Positive interactions between lactic acid bacteria:A must-have to develop new fermented foods

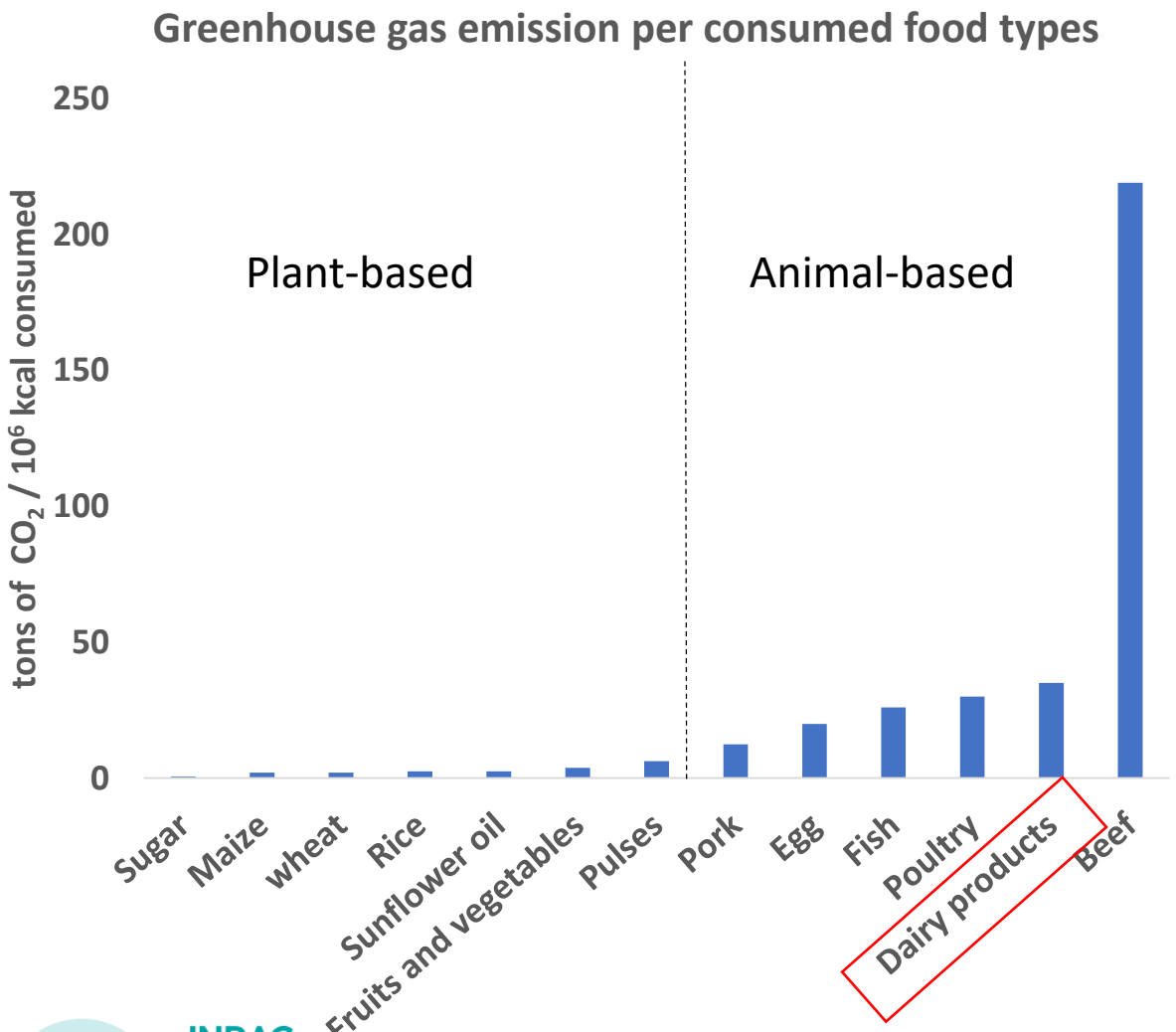
Fanny Canon, Anne Thierry, Valérie Gagnaire

Positive interactions between lactic acid bacteria: A must-have to develop new fermented foods

Fanny Canon, Anne Thierry, and Valérie Gagnaire

INRAE, Institut Agro, STLO, Rennes, France

Food transition context



- Food: responsible for one third of the greenhouse gas emission worldwide
- Necessity to decrease the proportion of animal-based food, notably proteins, in the diet to 50 % (French health and nutrition program *PNNS4 2019-2023*)
- Compatible with the emerging vegetarian and flexitarian diets: use of dairy products, in combination with plant-based products

100 % plant-based “yogurts” to help food transition, but…

- On the French market, plant–based “yogurts” are made of:
  - Soy milk
  - Almond milk
  - Coconut milk

Nutritional value

- Proteins ↘
- Vitamins ↘
- Ca^{2+} ↘
- KCAL ↗
- Phytic acid ↗

Sensory profile

- Hexanal ↗
- Texture ↘

Digestion

- GOS (raffinose, stachyose) ↗

⛔

Tangyu et al., 2019
Boek et al, 2021

Mixed dairy- and plant-based “yogurts” » : beneficial in-between

Trends in Food Science & Technology 108 (2021) 119–132

Contents lists available at ScienceDirect

Trends in Food Science & Technology

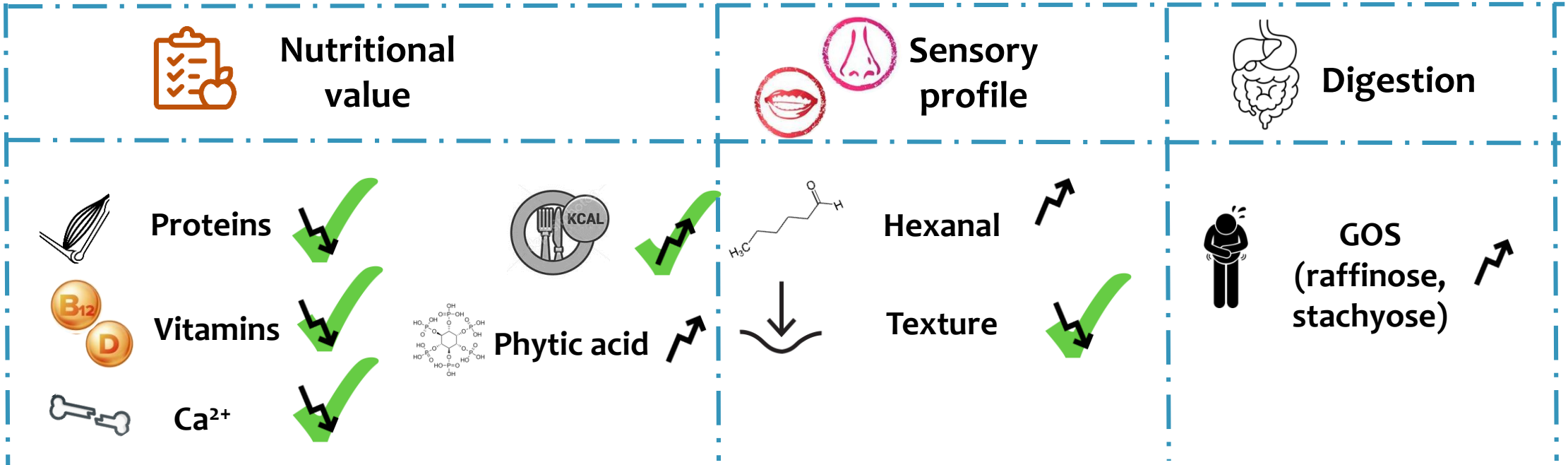
journal homepage: www.elsevier.com/locate/tifs

Mixing milk, egg and plant resources to obtain safe and tasty foods with environmental and health benefits

Fanny Guyomarc'h[a], Gaëlle Arvisenet[b], Saïd Bouhallab[a], Fanny Canon[a], Stephanie-Marie Deutsch[a], Valentin Drigon[b], Didier Dupont[a], Marie-Hélène Famelart[a], Gilles Garric[a], Eric Guédon[a], Thibaut Guyot[a], Manon Hiolle[a], Gwénaël Jan[a], Yves Le Loir[a], Valerie Lechevalier[a], Françoise Nau[a], Stéphane Pezennec[a], Anne Thierry[a], Florence Valence[a], Valérie Gagnaire[a,*]

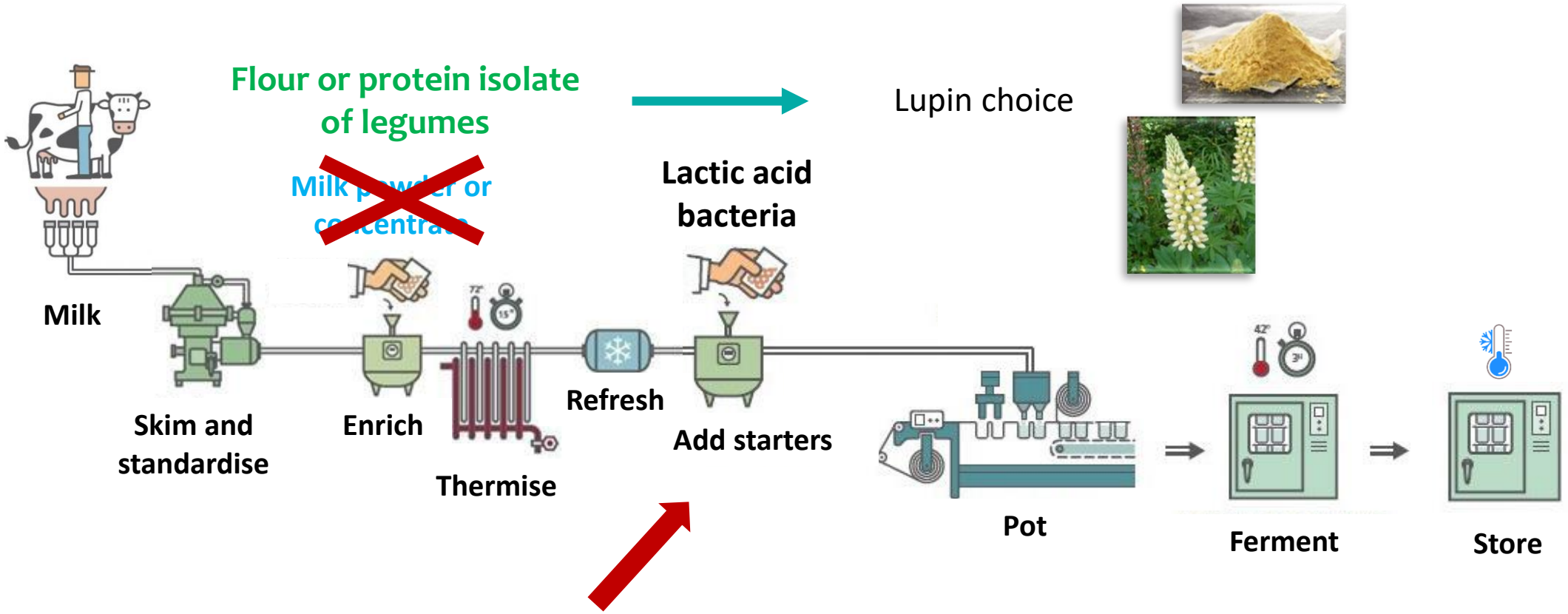
[a] INRAE, Institut Agro, STLO, F-35000 Rennes, France
[b] AgroSup Dijon, CNRS, INRAE, Université Bourgogne Franche-Comté, CSGA, F-21000, Dijon, France

➢ Association of plants with milk
(*Guyomarc'h et al. 2021*)

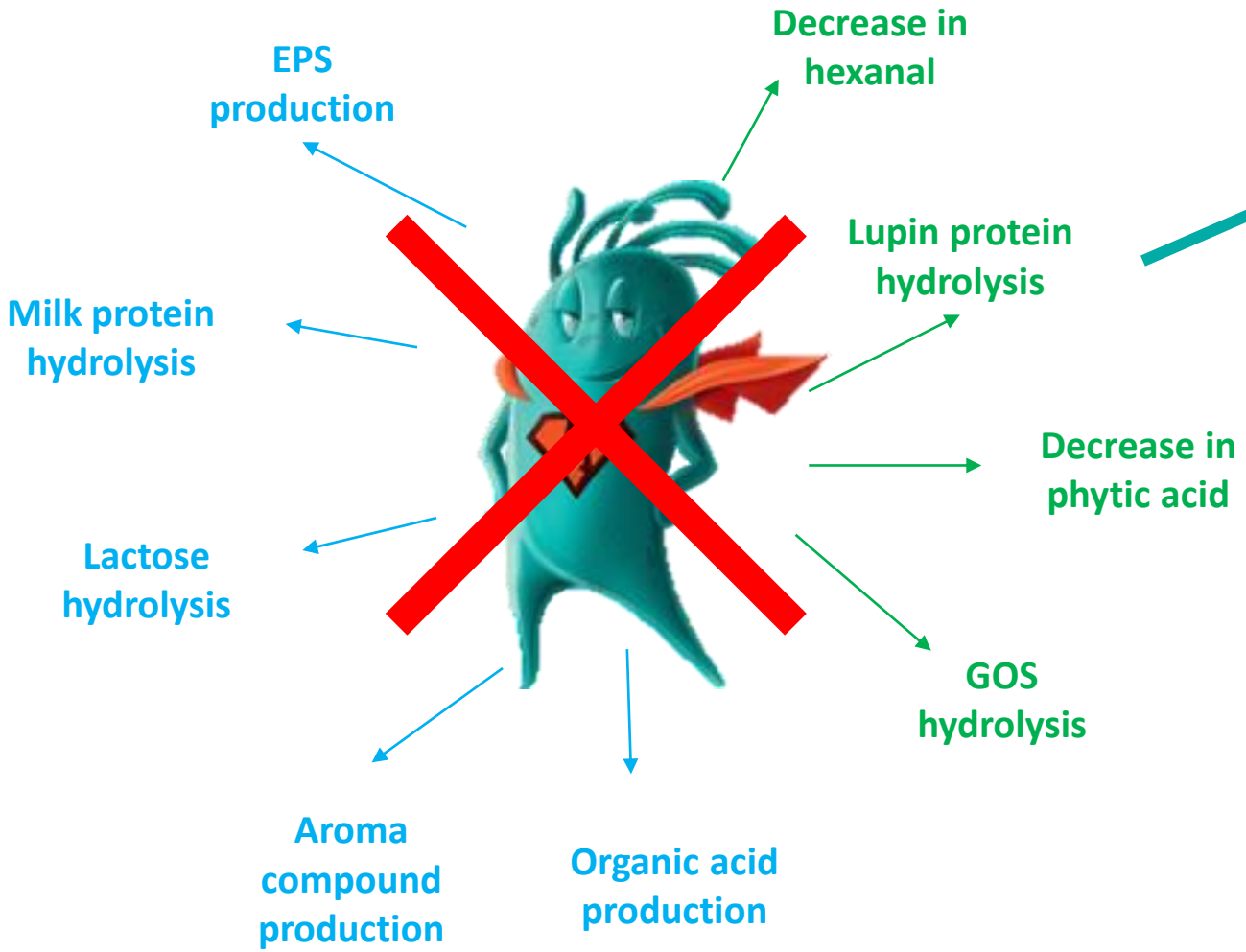


→ Possible to easily insert the plant fraction in the yogurt process

Scheme of yogurt and fermented milk production

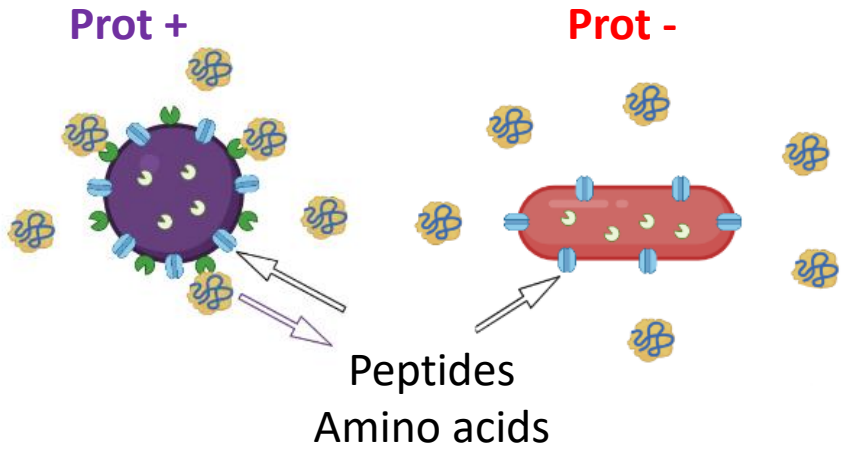


Objective : to add up functionalities of the lactic acid bacteria in fermented mixed plant and dairy based “yogurts”



Association of several strains required

Chosen approach: to favour positive interactions between strains based on their nitrogen metabolism



Canon et al (2021)

Experimental design for mixed milk-lupin yogurt manufacture

Three factors

Levels

Responses

5 starter cultures

Monocultures

- *E. faecalis* (F) — Proteolytic activity: +++
- *L. lactis* (L) — ++
- *L. plantarum* (P) — -

Cocultures

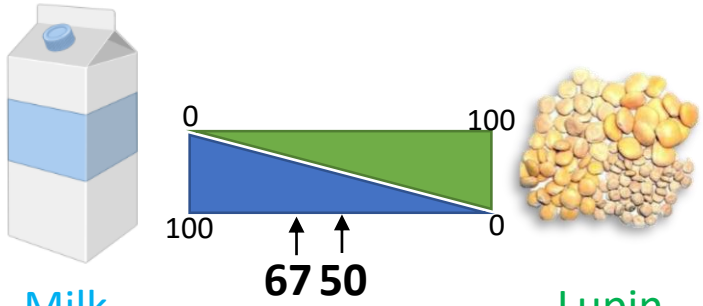
- F x P
- L x P

2 fat types

Milk fat (1,5 %)

Coconut oil (1,5 %)

2 milk/lupin protein ratios



[total proteins]=6.6%

Responses

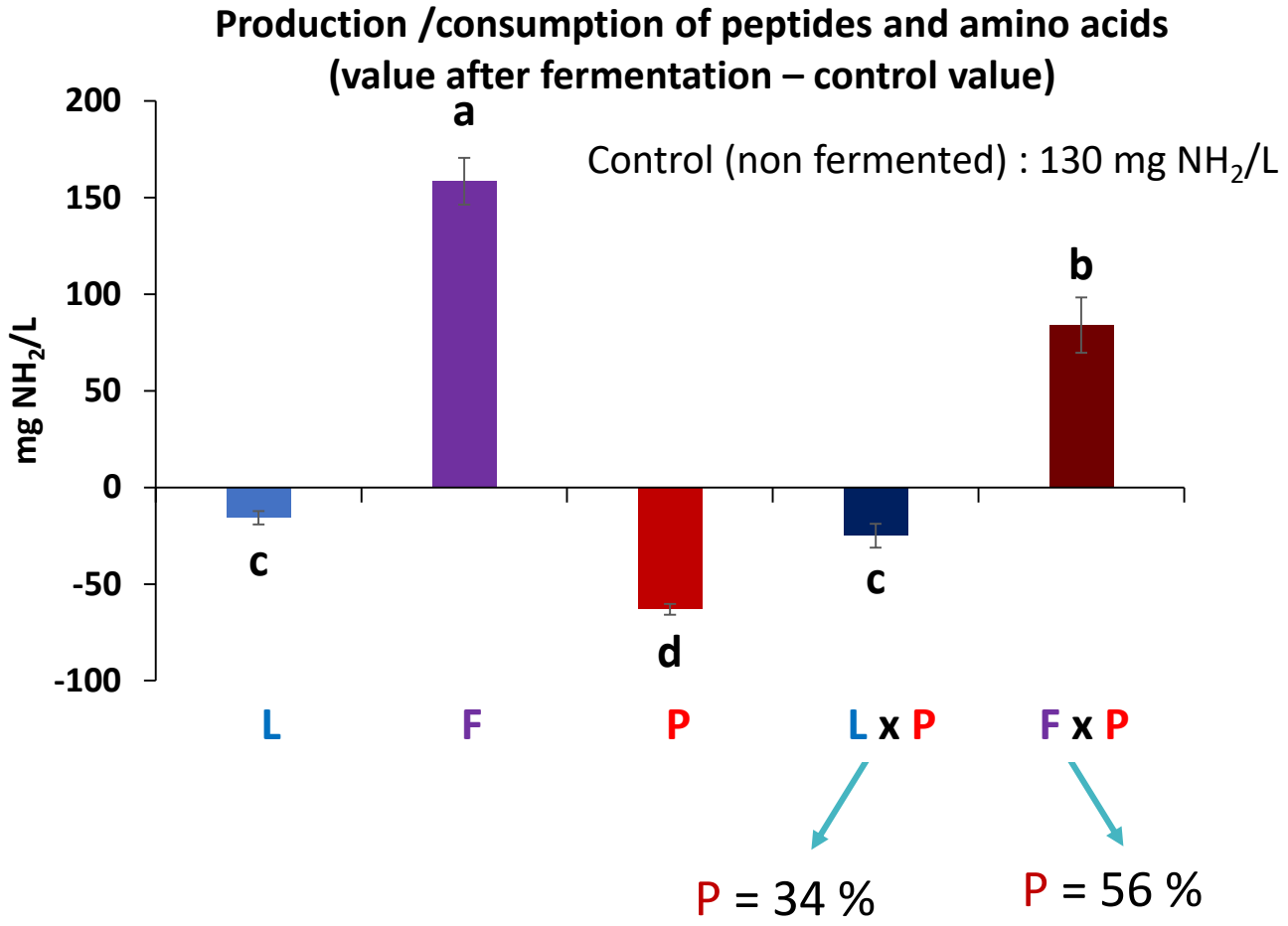
- Bacterial growth
- Acidification
- Proteolysis
- Volatile compounds and organic acid determination
- Physical Properties
  - Firmness
  - Viscosity
  - Water holding capacity (WHC)
- Sensory analyses on L and L x P yogurts

Positive *Canon et al* (2022) in revision in *Current Research in Food Science*

Growth and proteolytic activity of starter cultures in the milk-lupin yogurts

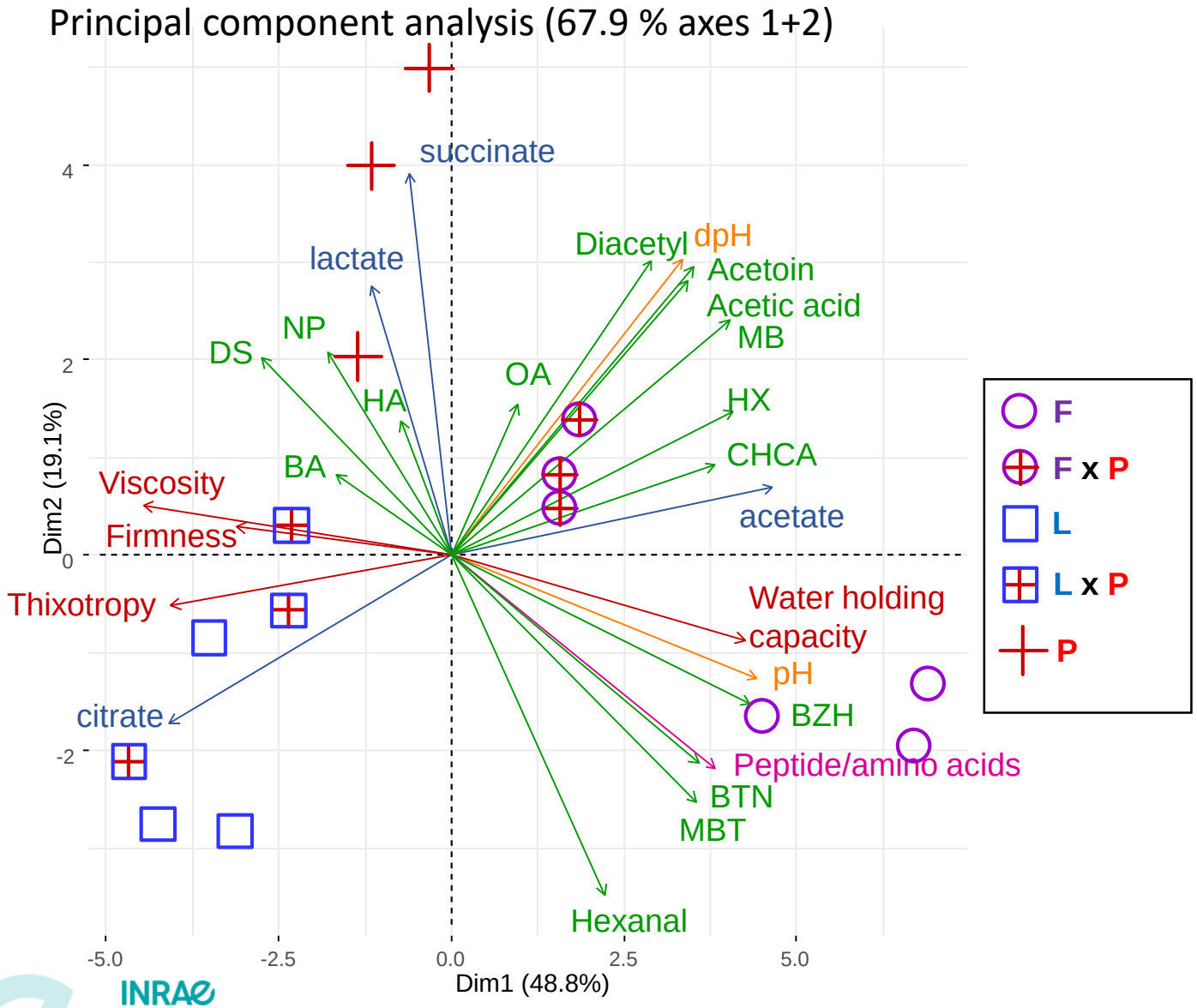
Cultures	Final pH	Time (h)
L and L x P	4.7	7
F	4.9	12
P and F x P	4.7	12

Total starter counts >10^9 cfu/g yogurt



- F : high proteolysis and high population of P in coculture ⇨ positive interaction favoured

Impact of cocultures on the functionalities of the milk-lupin yogurts



Proteolysis

Physical properties

Organic acids

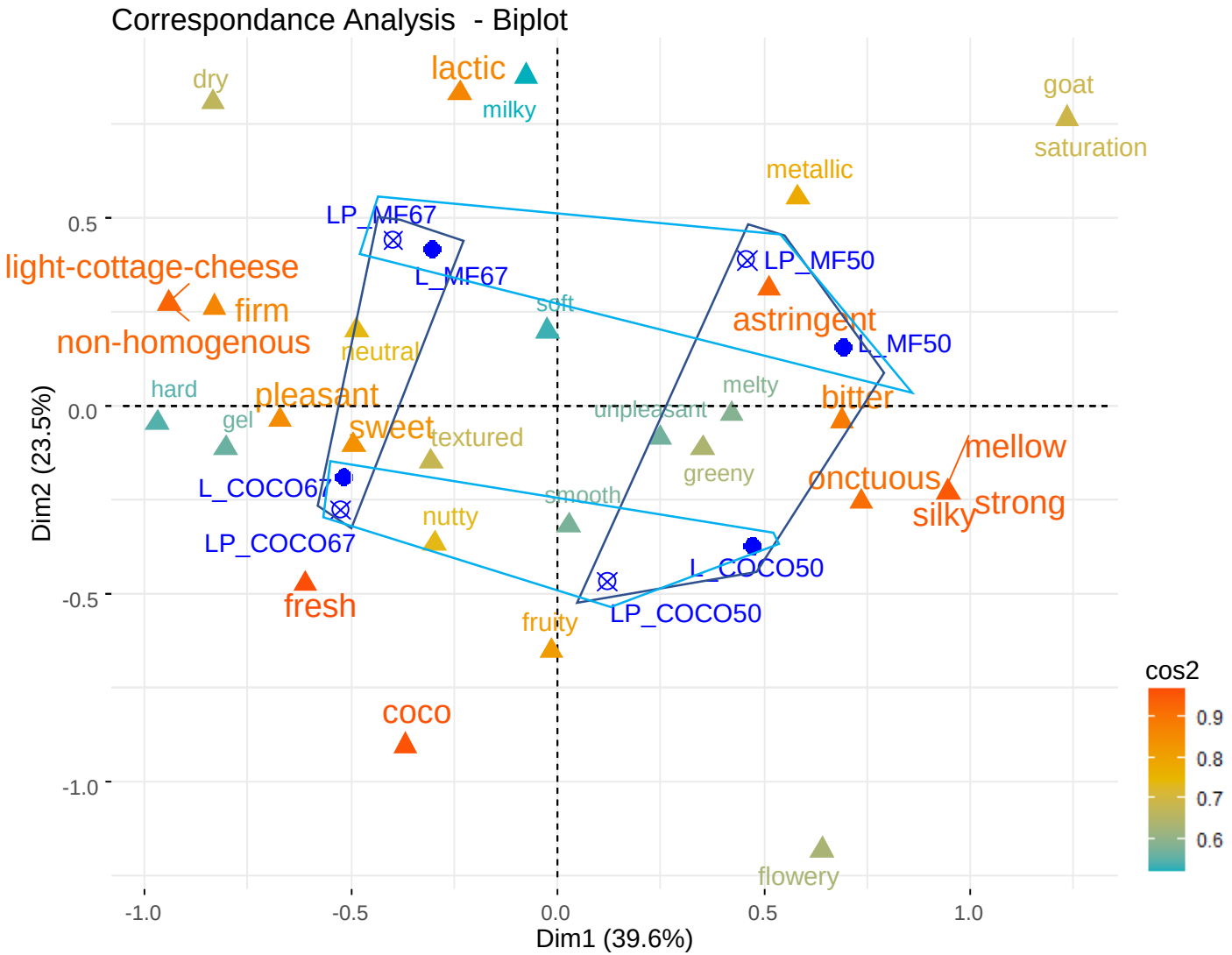
Acidification

Volatile compounds

BA: Butanoic acid
BTN: 2-Butanone
BZH: Benzaldehyde
CHCA: Cyclohexanecarboxylic acid
DS: Dimethyl sulfone
HA: Hexanoic acid
HX: 1-Hexanol
MB: 3-Methyl-1-butanol
MBT: 3-Methylbutanal
NP: 2-Nitroethyl propionate
OA: Octanoic acid

- F x P : between the two monocultures
- L et L x P : indistinguishable, no effect of the coculture

Sensory analyses (sorting task) also driven by the composition when L and L x P cultures are used



- **Milk/lupin protein ratio** differentiated on the 1st axis
  - ratio 50: unpleasant, bitter and with a mellow texture
  - ratio 67: pleasant, textured (hard gel) and nonhomogeneous

- **Fat type** differentiated on the 2nd axis
  - Milk fat: milky, lactic and “goaty”
  - coco as fruity, fresh and nutty

Untrained panellists

Take home message

- **Milk/plant protein ratio:**

  < 50 % of plant protein : higher firmness, more appreciated by panellists

- **Fat type:**

  coco associated with lower firmness, sensorially detected

- **Starter cultures**:
  - impact on pH and proteolysis and hence physical properties
  - more functionalities expressed in yogurt when there are interactions between strains

  as observed in the coculture F x P in which the proteolytic strain stimulated the non proteolytic strain

  Higher firmness and viscosity, higher diversity of organic acids and volatile compounds and higher decrease in hexanal

- **Mixed dairy-plant-based yogurt: good start for the diet transition** as it softly gets consumers acquainted with the unfamiliar properties of plant-based yogurts

Further readings and thanks for your attention…

fanny.canon@agrosupdijon.fr

anne.thierry@inrae.fr

valerie.gagnaire@inrae.fr

frontiers in Microbiology

2020

REVIEW
published: 04 September 2020
doi: 10.3389/fmicb.2020.02088

Understanding the Mechanisms of Positive Microbial Interactions That Benefit Lactic Acid Bacteria Co-cultures

*Fanny Canon[1], Thibault Nidelet[2], Eric Guédon[1], Anne Thierry[1] and Valérie Gagnaire[1]**

[1] STLO, INRAE, Institut Agro, Rennes, France, [2] SPO, INRAE, Montpellier SupAgro, Université de Montpellier, Montpellier, France

frontiers in Microbiology

2022

ORIGINAL RESEARCH
published: 11 January 2022
doi: 10.3389/fmicb.2021.793136

Positive Interactions Between Lactic Acid Bacteria Could Be Mediated by Peptides Containing Branched-Chain Amino Acids

*Fanny Canon, Valérie Briard-Bion, Julien Jardin, Anne Thierry and Valérie Gagnaire**

UMR STLO, INRAE, Institut Agro, Rennes, France

AMERICAN SOCIETY FOR MICROBIOLOGY | Applied and Environmental Microbiology®

2021

October 2021 Volume 87 Issue 20 e01055-21

https://doi.org/10.1128/AEM.01055-21

Positive Interactions between Lactic Acid Bacteria Promoted by Nitrogen-Based Nutritional Dependencies

Fanny Canon,[a] Marie-Bernadette Maillard,[a] Gwénaële Henry,[a] Anne Thierry,[a] Valérie Gagnaire[a]

[a]UMR STLO, INRAE, Institut Agro, Rennes, France