



NANOFILTRATION OF LACTIC ACID WHEY: A PROCESS TO IMPROVE THE DRYABILITY AND THE QUALITY OF POWDER

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Whey and whey powders

- ❑ **Increasing demand for Infant Formulae** (population growth, increasing wealth of the middle classes)

→ need for **lactose & whey proteins**

↳ Components of whey



- ❑ **Different types of whey depending of the production process** that differ from their composition (protein, minerals, lactose...):

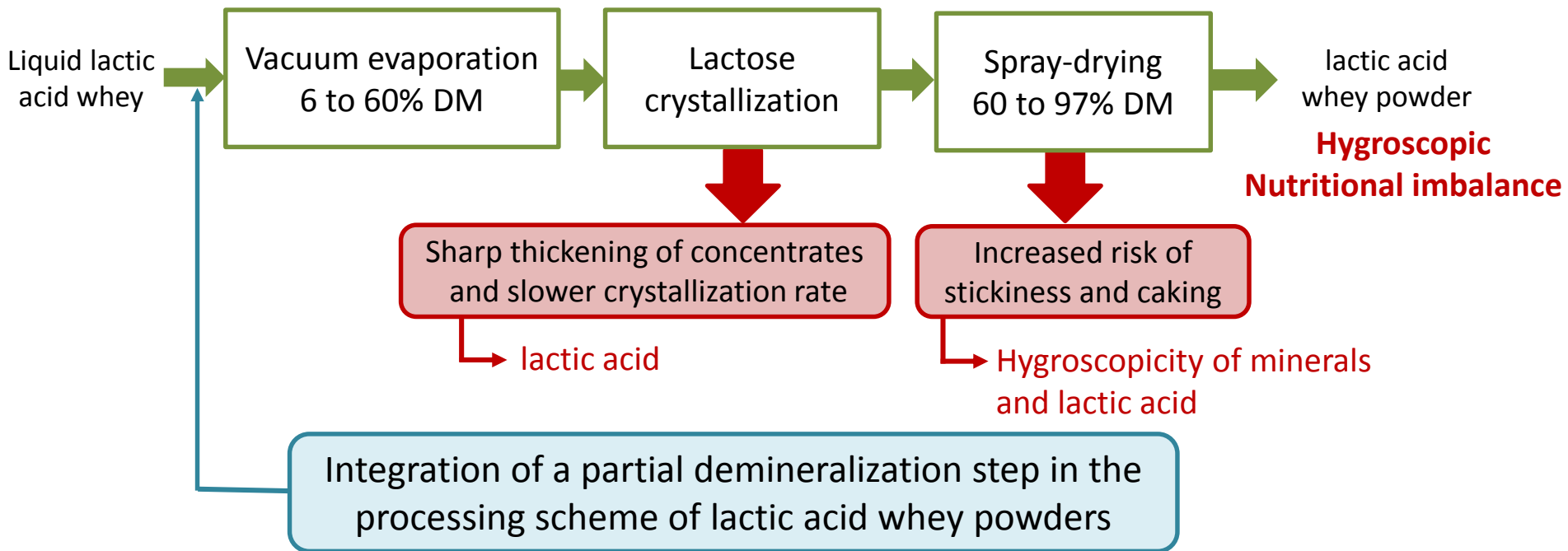
- sweet whey from cheese industries (hard-types cheeses)
- acid whey from fresh cheese and caseinate industries

	Sweet whey	Lactic acid whey
Dry matter DM (% w/w)	6.5	6.0
pH (-)	6.7	4.6
Ash (g/100g of DM)	8	12
Lactic acid (g/100g of DM)	1.8	10

Lower pH
Higher mineral and
lactic acid contents

Lactic acid whey processing

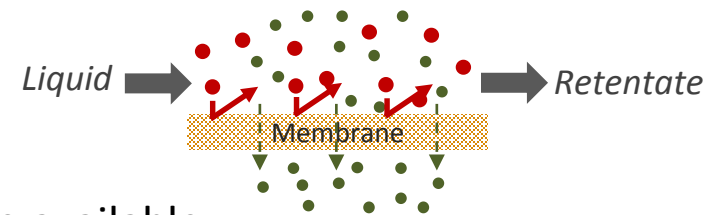
- For lactic acid whey, the high levels of minerals and lactic acid makes its processing into powder difficult and limited:



Partial demineralization of acid whey using nanofiltration

Nanofiltration (NF)

- ❑ Concentration (up to 20-22% dry matter)
- ❑ Partial demineralization (reduction of 25-60%)
- ❑ Partial removal of lactic acid



Data on performances of NF for acid whey processing are available :

- Demonstrations at lab-scale
- not representative of the **dairy industrial scale**

Objectives
of the study

What is the ability of nanofiltration for the production of partially demineralized lactic acid whey powders at semi-industrial scale ?

Dryability of the NF retentates ?

Properties of the powders ?

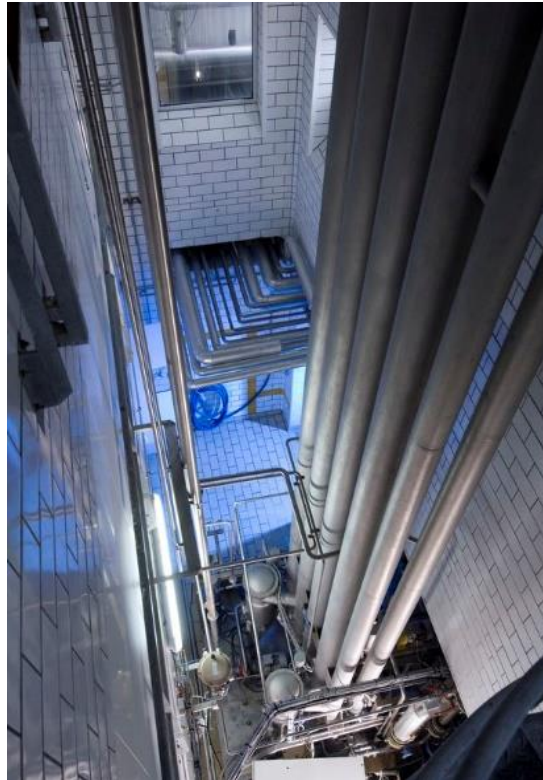
Concentration and spray drying facilities



BIONOV



Feed flow rate of 225 L/h

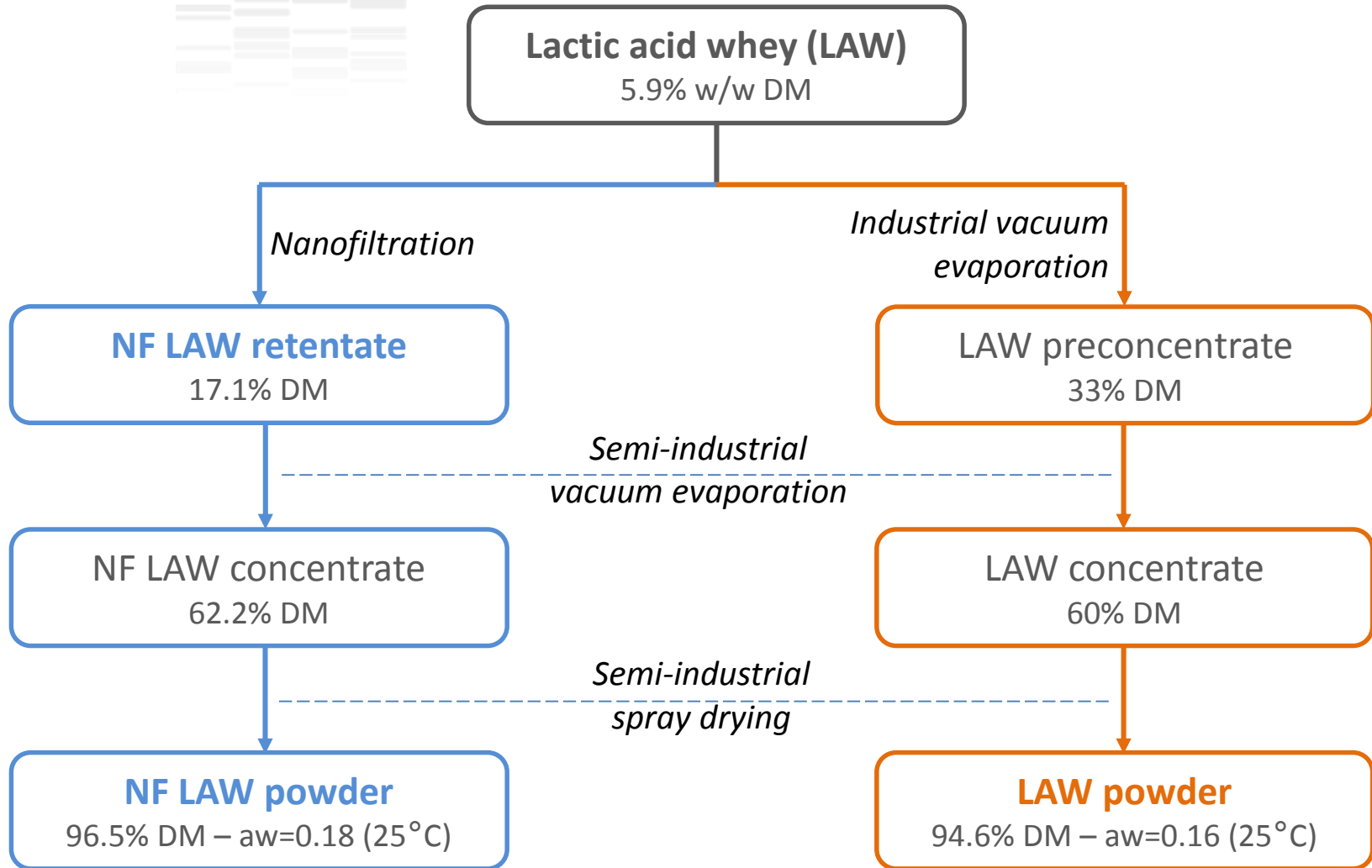


300 kg/h of water removed



80 kg/h of water removed

Technological schemes



Compositions of lactic acid whey retentate and powders

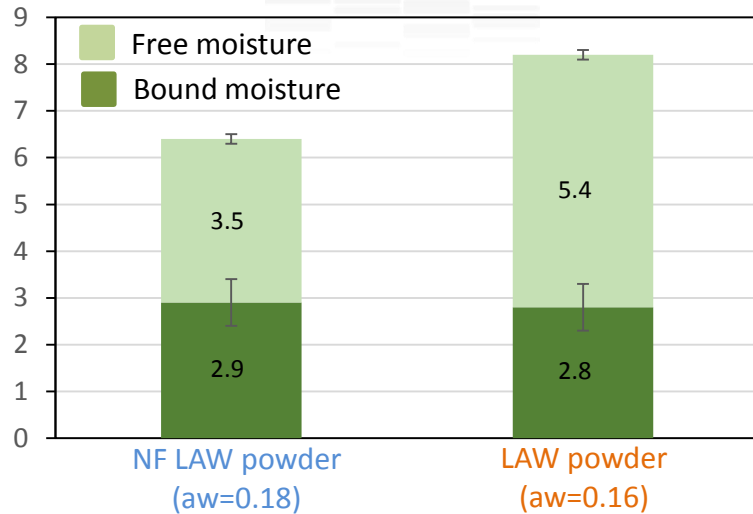
g/100 g (dry basis)	LAW liquid		NF LAW retentate
Lactic acid	10.8	-30%	7.6
Total nitrogen	7.9		7.9
Ash	11.6	-27%	8.5
Calcium	1.5		1.6
Magnesium	0.2		0.2
Potassium	2.8	-53%	1.3
Sodium	0.5	-60%	0.2
Chloride	1.7	-53%	0.8
Inorganic phosphate	2.8		3.0

Compositions of lactic acid whey retentate and powders

g/100 g (dry basis)	LAW liquid		NF LAW retentate	LAW powder		NF LAW powder
Lactic acid	10.8	-30%	7.6	11.2	-32%	7.6
Total nitrogen	7.9		7.9	7.8		7.5
Ash	11.6	-27%	8.5	11.4	-37%	7.2
Calcium	1.5		1.6	1.6		1.7
Magnesium	0.2		0.2	0.2		0.2
Potassium	2.8	-53%	1.3	2.4	-43%	1.3
Sodium	0.5	-60%	0.2	0.5	-60%	0.2
Chloride	1.7	-53%	0.8	1.5	-47%	0.8
Inorganic phosphate	2.8		3.0	2.8		2.7

Physico-chemical properties of acid whey powders

Total moisture (g/100g)

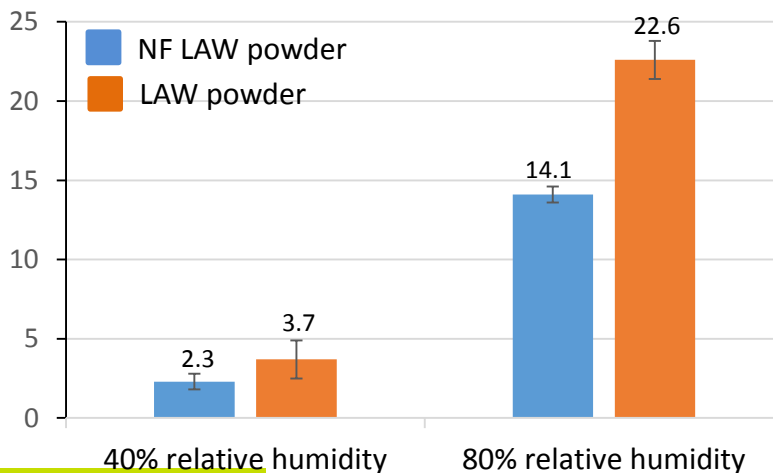


- ❑ Lower total moisture content for **NF LAW powder** but same bound moisture content for both powders

Provides an indication of lactose crystallization rate (calculation)

- ❑ Same lactose crystallization rate for both powders and close to 80% (optimal value) \Rightarrow slight impact of mineral environment on the quantitative aspect of crystallization

Hygroscopicity (g/100g)

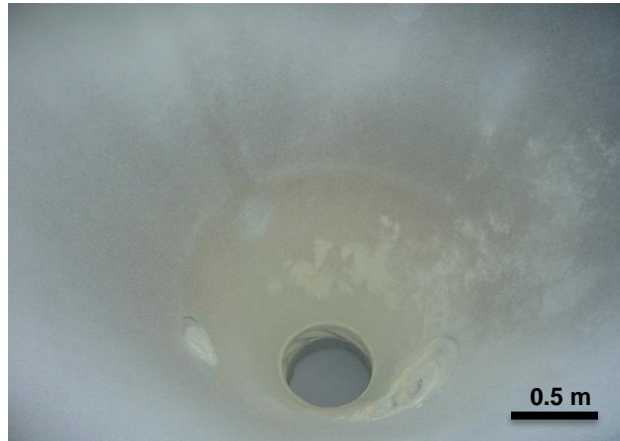


- ❑ Less hygroscopicity of **NF LAW powder** at 40 and 80% relative humidity :

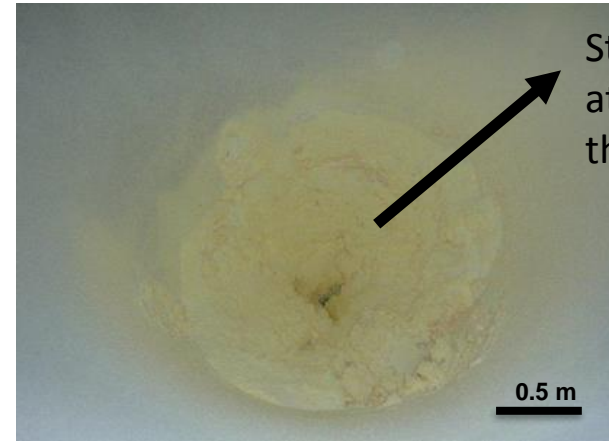
- ✓ Related to the removal of highly hygroscopic components that are monovalent ions (Na, K, Cl) and lactic acid

Dryability of the concentrates

NF LAW powder



LAW powder

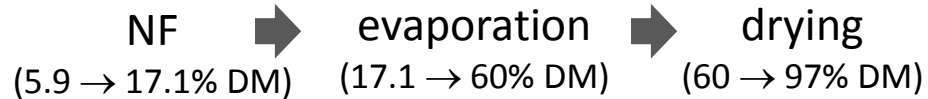


- ❑ Less stickiness of the NF LAW powder compared to the LAW powder
 - ✓ due to the higher glass transition temperature of the NF LAW powder (53°C) compared to 18°C for the LAW powder
 - ✓ due to the lower content of free moisture and lactic acid and both components have low Tg (Tg water: -132°C and Tg lactic acid -60°C)

Comparison of energy costs of processing schemes

- Theoretical comparison of energy costs for both processing schemes only **on the basis of removed water** (investments and operating costs are not taken into account) for the production of LAW powder from 1,000 kg of liquid at 5.9% DM

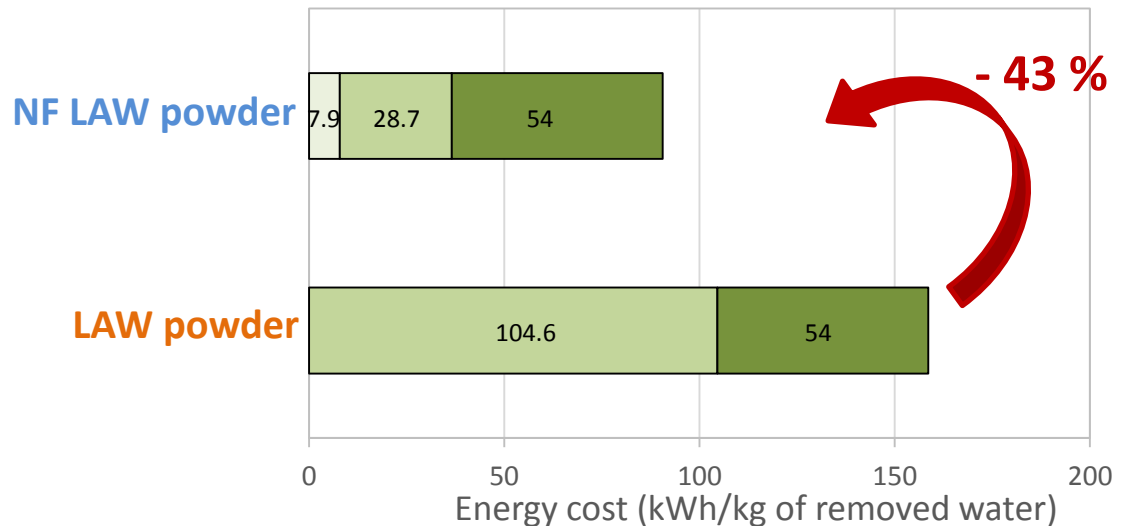
NF LAW powder



LAW powder



- nanofiltration
0.012 kWh/kg water
- vacuum evaporation
0.116 kWh/kg water
- drying
1.46 kWh/kg water





Conclusions

- ❑ As expected from the literature, the use of NF for the production of lactic acid whey powders improves the dryability of concentrates and the hygroscopicity of the resulting powders
→ **Demonstration at semi-industrial scale**
- ❑ On the sole basis of the energy required for the removal of water, the integration of NF could lead to about 40% of energy savings compared to the conventional process scheme

More information in Bedas, M., Tanguy, G., Dolivet, A., Méjean, S., Gaucheron, F., Garric, G., Senard, G., Jeantet, R., Schuck, P. (2017) Nanofiltration of lactic acid whey prior to spray drying: scaling up to a semi-industrial scale. *LWT-Food Science and Technology*, **79**, 355-360

***THANK YOU FOR
YOUR ATTENTION***

