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Development of innovative fermented beverages and “yogurt”-type gels with immunomodulatory properties from almond and/or chickpea milk analogues

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28th
International
ICFMH
Conference

FOOD
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2024

TECHNOLOGICAL EVOLUTION
AND REVOLUTION IN FOOD
MICROBIOLOGY

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2024

TECHNOLOGICAL EVOLUTION
AND REVOLUTION IN FOOD
MICROBIOLOGY

Development of innovative fermented
beverages and “yogurt”-type gels with
immunomodulatory properties from almond
and/or chickpea milk analogues



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and Eggs (STLO)

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Growing demand for plant-based fermented products...



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Development of probiotics fermented plant-based products



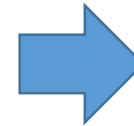
➡ Mediterranean nuts and legumes offer opportunities to diversify fermented products and to gradually move towards a more plant-based diet ➡ almond and chickpea

Fermented almond milk beverages: Design

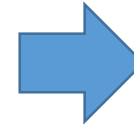


The 23 LAB strains grown on almond milk and tasted in lab → three LAB consortia performed → one consortium chosen:

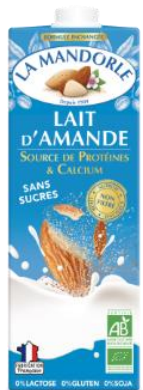
CodePAB	Species	Strain number
LAB consortium	<i>Streptococcus thermophilus</i>	St CIRM-BIA772
	<i>Lactocaseibacillus casei</i>	Lc CIRM-BIA1643
PAB strain	<i>Propionibacterium freudenreichii</i>	Pf CIRM-BIA140



Good acidification with a lactic and fresh note in preliminary test lab



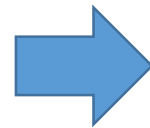
High level of immune properties *in vitro* high IL10/IL12 ratio



± 2.5 %
 sucrose



LAB
 PAB
 strains



Before stirring
 → firm gel with syneresis

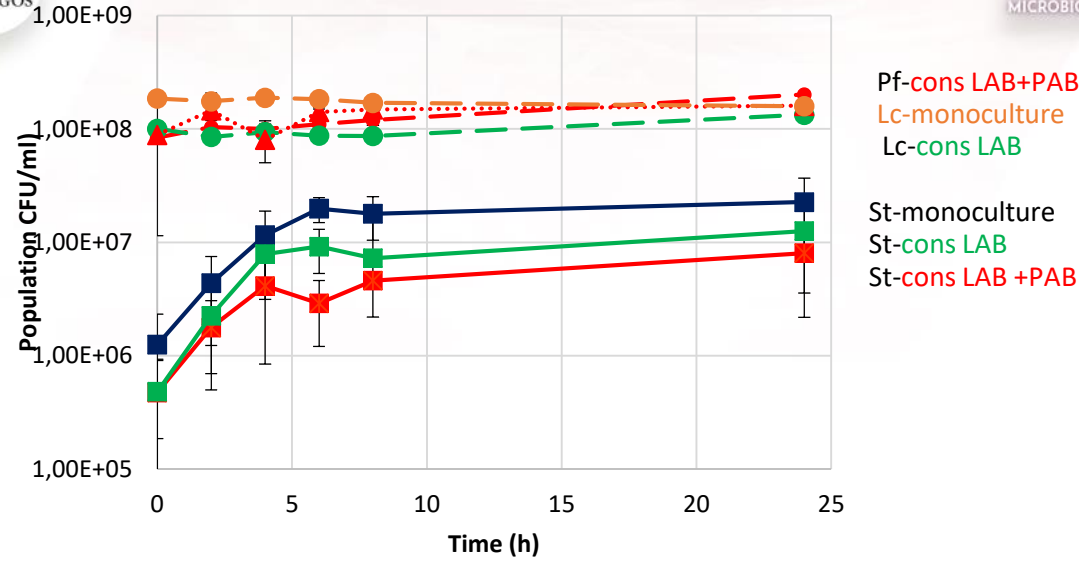


After stirring
 → Smooth beverage

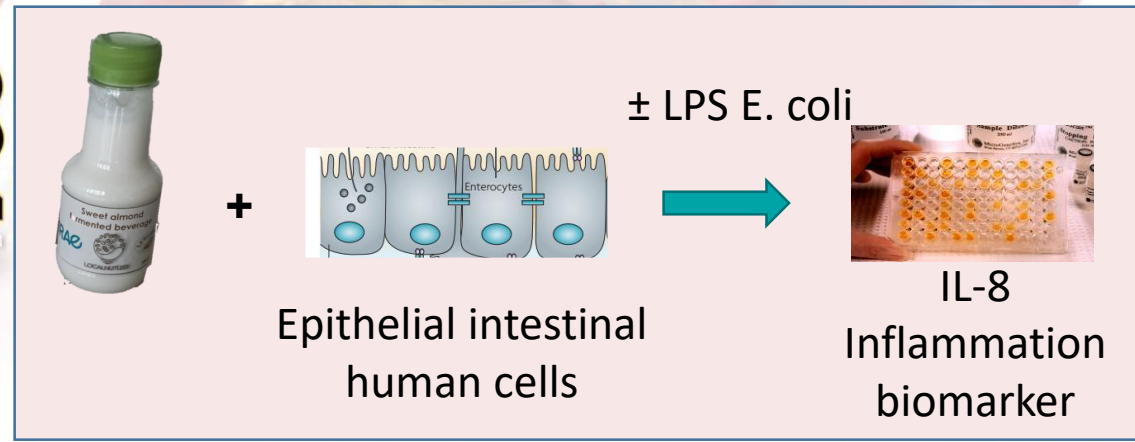
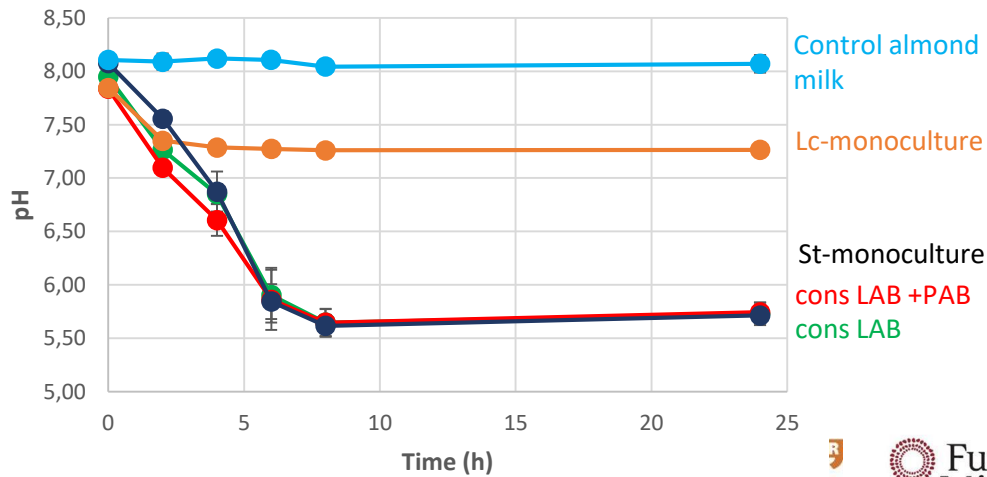
Fermented almond milk beverages: Main characteristics



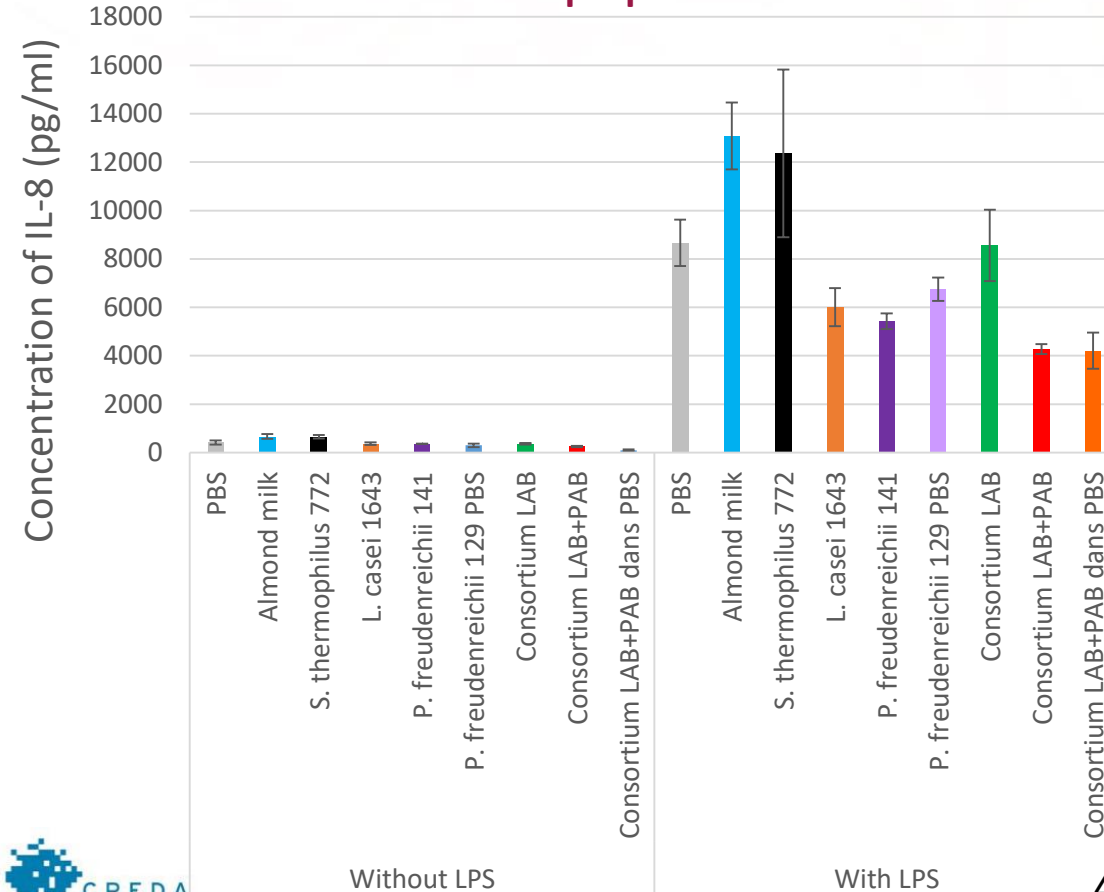
LAB and PAB strain population



Acidification



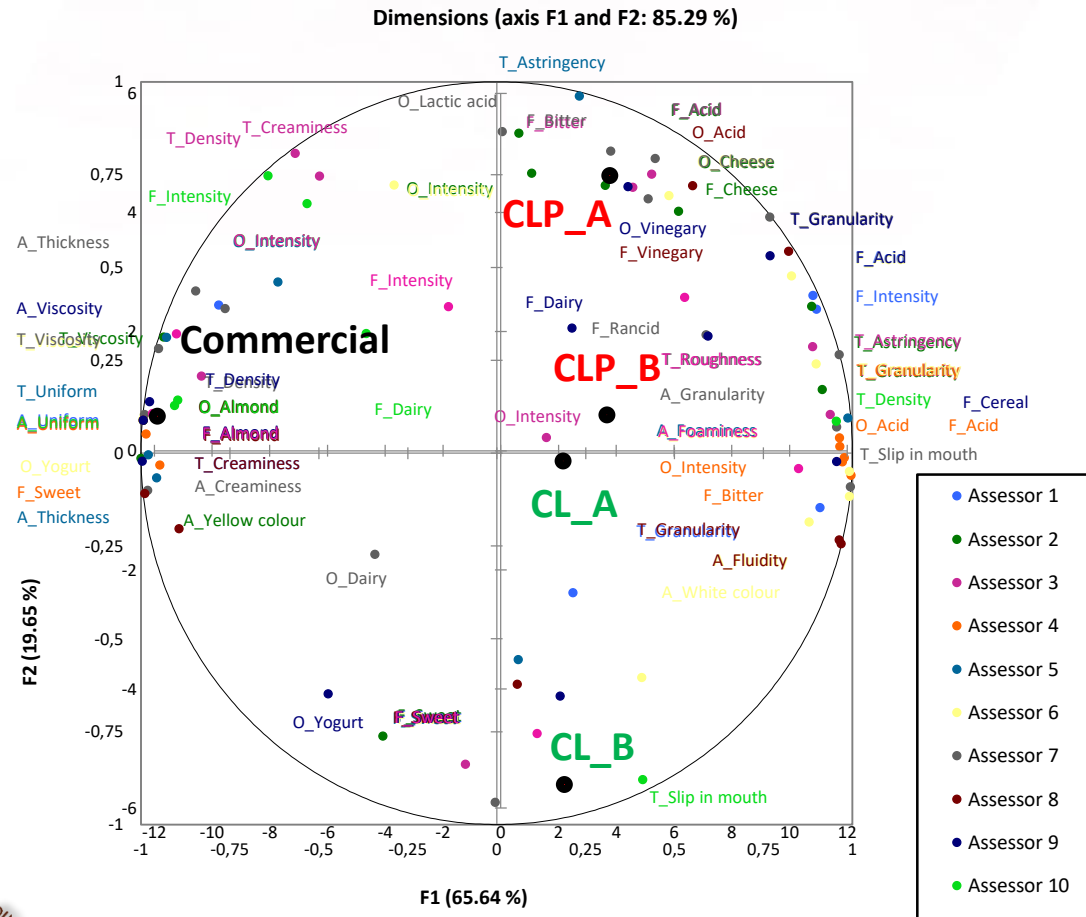
Immunomodulation properties



Fermented almond milk beverages: Sensory analyses

Sensory analyses were performed on the fermented beverages by free choice profiling technique.

PCA of the sensory analysis



Main results of the sensory analysis



Consortium LAB (CL)	Foaminess Astringent Granularity Roughness	Sweet Yogurt Slip in mouth
Consortium LAB+PAB (CLP)	Cheese Intensity Acid Bitter Granularity	Foaminess Astringent Granularity Roughness

The fermented beverages were differently perceived by consumers, regarding the presence of the two LAB strains and of the LAB and PAB strains and addition or not of sucrose.

Yogurt-type fermented probiotic gels: Experimental strategy

Production of protein-enriched plant-based juices (mix almond/chickpea)
 3% of protein

Almond	Chickpea
100%	0%
75%	25%
50%	50%
25%	75%
0%	100%

Almond/chickpea milk mixes

Fermentation of plant-based juices :

- Fermentation by *S. thermophilus* CIRM-BIA772 and *L. helveticus* CIRM-BIA100 (probiotic + proteolytic) at 43°C
- The fermentation stopped when the pH dropped to 4.5

Analyses of plant-based fermented juices

- Bacterial counts and acidification
- Syneresis evaluation → by centrifugation
- Rheological measurements (Rotational, Amplitude and Frequency) → using rheometer
- Sensory analyses
- Overall composition of the fermented juices and target metabolites (carbohydrates, organic acid, free NH₂...)
- Anti-inflammatory properties



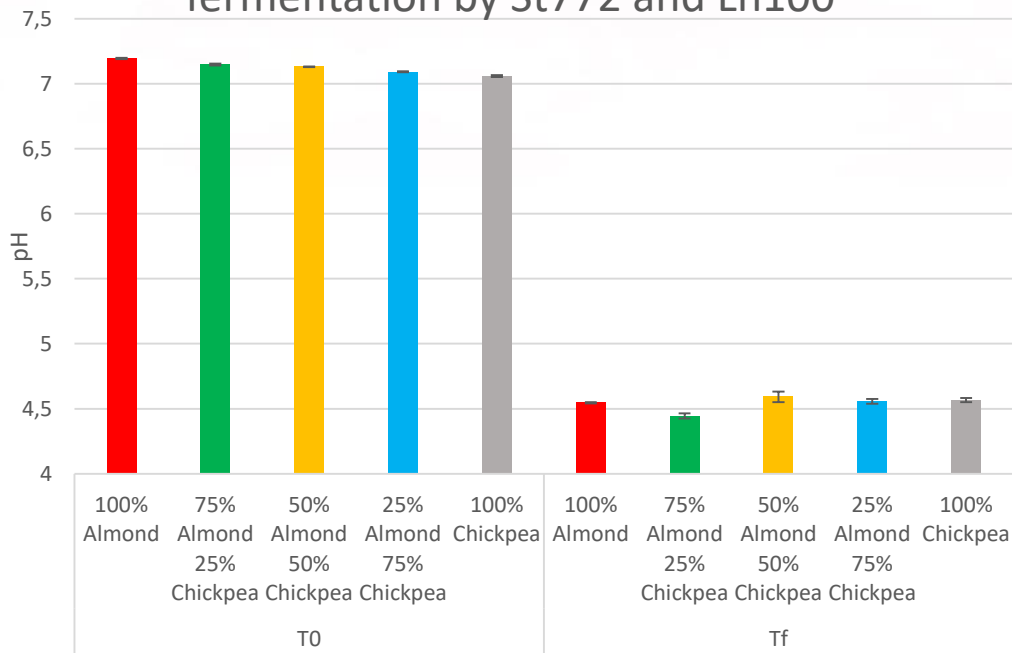
Yogurt-type fermented probiotic gels: Growth assessment



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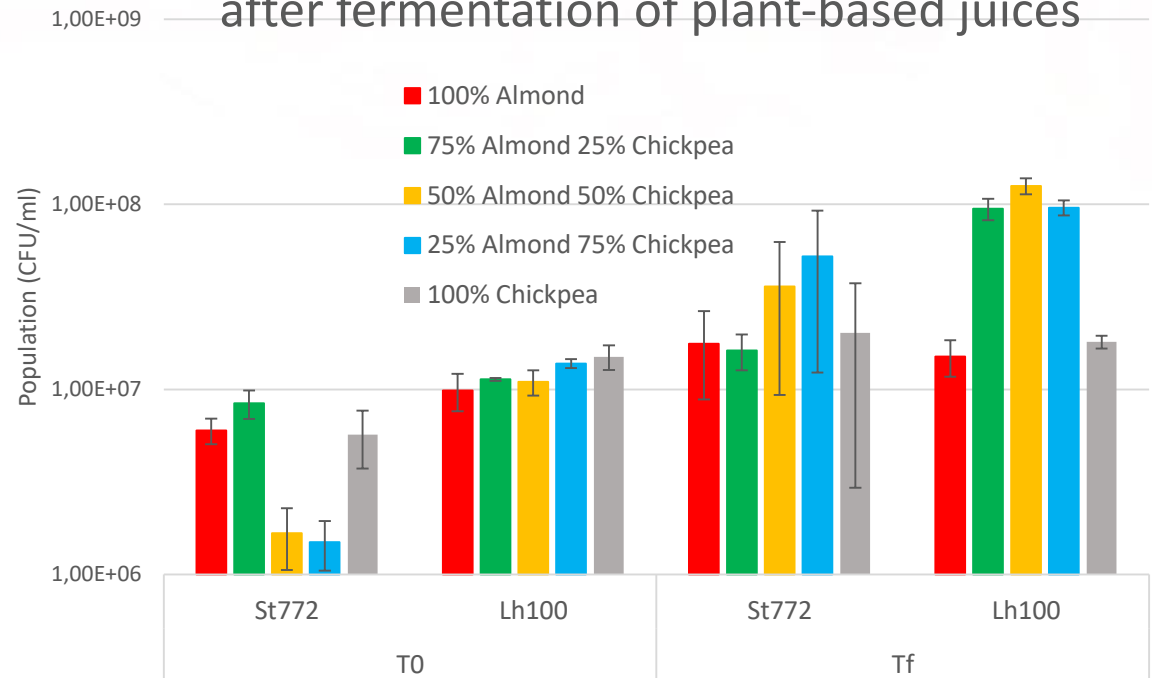
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pH of plant-based juices before and after fermentation by St772 and Lh100



Good acidification of milk analogues
 -pH before fermentation: 7.2 – 7.0
 -pH after fermentation: 4.4 – 4.6

Population of St772 et Lh100 before and after fermentation of plant-based juices



- Before fermentation population around 10⁷ CFU/ml
 - After fermentation: higher growth of LAB strains in mix compared to 100% almond or chickpea juices

Yogurt-type fermented probiotic gels

100% Almond	75% Almond 25% Chickpea	50% Almond 50% Chickpea	25% Almond 75% Chickpea	100% Chickpea
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Appearance of the gel



- A yogurt taste with a score of 2 out of 3 for all products (no significative differences)
- **100% Almond** : a higher score for aqueous and liquid
- **100% Chickpea** : viscous and granular
- **Mixture almond/chickpea** : more acidic

Appearance of the gel in the spoon



% syneresis	53.6	43.2	25.3	9.4	4.3
G' (Pa)	98	94	126	223	375
G''(Pa)	25	25	33	61	89

Take home message

- All fermented beverages had immunomodulatory properties, in contrast to the initial plant-based milk analogues.
- The almond/chickpea ratio also influenced the LAB strains growth with higher population observed in 50/50 ratio and higher immunomodulatory properties in 25/75 ratio.
- These innovative fermented almond beverages and almond/chickpea yogurt analogues can be an alternative to widely consume fermented plant-based products, with functional properties, and may help diversifying flexitarian and vegetarian consumers' diets.

Thank to all my colleagues

INRAE

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Gwénaël Jan
- Strain selection and growth
 - Conception of fermented products
 - Metabolic profiles
 - Immunomodulatory properties



Fraunhofer IVV

- Andrea Hickisch
- Milk analogue preparation
 - rheology



Fundació Miquel Agustí



- Laura López-Mas Zein Kallas
- Sensorial analyses

IRTA^R

- Ingrid Aguilo
coordinator
LOCALNUTLEG project

Developing innovative plant-based added-value food products through the promotion of **LOCAL Mediterranean NUT and LEGUME** crops

Section 1– Agro-food Value Chain 2020 – Innovation Action



Thank you for your attention

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