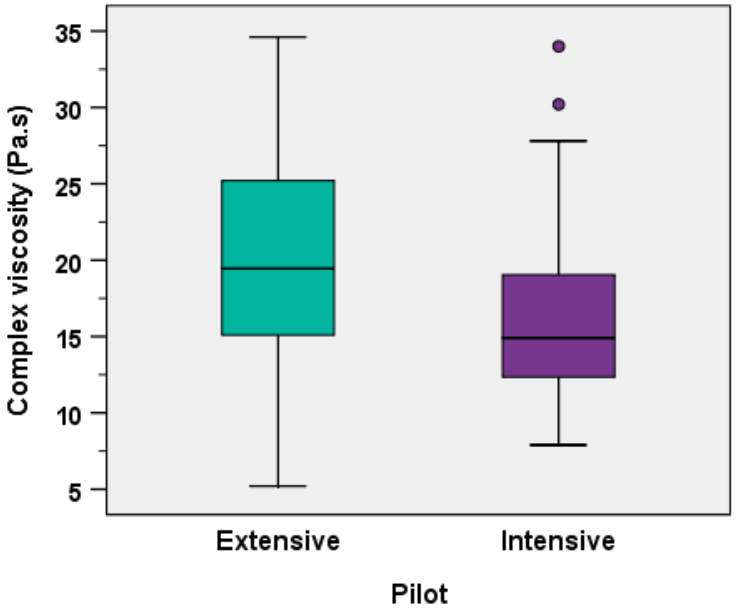
Results

Frequency sweep - analysis







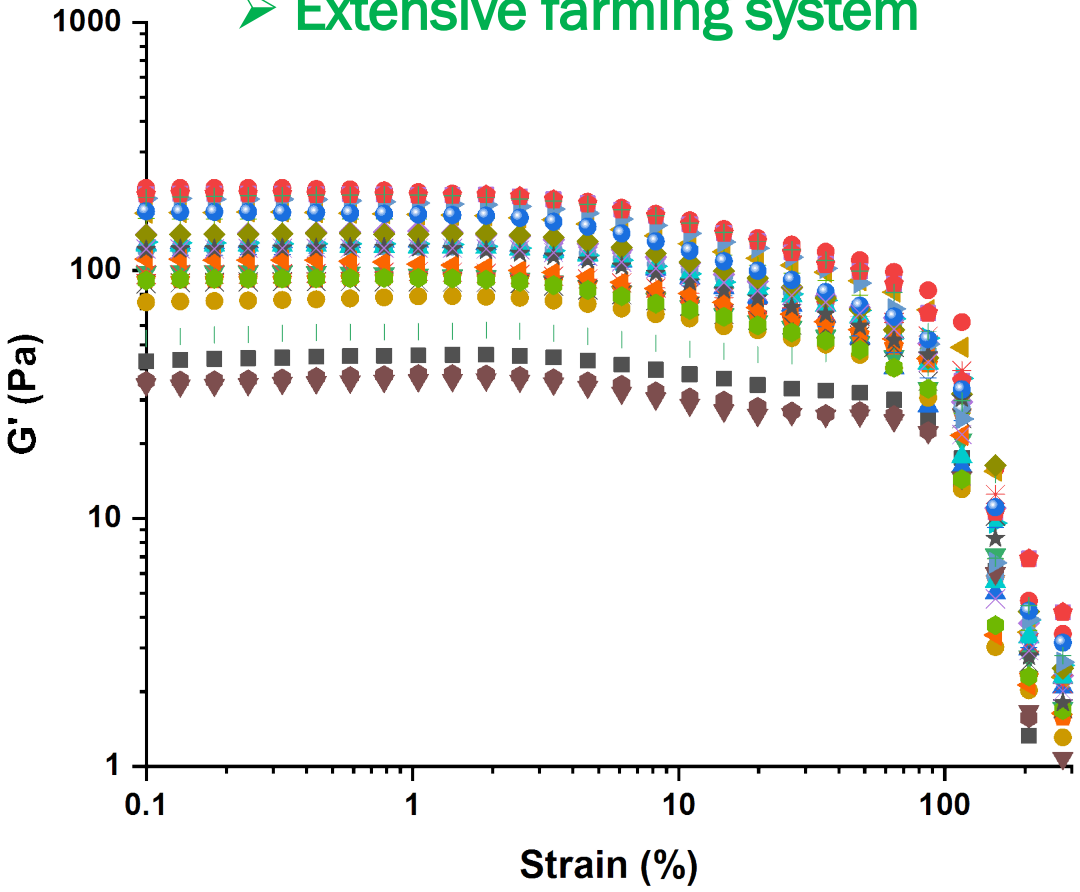


Rheological Parameters at 1Hz	Extensive	Intensive
Storage modulus (**G'**) (Pa)	124 [b]	104 [a]
Loss modulus (**G"**) (Pa)	39 [b]	31 [a]
Loss tangent (**tanδ = G" / G'**)	0.32 [b]	0.30 [a]
Complex viscosity (**η***) (Pa.s)	19.6 [b]	16.4 [a]

Results

Amplitude sweep – raw data

➢ Extensive farming system



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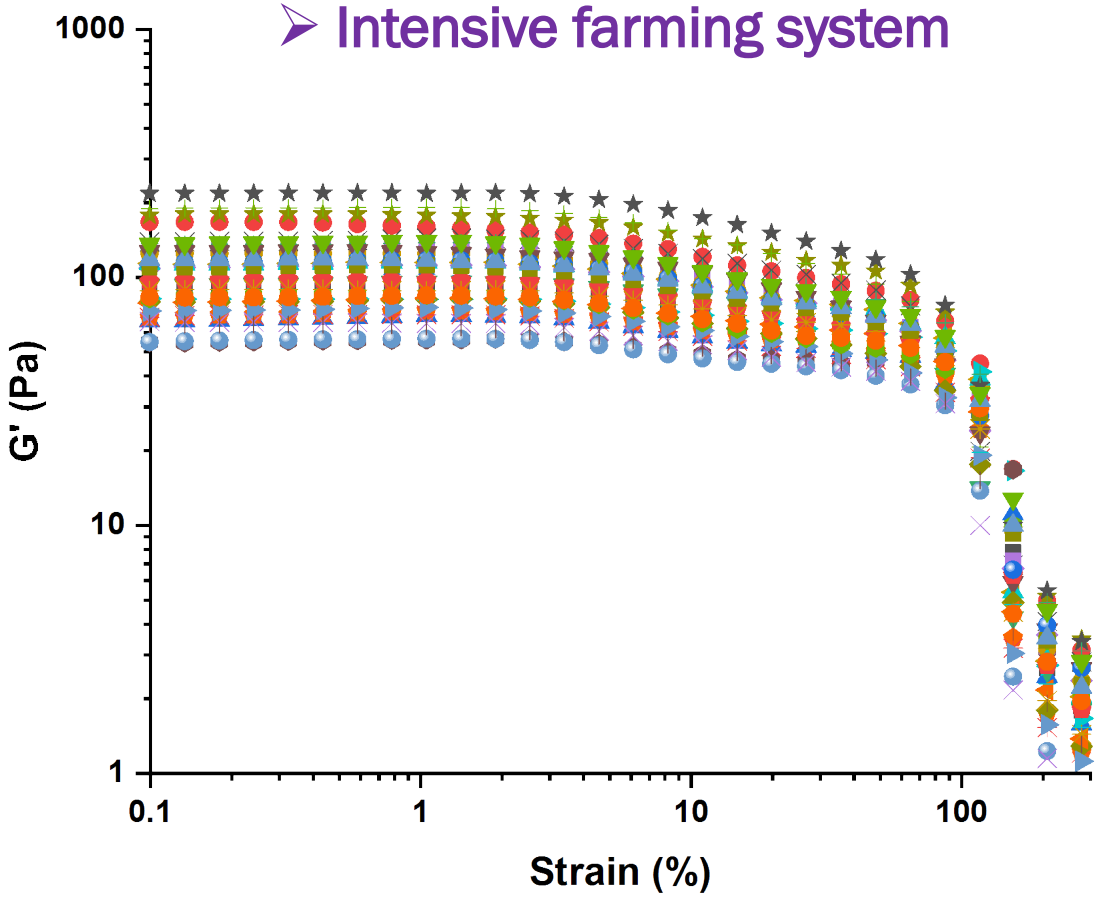
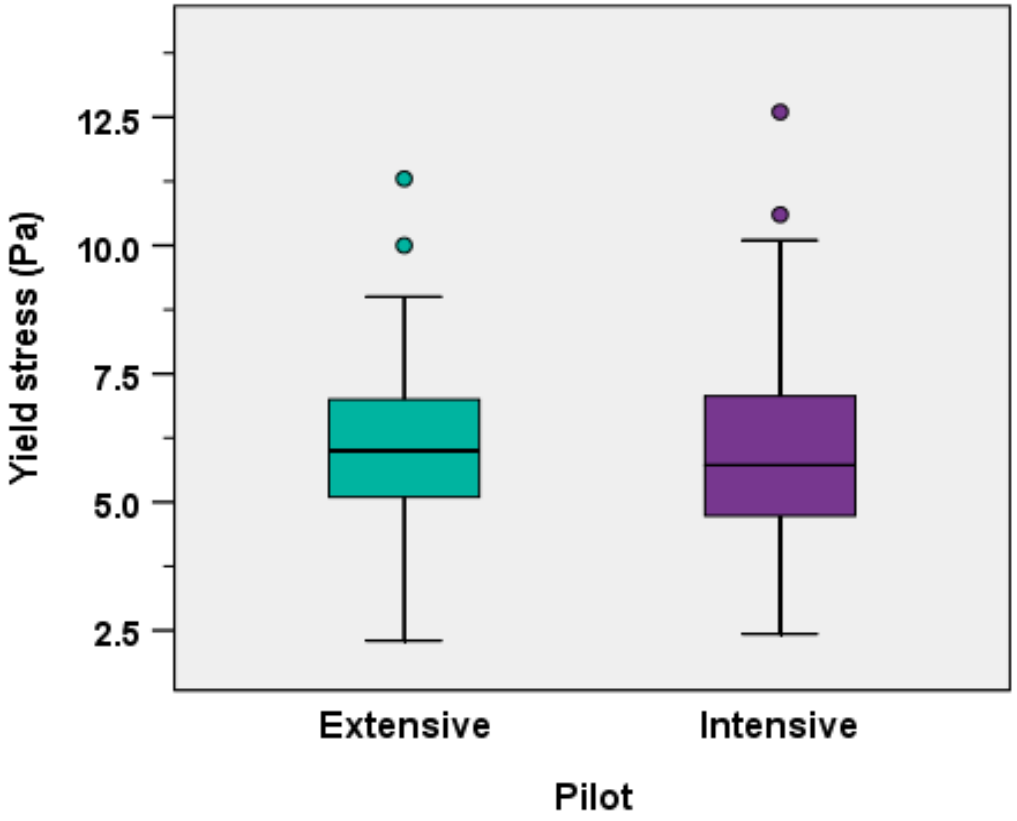


Results

Amplitude sweep - analysis



	Extensive	Intensive
Yield stress (Pa)	6.1 [a]	6.1 [a]

Conclusions

		Extensive farming system		Intensive farming system
Gelation kinetics	Gelation time (min)		>	
	Time $_{G'=20Pa}$ (min)		=	
	G' $_{35°C,48min}$ (Pa)		=	
	Elasticity Increment (min^{-1})		=	
	Time IE (min)		>	
Frequency sweep	Storage modulus (G') (Pa)		>	
	Loss modulus (G'') (Pa)		>	
	Loss tangent (tanδ)		>	
	Complex viscosity (η*) (Pa.s)		>	
Amplitude sweep	Yield stress (Pa)		=	

The rheological evaluation of rennet-induced curdling of goat milks obtained by an extensive and an intensive farming system:

- ✓ milks obtained from the extensive farming system **exhibited a longer gelation time** and **their curds were characterized by stronger gel network structures**, as shown by the gelation kinetic profiles and the frequency sweep tests
- ✓ the yield stress of the curds was not influenced by the farming system, as shown by the amplitude sweep test.

Conclusions

- ✓ The observed differences in the rheological behavior **may be ascribed to differences in the composition (chemical composition and/or microbial load) and/or structural characteristics of the protein components** (e.g. casein fractions) between the two groups of samples.
- ✓ Examination of more samples will provide us more information on the nature of such variability in the gelation kinetics.

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The rheological findings make an interesting contribution to the fields of animal science and cheesemaking by **demonstrating how goat husbandry practices** could affect the mechanical properties of rennet-coagulated cheese products, which can have an impact on the cheese yield and end-product quality.

code: re-farm

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Thank you for your attention!

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