ESAC – IPC
College of Agriculture – Polytechnic Institute of Coimbra
Department of Food Science and Technology

LECTURE 1

WHEY FRACTIONS TO INNOVATIVE FOODS PRODUCTS

using membrane technologies

Poznan University – Poland
Faculty of Food Science and Technology
Erasmus mission

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outline

Part A. Introduction
- motivation and scope
- main objective

Part B. Whey protein concentrates

Production and characterization of whey proteins concentrates

LWPC	WPC

Part C. Conventional applications
- LWPC on fresh cheese and set yogurts
- Ovine and bovine LWPC in set yogurts
- LWPC as primary raw material for dairy gels

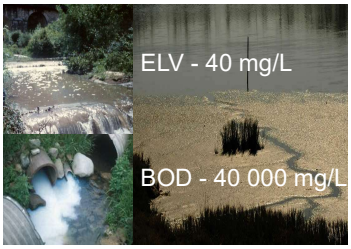
Part D. Nonconventional applications
- WPC-based films produced by UV modification
- WPC-based coatings with antimicrobial activity

Part E. Final remarks
- Conclusions
- Suggestions for future research

motivation and scope

Whey

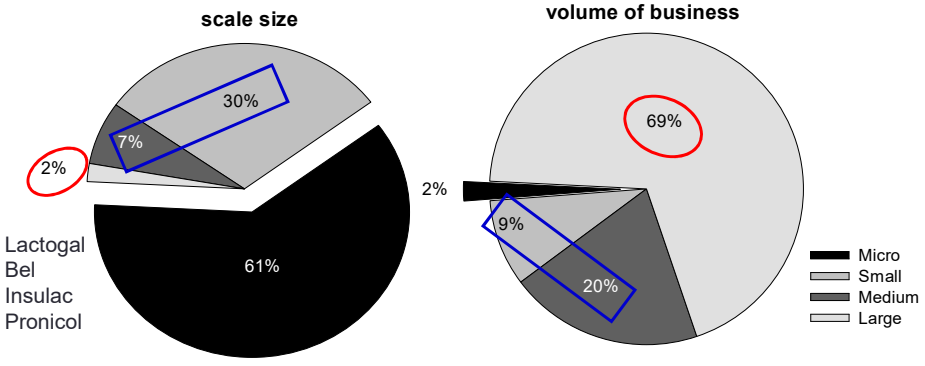
- recognized **high nutritional value**
- **main effluent** of the cheese industries
- production (per year)
  - 171 billion L (worldwide)
  - 83 billion L (EU)
- **high environmental impact**
- no efficient biological treatment
- common practice: drying processes
  - scale size; technological and economical resources



motivation and scope

Portuguese scenario

- 690 million L whey/year
- only a little more than 50% have a known destination



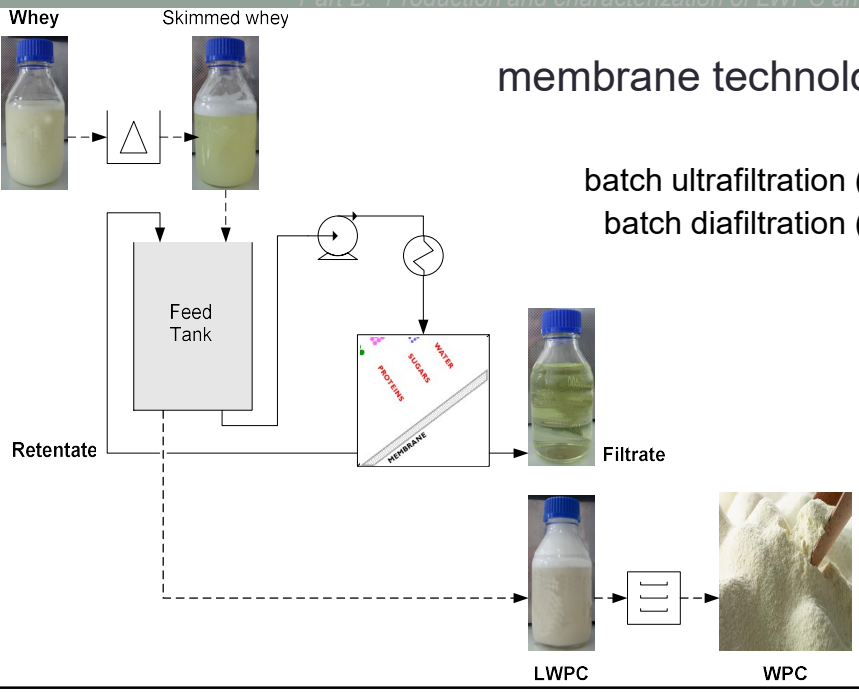
main objective

develop process solution alternatives for whey valorisation in small/medium-sized cheese factories

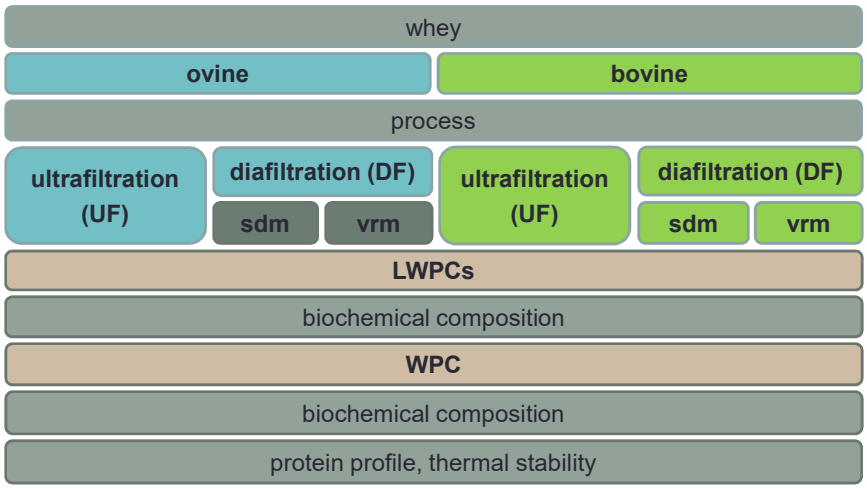
- particularly for the whey protein fraction

membrane technology

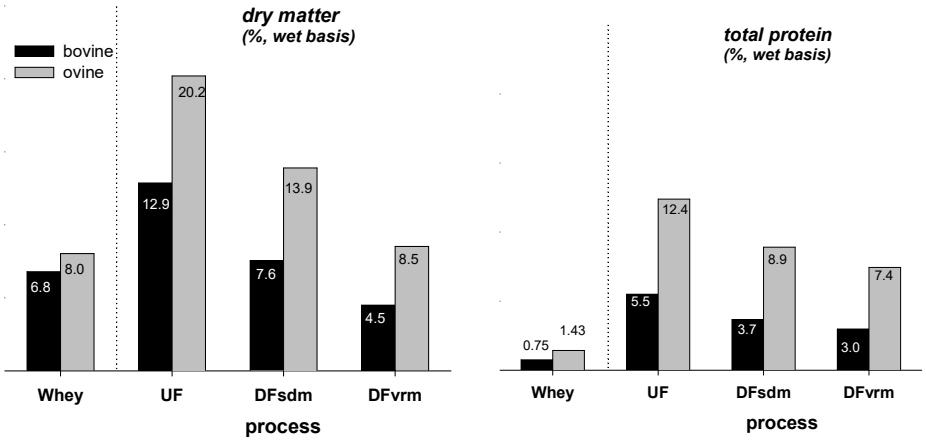
batch ultrafiltration (UF)
batch diafiltration (DF)



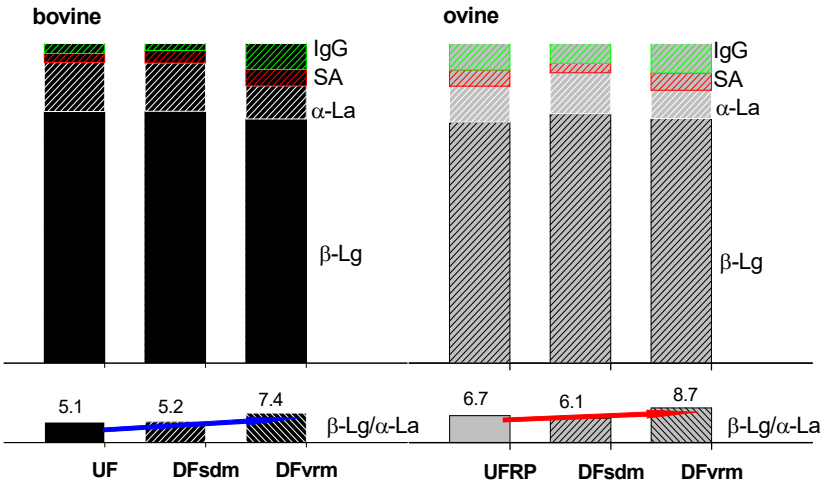
Part B. production and characterization of LWPC and WPC



LWPC



WPC – *protein profile*

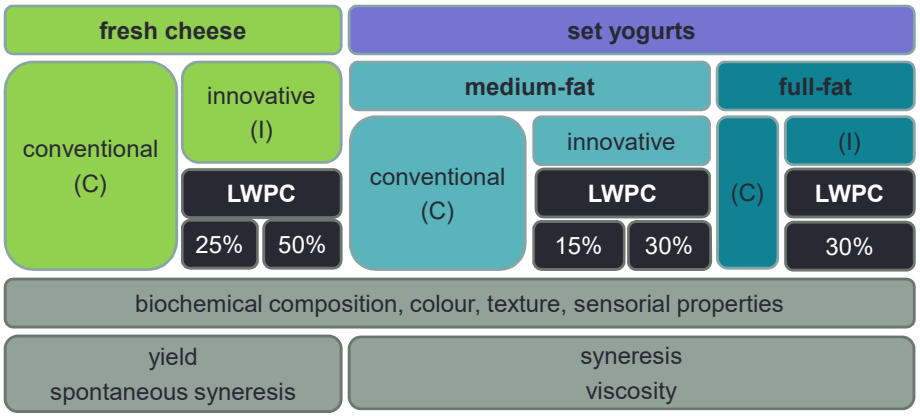


Part C. conventional applications

LWPC | fresh cheese | set yogurt | dairy gels

- **nutritional properties**
  - high biological value
  - essencial aminoacids
- **functional properties**
  - solubility, swelling, viscosity, gelation, water retention
  - foaming, emulsification
  - denaturation

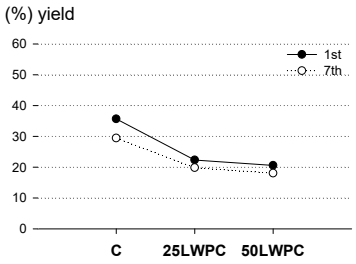
Part C. LWPC in fresh cheese and set yogurts

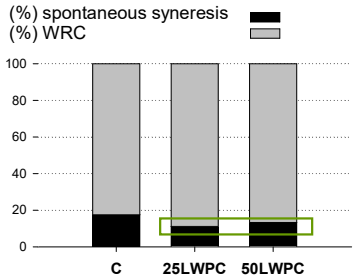


use of LWPC instead WPC

what is new…

fresh cheese - *yield, syneresis, colour, texture*

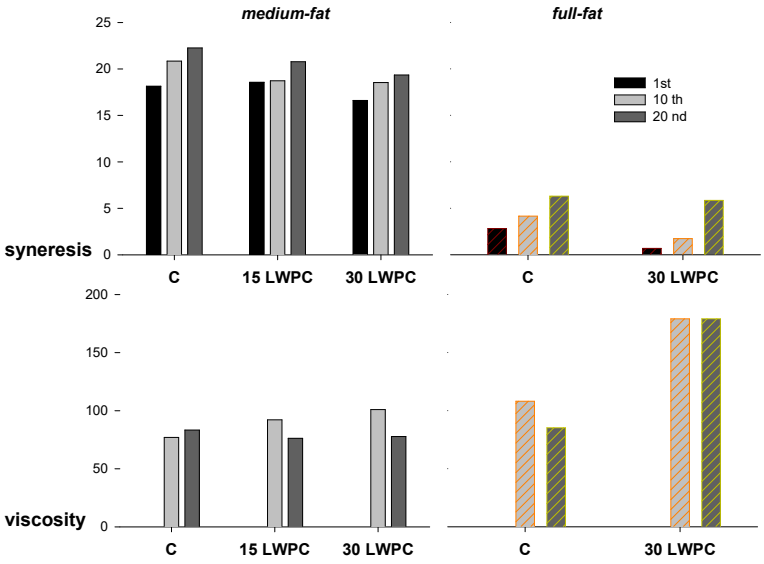




using LWPC

- decrease cheese darkening during storage - **better product appearance**
- no significantly differences were found in **texture** between conventional and innovative products.
- **texture** parameters decreased during storage

set yogurts – *syneresis, viscosity*

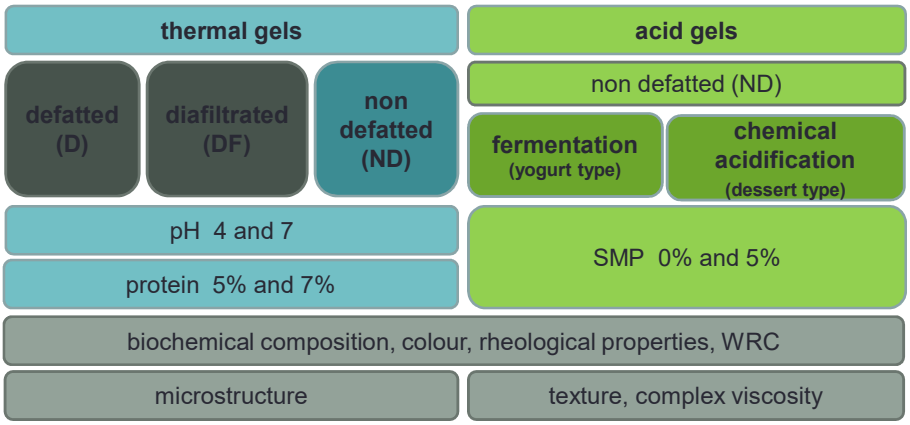


sensorial evaluation

Tests	triangular test		preference test (preference percentage)
	right answers	result ($p < 0.05$)	
fresh cheese			
C & 25LWPC	21/31	differ	25LWPC (52%)
C & 50LWPC	24/31	differ	C (68%)
set yogurt medium-fat			
C & 15LWPC	4/35	do not differ	C (74%)
C & 30LWPC	13/35	do not differ	C (83%)
set yogurt full-fat			
C & 30LWPC	3th day 7/20 10th day 10/15	do not differ differ	C (63%)

reasons for preference: smoother texture (fresh cheese); softer (set yogurt)

Part C. LWPC as raw material for dairy gels

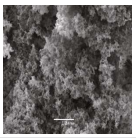
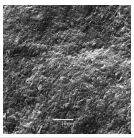
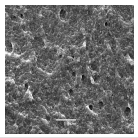
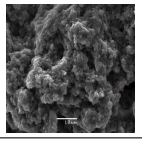
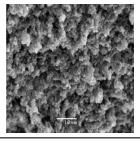
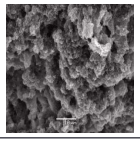
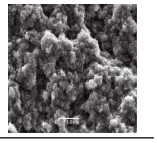
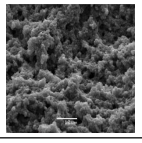
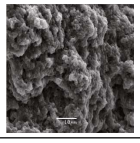
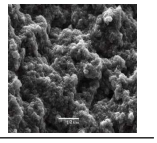


use LWPC as raw material not as coadjuvant — *what is new…*

thermal gels – *appearance, WRC (%)*

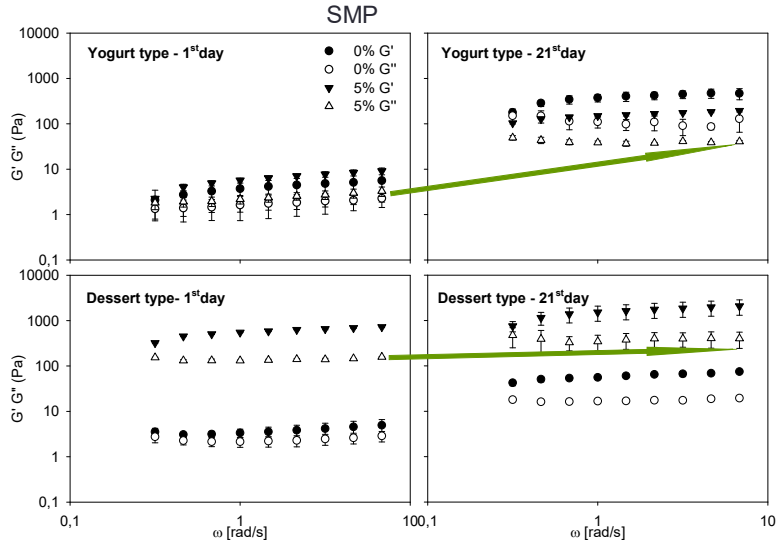
pH		4		7	
protein (%)		5	7	5	7
Gel type	ND	97.72±0.89	99.50±0.47	nd	98.80±1.59
	D	94.61±0.80	96.21±0.64	nd	96.06±0.51
	DF	92.60±0.92	98.24±0.73	nd	97.92±0.35

thermal gels – *microstructure*

pH		4		7	
protein (%)		5	7	5	7
Gel type	ND			nd	
	D				
	DF			nd	

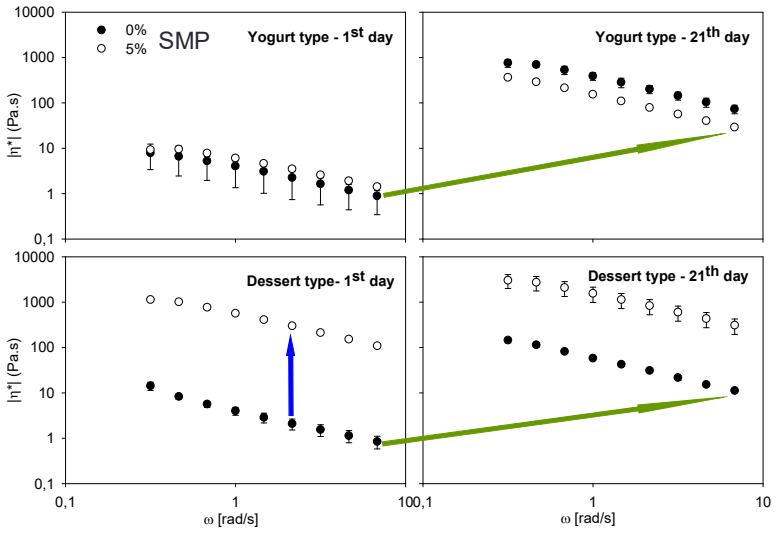
acid gels – *rheological properties*

G' and G" (Pa)



acid gels – *rheological properties*

complex viscosity |η| (Pa.s)*



conclusions

- batch **UF/DF** solve the environmental problem of **bovine/ovine whey** in **medium/small** cheese industries
- incorporating **LWPC** into dairy products, such fresh cheese and set yogurts, **increase** the overall **process yield** and their **functional properties**
- depending on the gelation process and manufacture conditions, **innovative products** based on **LWPC** can be produce according to the desired food application

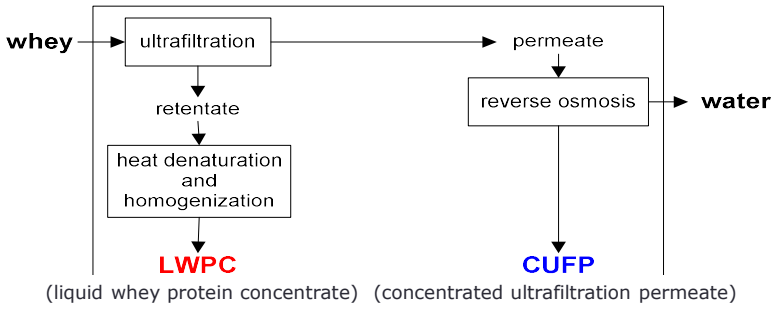
Current work

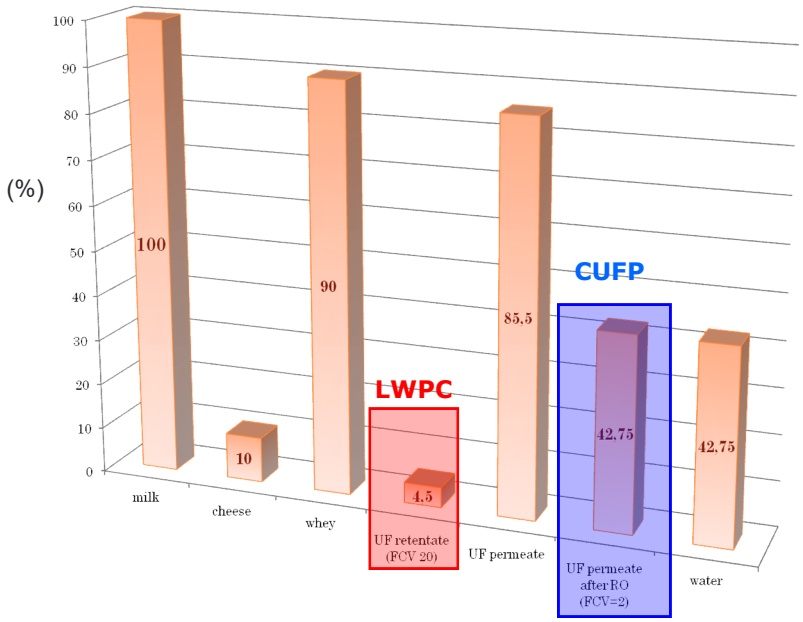
USE OF **LWPC** and **CUFP** AS MAIN INGREDIENTS IN:

- KEFIR & PROBIOTIC DRINKS
  - Bovine origin
  - Ovine origin

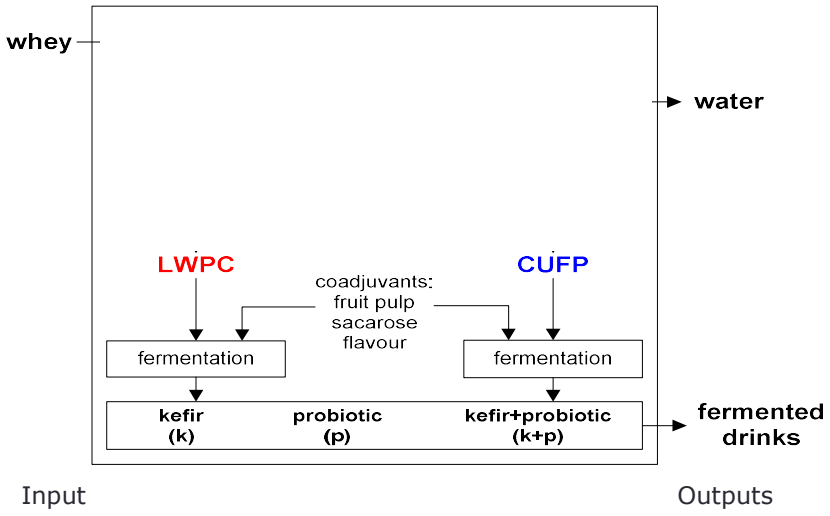
CUFP (concentrate ultrafiltration permeate)

Our approach



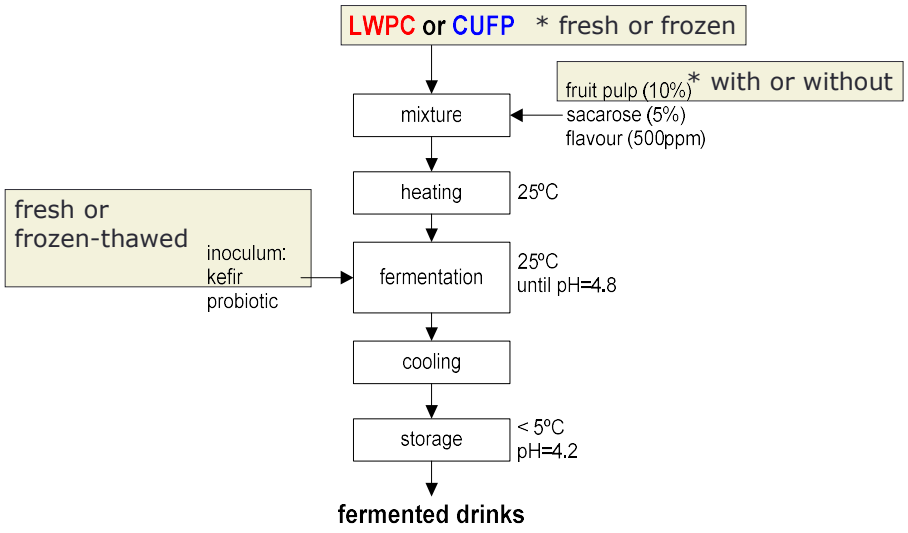


Our approach



Our approach

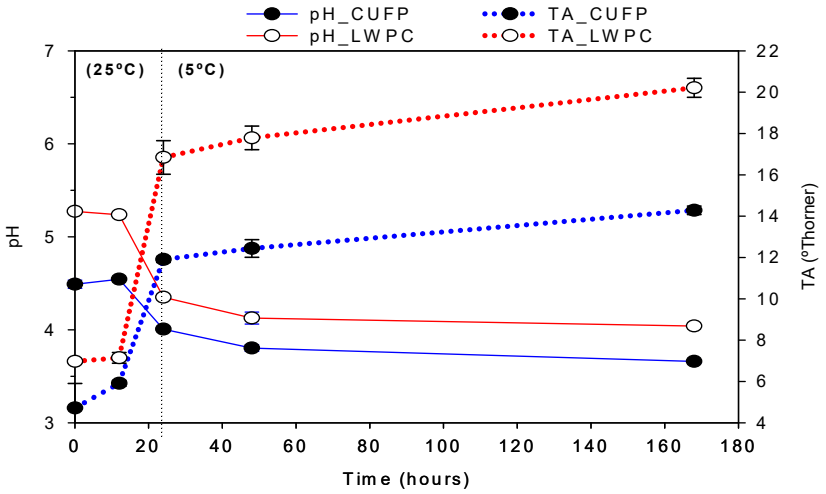
fermented drinks

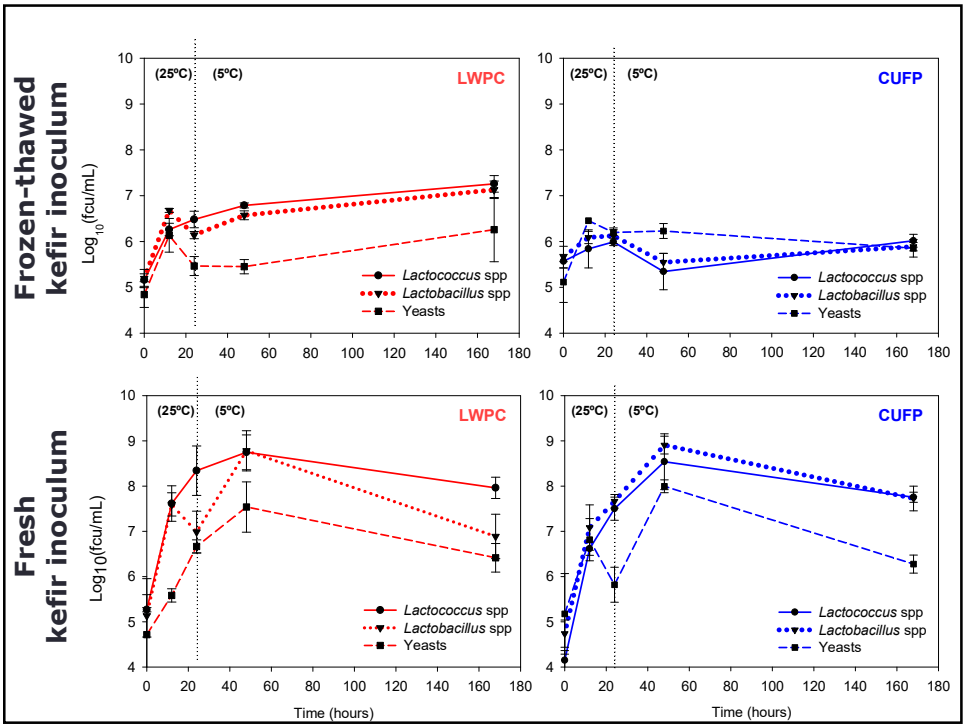


	Products	Analyses
	LWPC Kefir (k) *(Patent: WO 2011005128 20110113)* Probiotics (p) *L. acidophilus, L. casei and L. rhamnosus (1:1:1)* Kefir+Probiotics (k+p)	**Physicochemical** pH T. acidity Total solids Fat Viscosity **Microbiological** (during fermentation and storage – 0, 12, 24, 48 and 168 h) *Lactococus* spp *Lactobacillus* spp Yeasts **Sensorial** (at the end of the storage time) Triangular tests Preference tests
	CUFP Kefir (k) Probiotics (p) Kefir+Probiotics (k+p)	

Fermented drinks_kefir

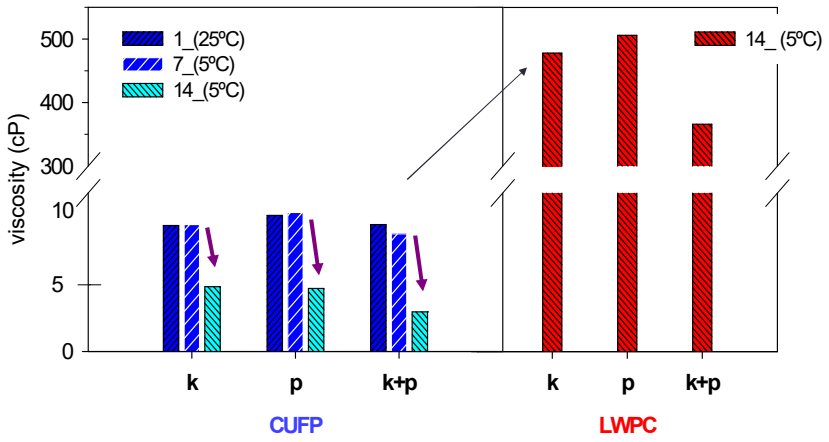
pH and T Acidity (during fermentation and storage)





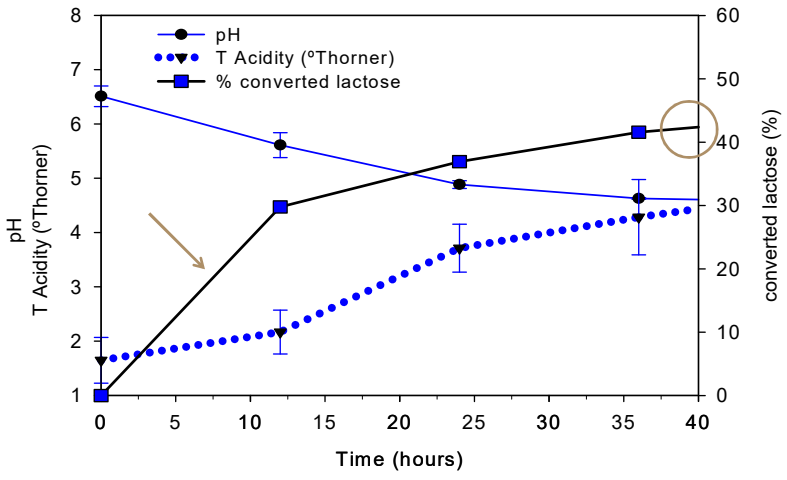
Fermented drinks *(**without** fruit pulp)*

viscosity (during fermentation and storage)



Fermented drink_CUFP_kefir

converted lactose, pH and T Acidity (during fermentation)



Sensorial analyses

- Preference test (untrained panelists n=31)

LWPC_kefir vs CUFP_kefir

- LWPC_kefir (74.2%)
- CUFP_kefir (25.8%)

- Triangular test (untrained panelists n=45)

LWPC_kefir vs LWPC_probiotic vs LWPC_k+p

(Differences between fermented drinks were detected at a confidence level of 95%)

Conclusions

- **LWPC and CUFP** are (chemical, microbial and sensorial) stable and **attractive** to produce **fermented drinks**
  - LWPC_fermented drinks looks like a liquid yogurt
  - CUFP_fermented drinks looks like a fruit juice
- **Frozen-thawed** kefir **inoculums' penalize** fermentation
- **Frozen LWPC or CUFP** does **not influence** the fermentation
- In CUFP_fermented drinks (about **45% lactose conversion**)
- **LWPC_fermented** drinks **are preferred** to CUFP_fermented drinks
  - For LWPC products - LWPC_kefir is the preferred
  - For CUFP products - CUFP_probiotic is the preferred