Designing Hybrid Dairy: Fermentation Performance and Gel Structure with Plant Protein

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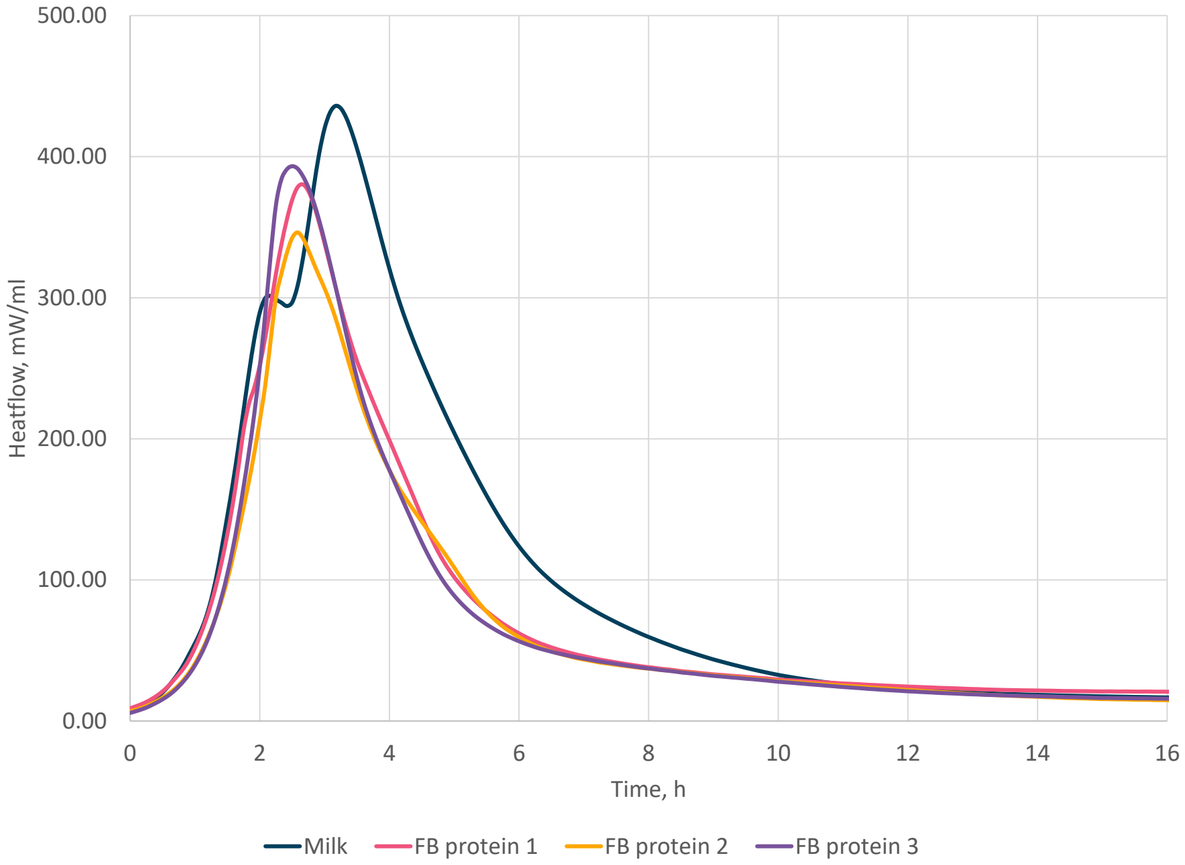
Established in 2004 | Located in Tallinn, ESTONIA

Fermentation

Screening of proteins in hybrid combinations

SOURCE	TYPE	DISPERSION	TEXTURE	SENSORY PROFILE
FABA	ISOLATE	SEDIMENT	WEAK	PUNGENT, SWEATY, CHEESY, POWDERY
FABA	ISOLATE	NO SEDIMENT	WEAK	FRUITY, ASTRINGENT
FABA	ISOLATE	NO SEDIMENT	VERY WEAK	OFF-NOTES, ASTRINGENT, SOUR, POWDERY
FABA	ISOLATE	SEDIMENT	GOOD	ASTRINGENT, WOODY, NUTTY, POWDERY
FABA	ISOLATE	SEDIMENT	WEAK	INTENSE VEGETABLE, EARTHY
FABA	ISOLATE	NO SEDIMENT	GOOD	ASTRINGENT, NEUTRAL
FABA	ISOLATE	NO SEDIMENT	GOOD	ASTRINGENT, NUTTY, SOUR
SOY	ISOLATE	-	-	FRUITY, CITRUS, POWDERY, VEGETABLE, PUNGENT
SOY	ISOLATE	-	-	CITRUS, ASTRINGENT, PUNGENT, CHEESY
SOY	ISOLATE	-	-	VEGETABLE, POWDERY, WOODY
PEA	ISOLATE	NO SEDIMENT	GOOD	PEA, POWDERY, ASTRINGENT
PEA	ISOLATE	SEDIMENT	GOOD	RHUBARB, FRUITY
PEA	ISOLATE	NO SEDIMENT	GOOD	ASTRINGENT, NUTTY, CITRUS
PEA	ISOLATE	NO SEDIMENT	VERY WEAK	PEA, ASTRINGENT, GREEN, VEGETABLE
MUNGBEAN	ISOLATE	NO SEDIMENT	GOOD	FRUITY, CITRUS, VEGETABLE, BEANY, GREEN
CHICKPEA	CONCENTRATE	SEDIMENT	WEAK	POWDERY, FLOURY, BITTER, ASTRINGENT
RICE	ISOLATE	SEDIMENT	WEAK	RICE, ASTRINGENT, POWDERY, CHALKY

Addition of adjunct culture for flavor development



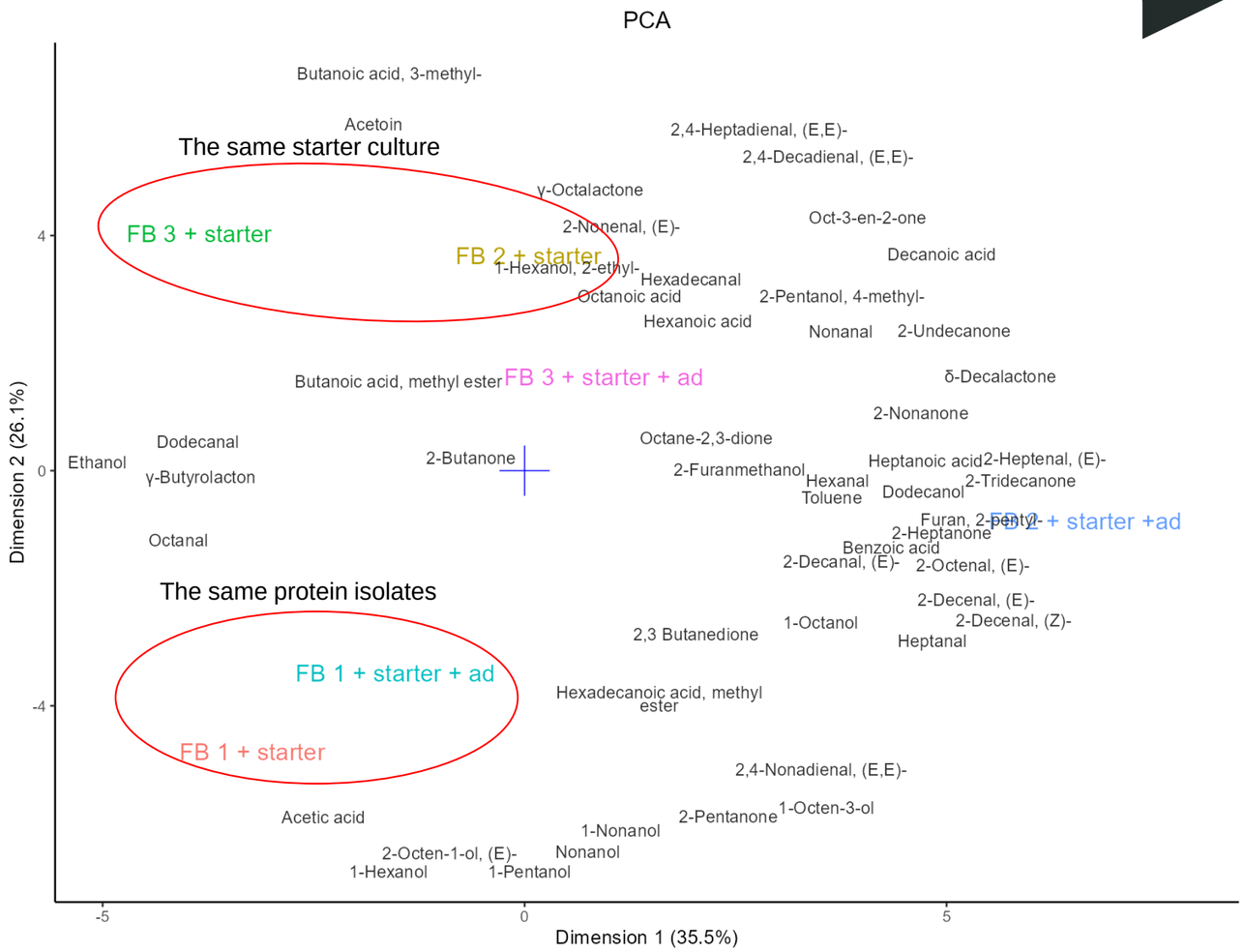
✓Reduced beany notes

✓Introducing creamy, dairy-like notes

Volatile profiles

	Diacetyl content, ppb		
	FB protein 1	FB protein 2	FB protein 3
Starter culture	547	608	615
Starter culture + adjunct	917	786	639
Increase	**67%**	**29%**	**4%**

	Green aldehydes, ppb		
	FB protein 1	FB protein 2	FB protein 3
Starter culture	216	483	305
Starter culture + adjunct	215	508	345
Reduction/Increase	**-0.4%**	**+5%**	**+13%**



Hybrid cheese technologies

Gouda-type cheese production

Plant protein: mixing with water, sterilization

Adjustment of pH

Milk pasteurization → Addition of starter culture and rennet → Cutting the curd, stirring, heating → Whey separation, forming, pressing → Salting → Maturation

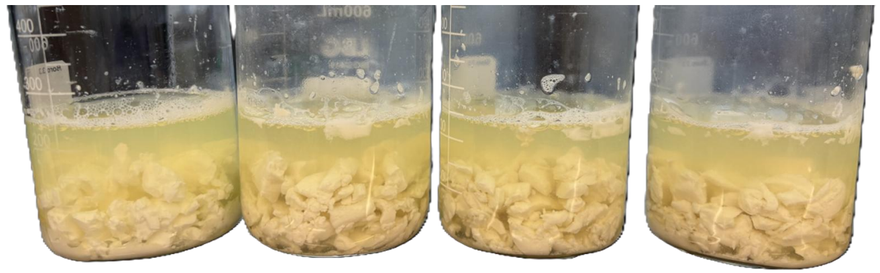
Screening plant proteins for network formation

Plant proteins and casein network:

1) Integrate into the network
2) Act as a filler
3) Disrupt the network

Key selection criteria:

1) Dispersion behavior (no sediments)
2) Gelling ability (strong gel in combination with milk)



PROTEIN SOURCE	PROTEIN TYPE	DISPERSION	GELLING
FABA	ISOLATE	NO SEDIMENT	STRONG GEL
FABA	ISOLATE	NO SEDIMENT	STRONG GEL
FABA	ISOLATE	SEDIMENT	WEAK GEL
FABA	ISOLATE	SEDIMENT	WEAK GEL
FABA	ISOLATE	SEDIMENT	WEAK GEL
PEA	ISOLATE	SEDIMENT	WEAK GEL
PEA	ISOLATE	SEDIMENT	WEAK GEL
POTATO	ISOLATE	NO SEDIMENT	WEAK GEL
CHICKPEA	CONCENTRATE	NO SEDIMENT	WEAK GEL
MUNGBEAN	ISOLATE	SEDIMENT	WEAK GEL
RICE	ISOLATE	SEDIMENT	WEAK GEL
SOY	ISOLATE	SEDIMENT	WEAK GEL

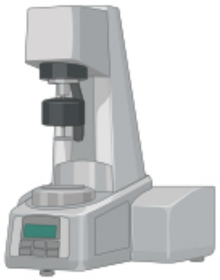
Rheological experiments

SOLUTION MIXING

pH ADJUSTMENT

RENNET ADDITION AND MIXING

RHEOLOGY

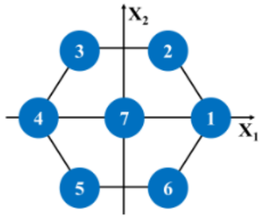


DOEHLERT DESIGN

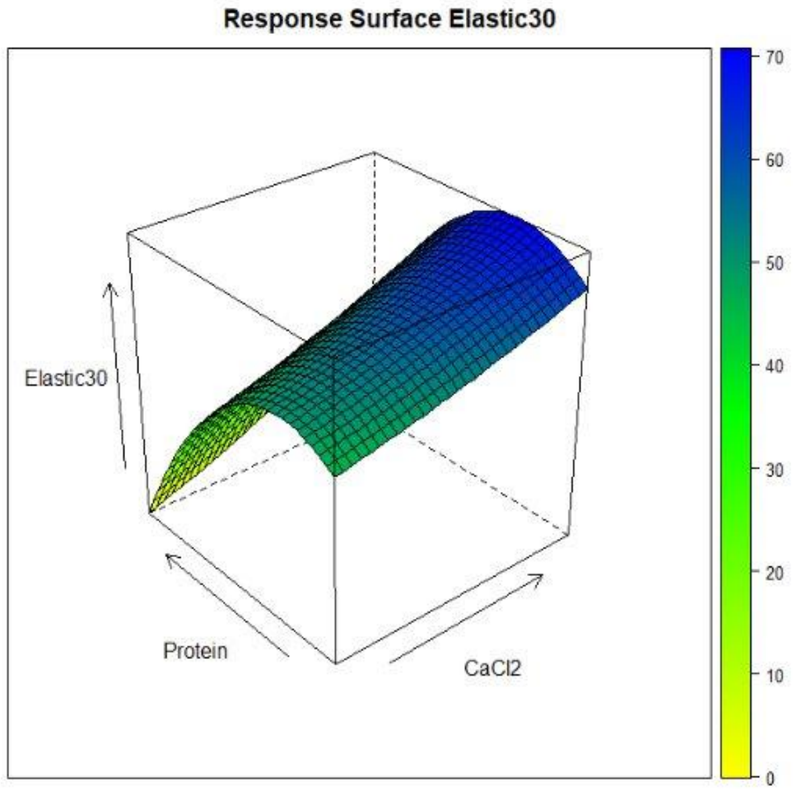
It studies **k** factors, each at a different number of **equally spaced** levels, with a number of experiments equal to $\mathbf{k^2 + k + n}$

With k=2, the experimental matrix is the following:

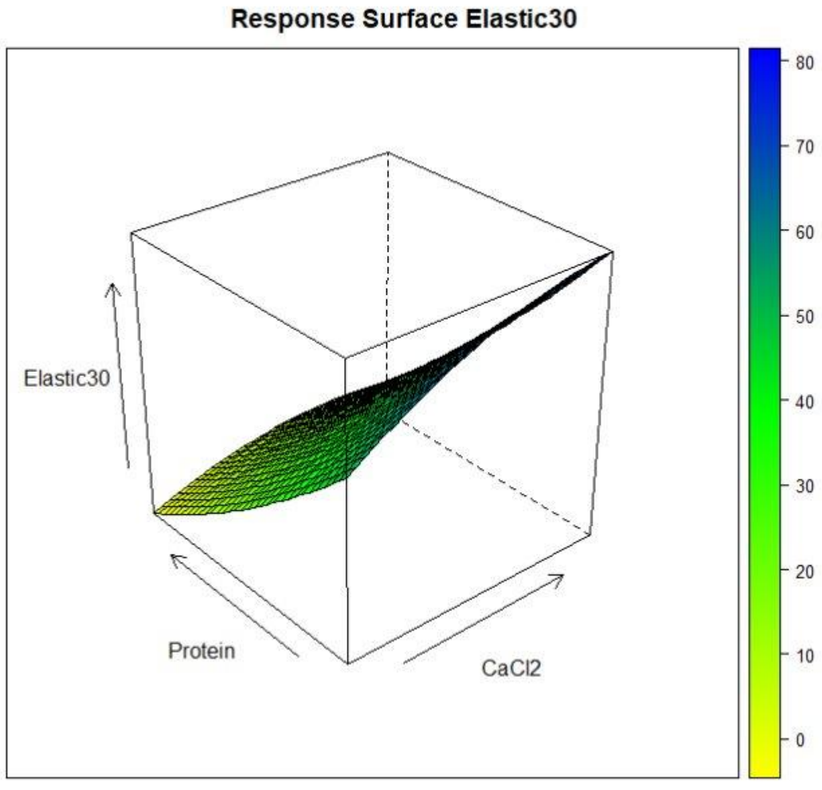
	X1	X2
1	1	0
2	0.5	0.867
3	-0.5	0.867
4	-1	0
5	-0.5	-0.867
6	0.5	-0.867
7 (n)	0	0



Predictive model for elastic modulus



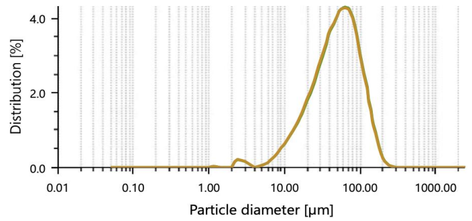
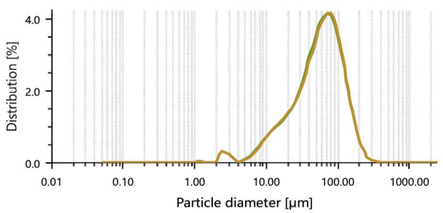
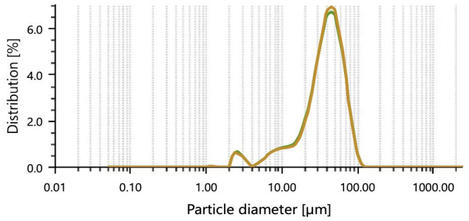
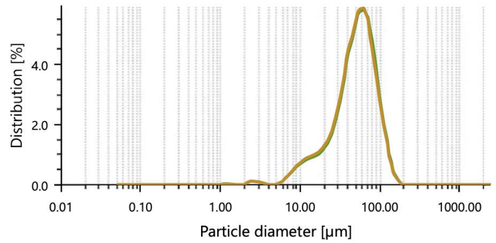
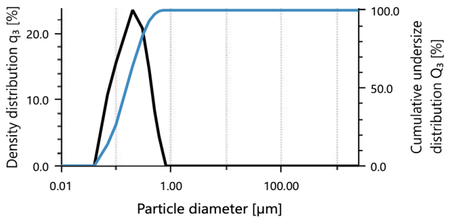
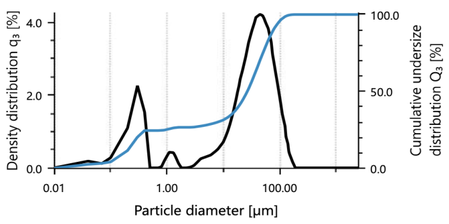
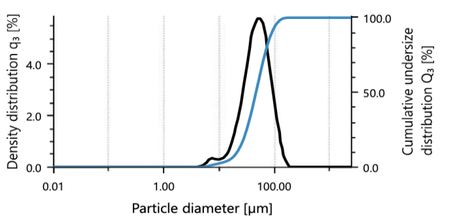
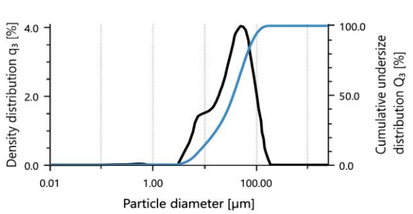
- Increase of elastic modulus with the increase in added $CaCl_2$
- Up to 19% plant protein inclusion increase of elastic modulus observed



- Increase of elastic modulus with the increase in CaCl2
- Decrease of the elastic modulus with plant protein addition

Particle size distribution

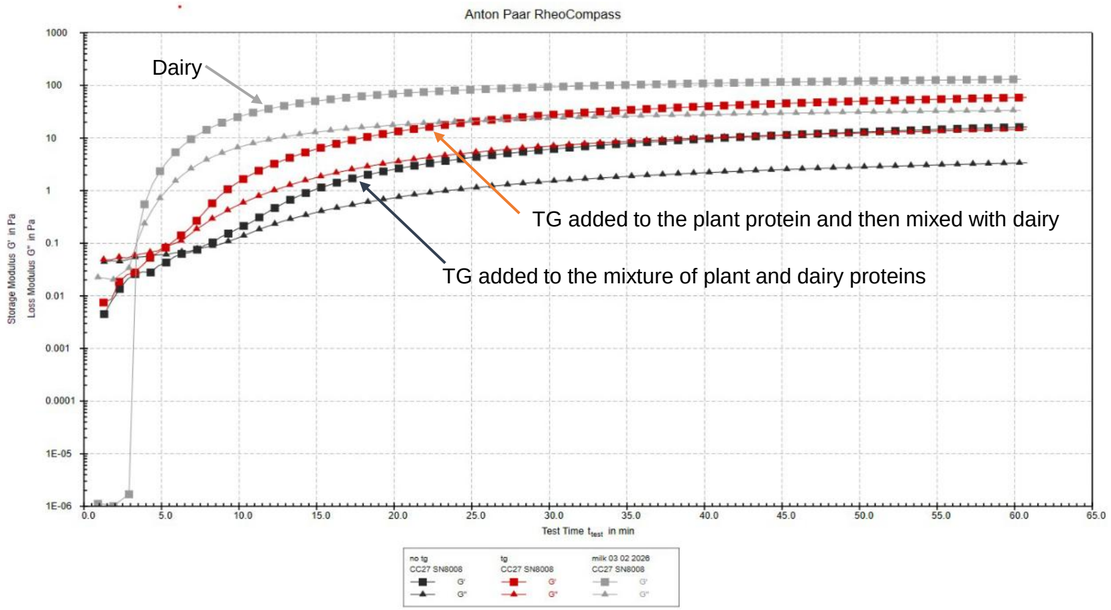
PARTICLE SIZE ANALYSIS

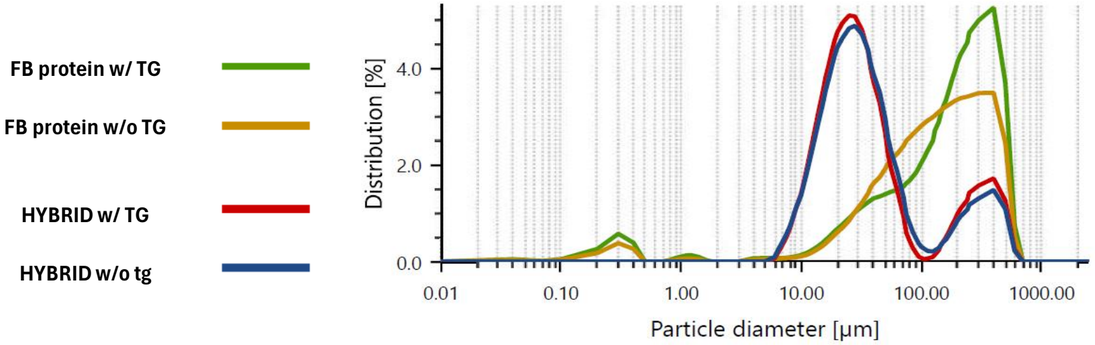
	LHSMP	Faba bean protein 1	Faba bean protein 2	Faba bean protein 3
DRY				
WET				

The compatibility of plant proteins within the dairy matrix is strongly governed by colloidal properties such as particle size and zeta potential, which determine dispersion stability and aggregation behavior during acidification and coagulation.

PROTEIN POWDER	D50 WET	D50 DRY
LHSMP	0.2318	48.325
Faba bean isolate 1	26.647	55.482
Faba bean isolate 2	46.849	37.316
Faba bean isolate 3	35.857	49.648

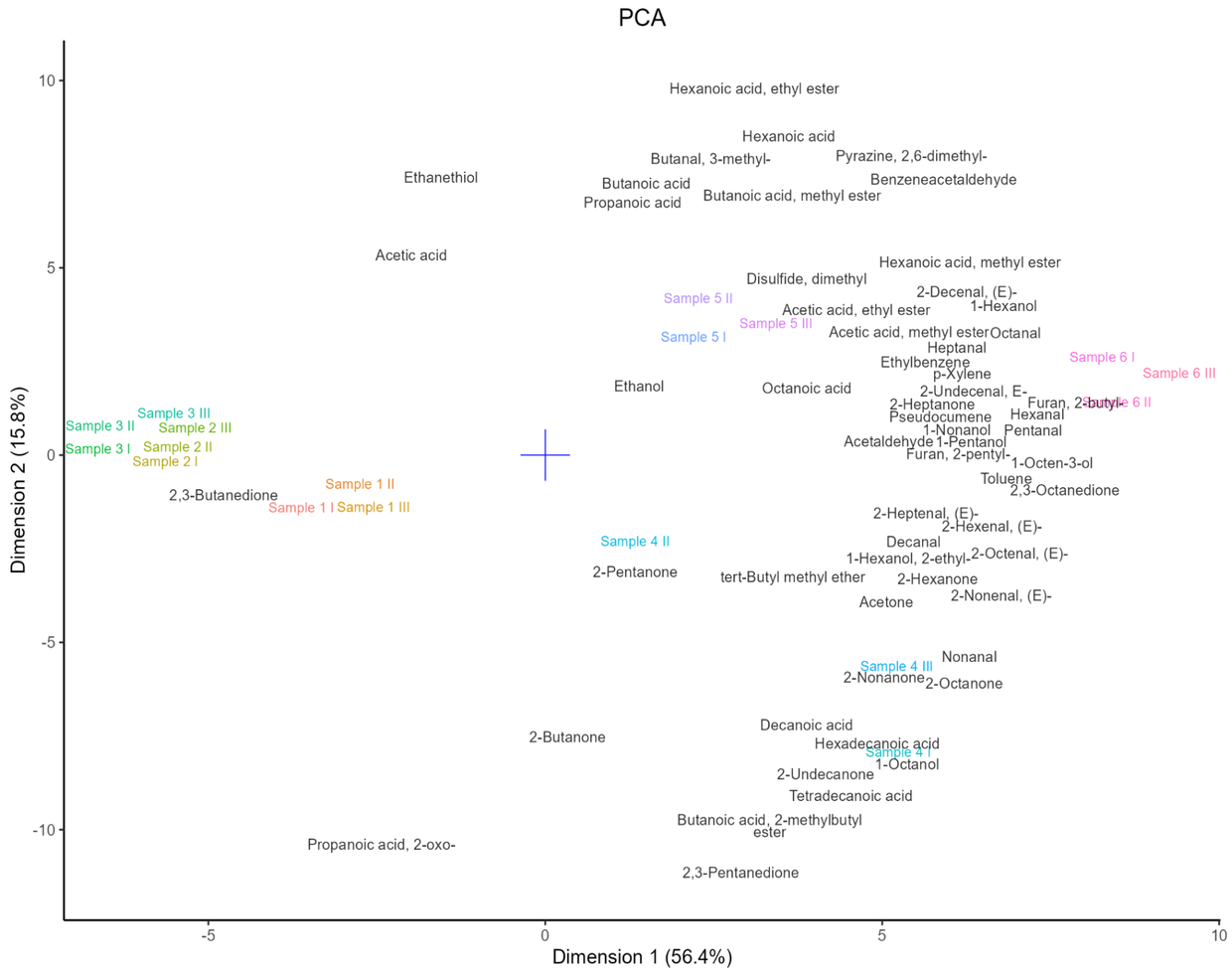
Transglutaminase (TG) addition





TG addition showed positive result on gel strength when treated before mixing with dairy proteins

Pilot productions of 20% FB protein hybrid cheese



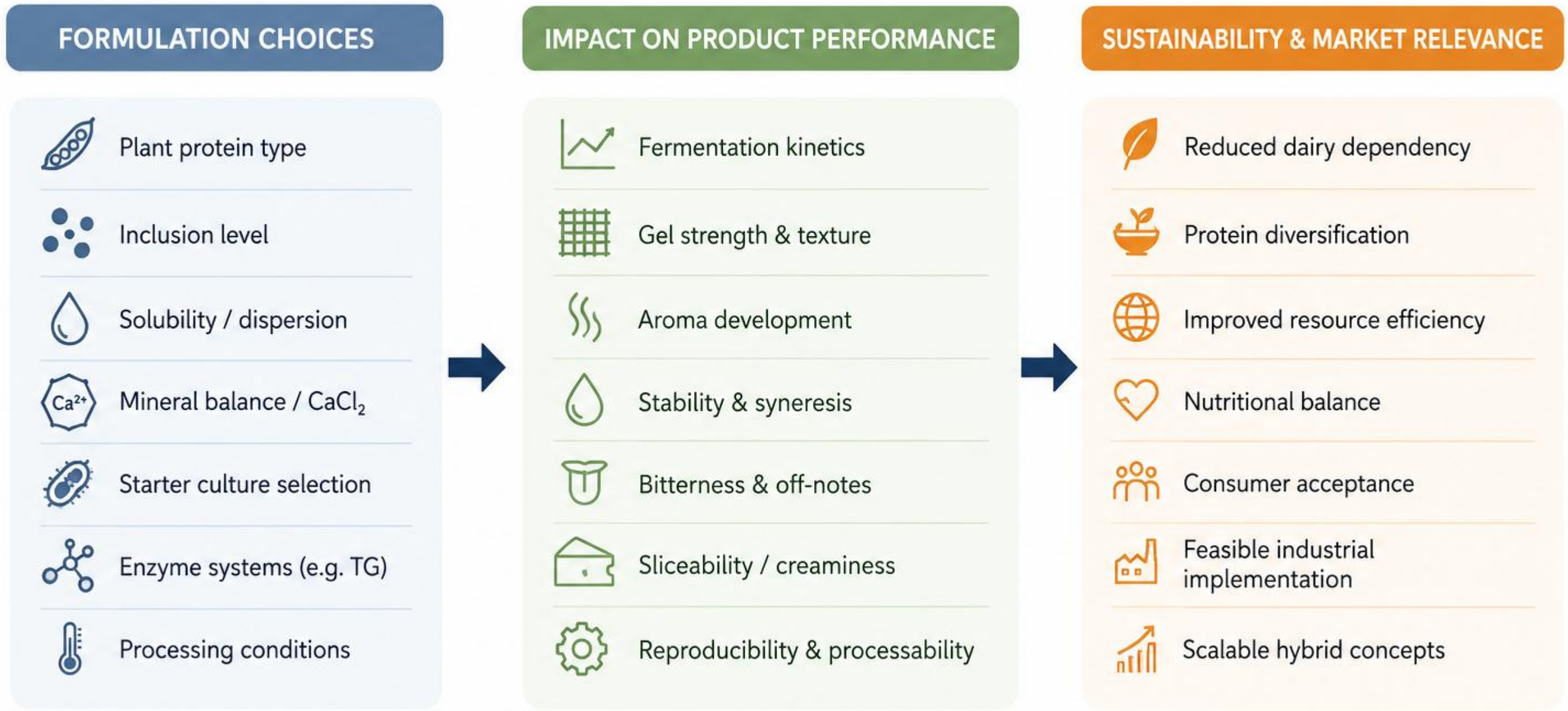
Samples 1, 2, 3 – *L. lactis, L. cremoris, Str. Thermophilus + Lactobacillus helveticus, Lacticaseibacillus casei*

- ✓ Less volatiles
- ✓ Milder bitterness
- ✓ More free amino acids

Samples 4, 5, 6 – *L. lactis, L. cremoris, Str. thermophilus*

- ✓ Higher variation for volatiles in time from 0 to 2 months
- ✓ More bitterness
- ✓ More plant-based notes

From formulation to product performance and market relevance!



Key takeaways!

- ✓ Hybrid dairy systems are fundamentally driven by **protein interactions and colloidal behavior**
- ✓ Plant proteins with the same botanical origin can behave very differently in fermentation and gelation systems
- ✓ Successful hybrid textures require not only gelling ability, but also **good solubility and compatibility with the dairy matrix**
- ✓ Moderate plant protein inclusion can create **synergistic effects on gel structure and functionality**
- ✓ Designing successful hybrid dairy products requires balancing:
  - functionality
  - sensory quality
  - and sustainability

Thank You!

Visit our booth D5
for tasting!

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