Research in Food Science and Formulation : From raw material to final product

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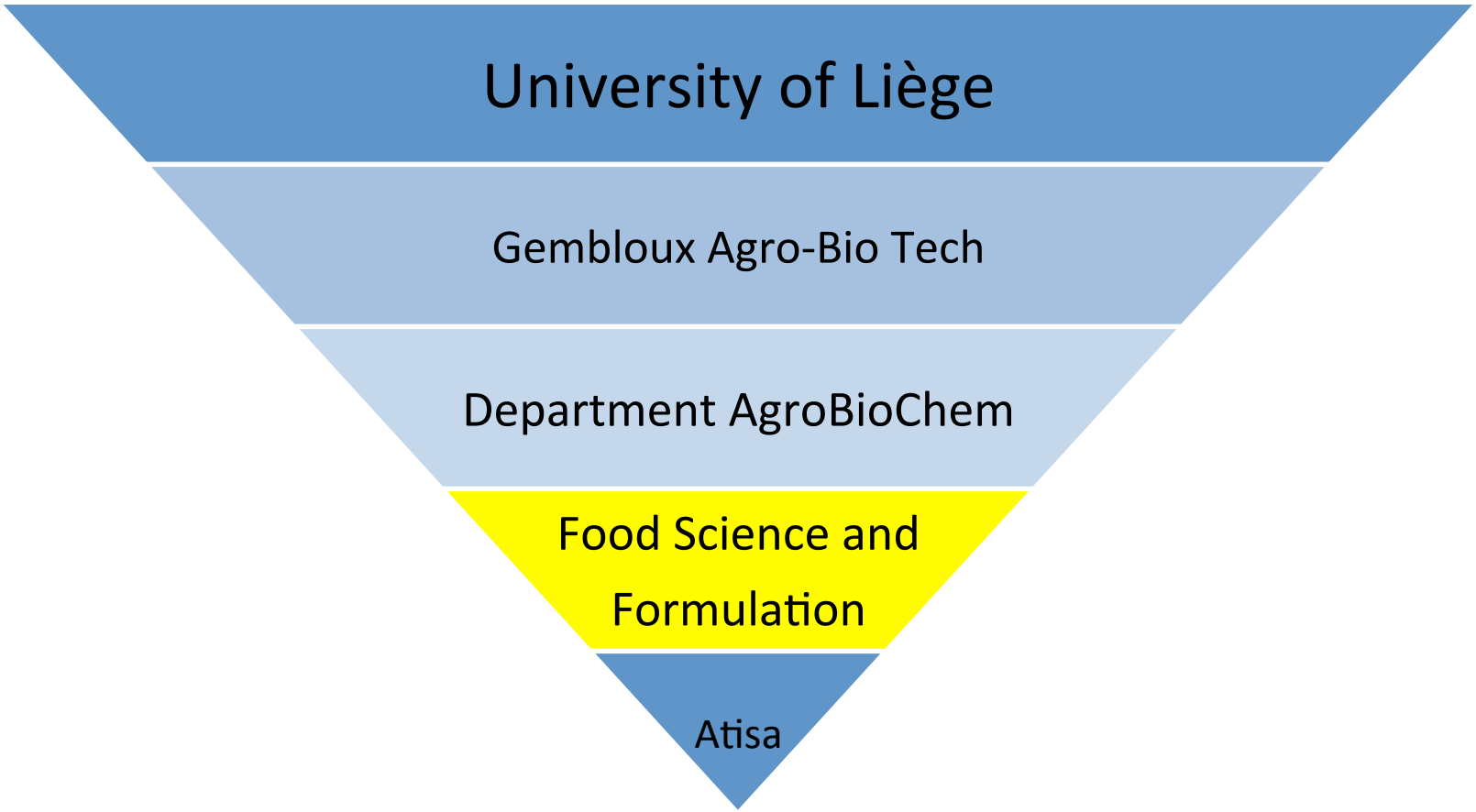

University of Liège
Gembloux Agro-Bio Tech
Department AgroBioChem
Food Science and Formulation
Atisa

Human forces

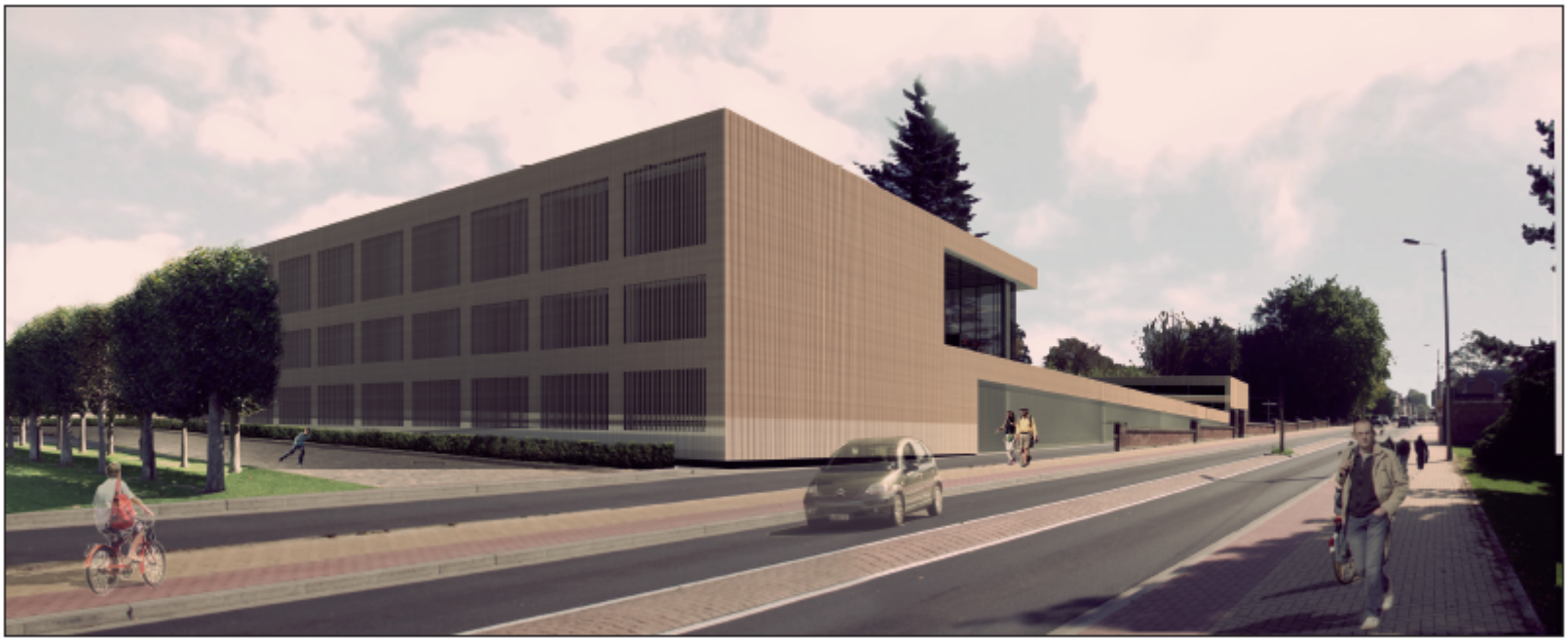
Academics :

- Dr Ir Christophe Blecker
- Dr Ir Sabine Danthine

and a team of MSc. and Ph.D graduate students, postdoctoral fellows, research associates and technicians make up the lab

FoodIsLife

R&D platform in food science and biotechnology



VUE A - Vue depuis l'avenue de la faculté

FoodIsLife : R&D platform

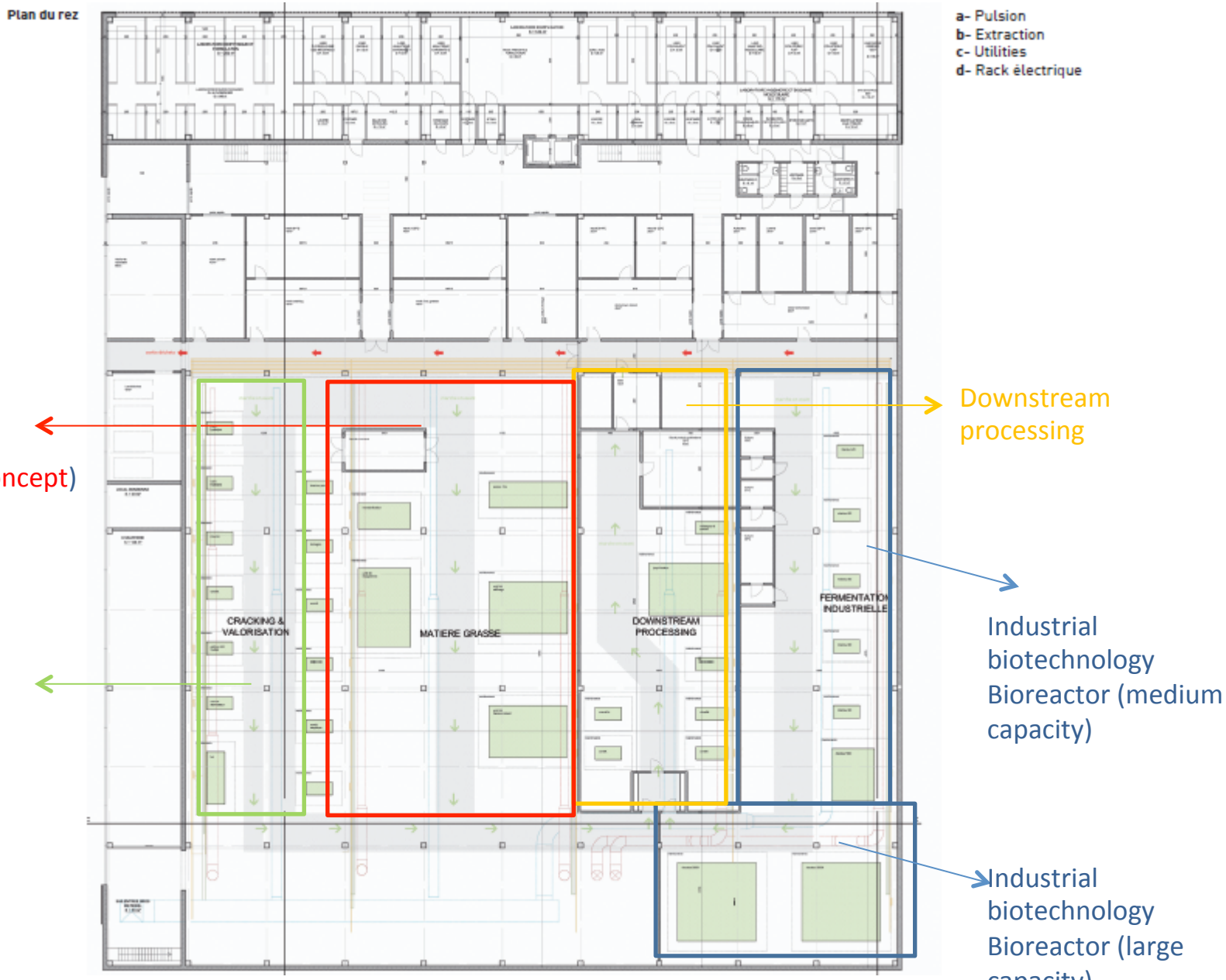
- Expertise in the area of food science and biotechnology
- Cutting-edge lab-scale equipments
- Access to pilot-scale equipments
- Reinforcement of the links between university and private partners
- Promotion of the Walloon expertise in food science research at an national and international level

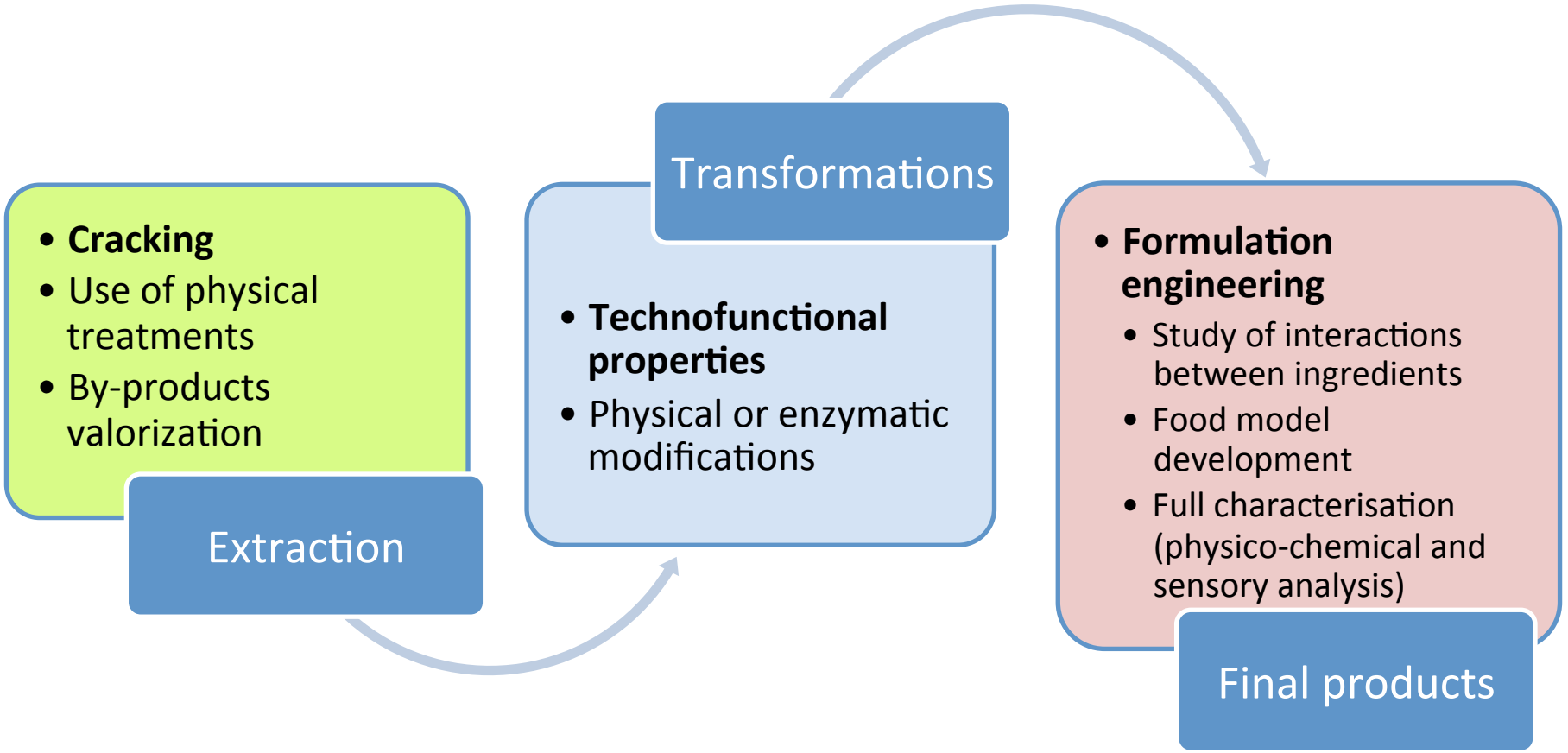
Skills

- Research activities in food science, microbial biotechnology, biological chemistry

Equipments

- Lab equipments
- Pilot scale equipements : for the production of small quantities (as test sample) to medium quantities (10 Kg for preproduction to several hundreds of Kg for scaling-up demonstration)

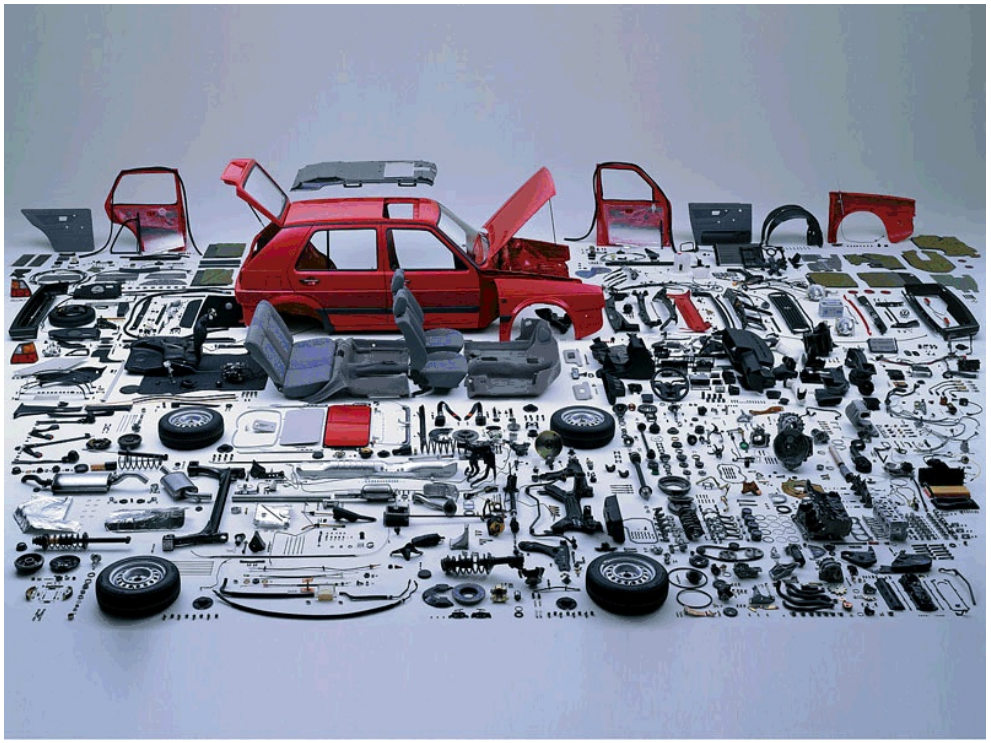

Plan du rez
a- Pulsion
b- Extraction
c- Utilities
d- Rack électrique
CRACKING & VALORISATION
MATIERE GRASSE
DOWNSTREAM PROCESSING
FERMENTATION INDUSTRIELLE
Cracking and valorisation of bioproducts (bioreffinery concept)
Downstream processing
Oils and fat processing
Industrial biotechnology Bioreactor (medium capacity)
Industrial biotechnology Bioreactor (large capacity)


• **Cracking**
• Use of physical treatments
• By-products valorization
Extraction
Transformations
• **Technofunctional properties**
• Physical or enzymatic modifications
• **Formulation engineering**
• Study of interactions between ingredients
• Food model development
• Full characterisation (physico-chemical and sensory analysis)
Final products

Examples of activities carried out in the field of cracking and valorization of bioproducts

- Cracking of agricultural raw materials allows us to produce new ingredients

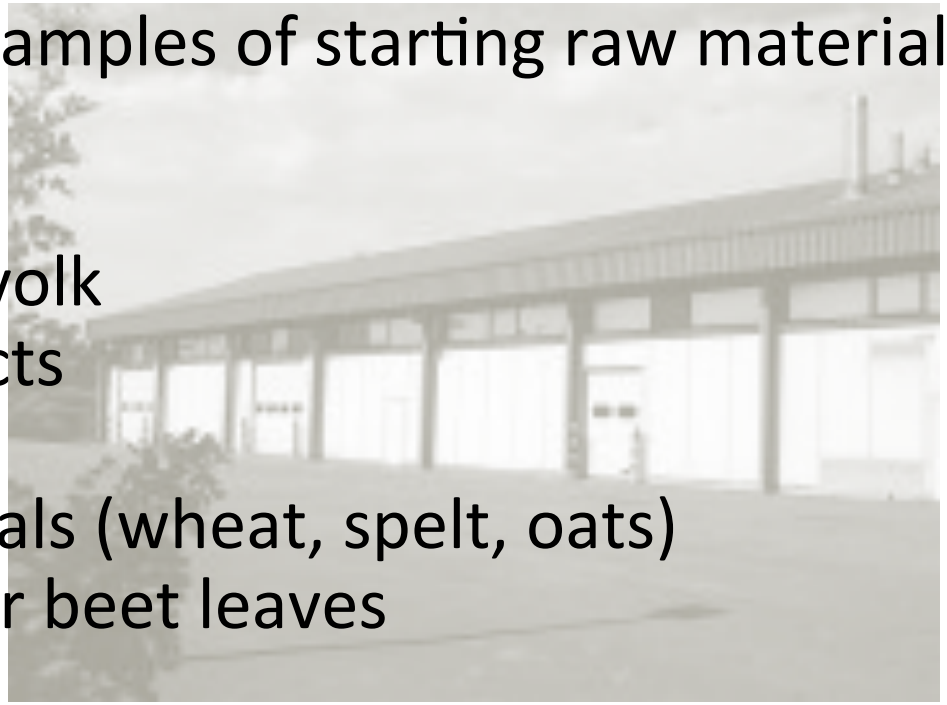
- Cracking can lead to clean label ingredients and provide added values to agricultural productions



A long tradition of by-product valorization exists in Gembloux :
more than 20 years!
(different fields)

Cracking in Gembloux Agro-Bio Tech

Some examples of starting raw materials



- Milk
- Egg yolk
- Insects

- Cereals (wheat, spelt, oats)
- Sugar beet leaves
- Date
- Flax seed
- Pea

Milk fractionation

- Proteins
  - Proteose-peptone fraction

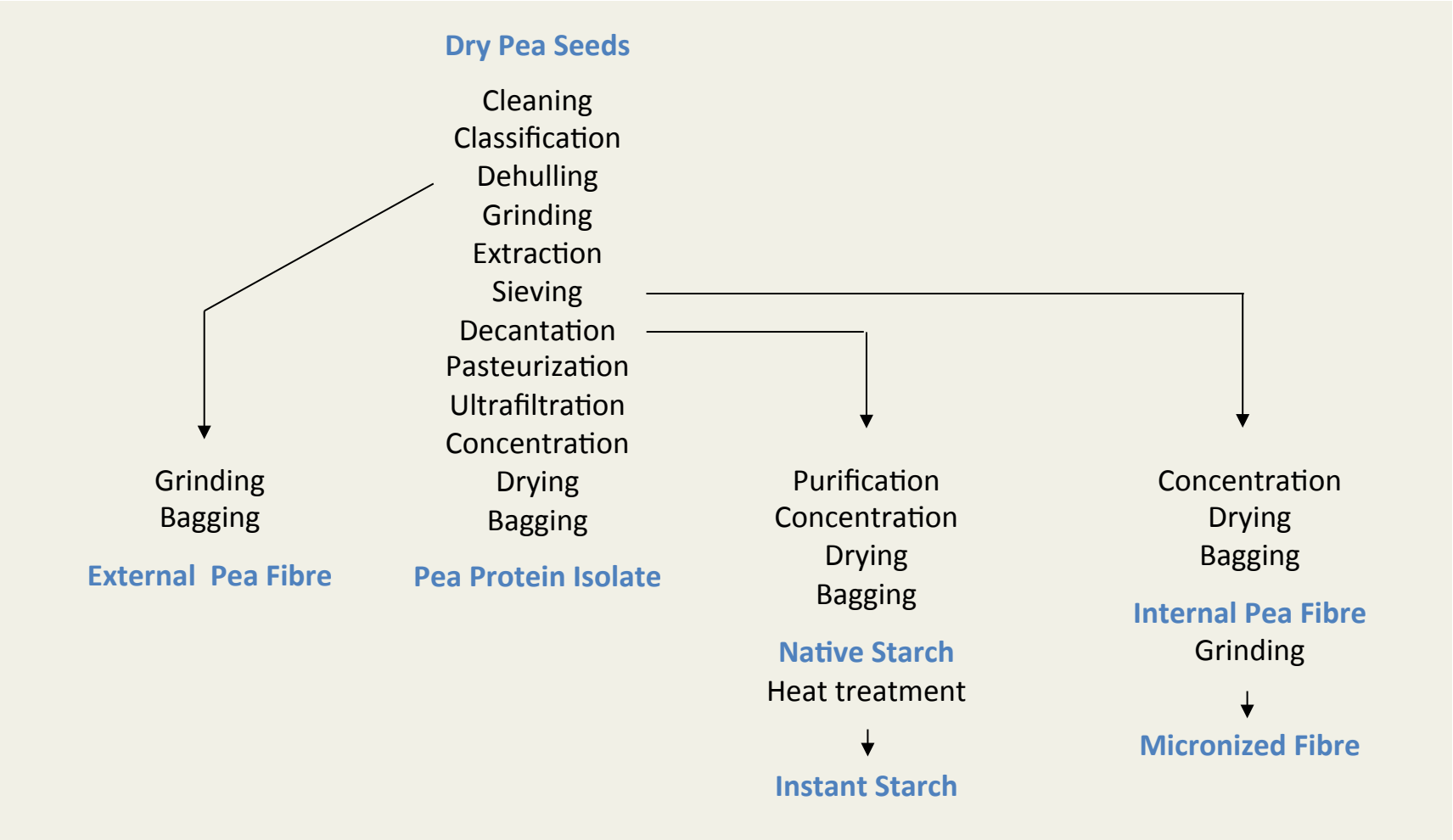
- Lipids
  - Anhydrous milk fat
  - Polar lipids

Date fractionation

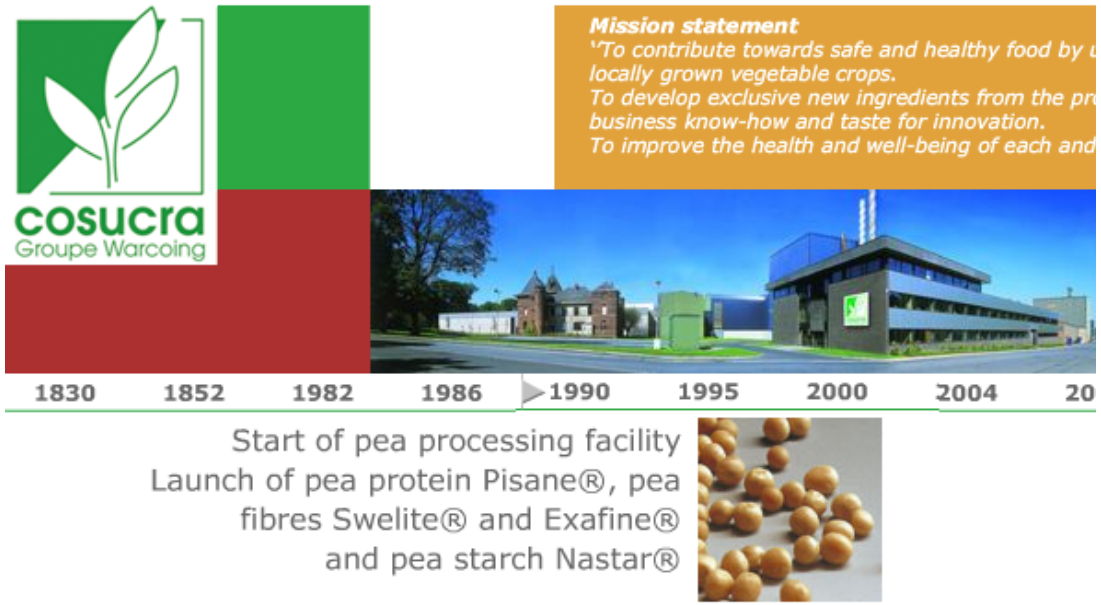
- Seed (pit)
  - Oil, phenolic compounds

- Flesh
  - Dietary fiber, pectin
  - Proteins

Industrial fractionation of pea



Industrial valorisation of our research

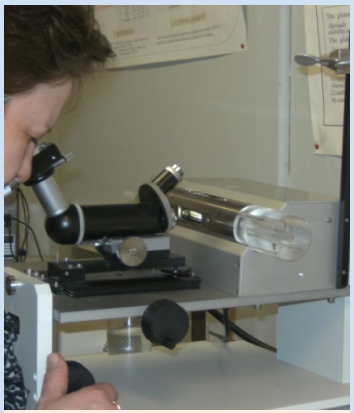


Product characterization

- Techno functional properties
- Physical state of powders
- Interfacial properties
- Physico-chemical properties of lipids

Equipment (1)

- **Interfacial properties**
  - Adsorption kinetics, monolayers, CMC…



Spinning drop

Bubble pressure

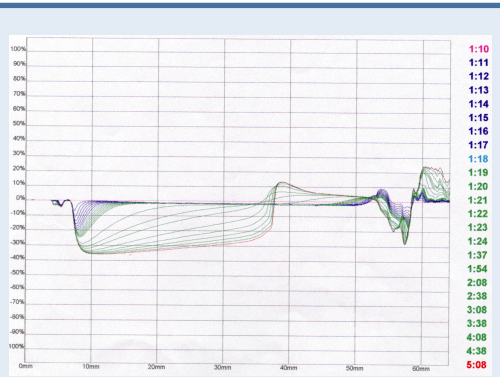
Hanging drop Tensiometer

Langmuir film wage

Equipment (2)

- Emulsions, foams,…

Turbiscan

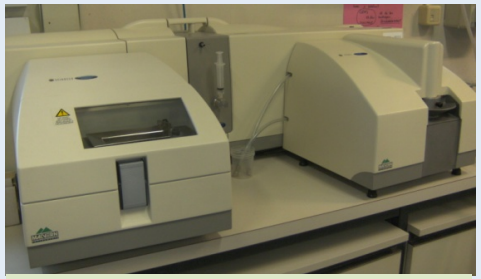


Foam scan

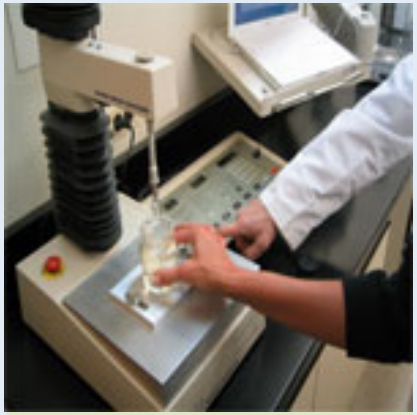
Equipment (3)

- Rheology, texture analysis, particule/globule sizer, …

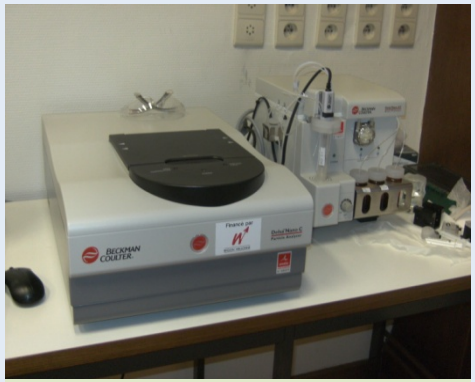
Rheometer



Master sizer



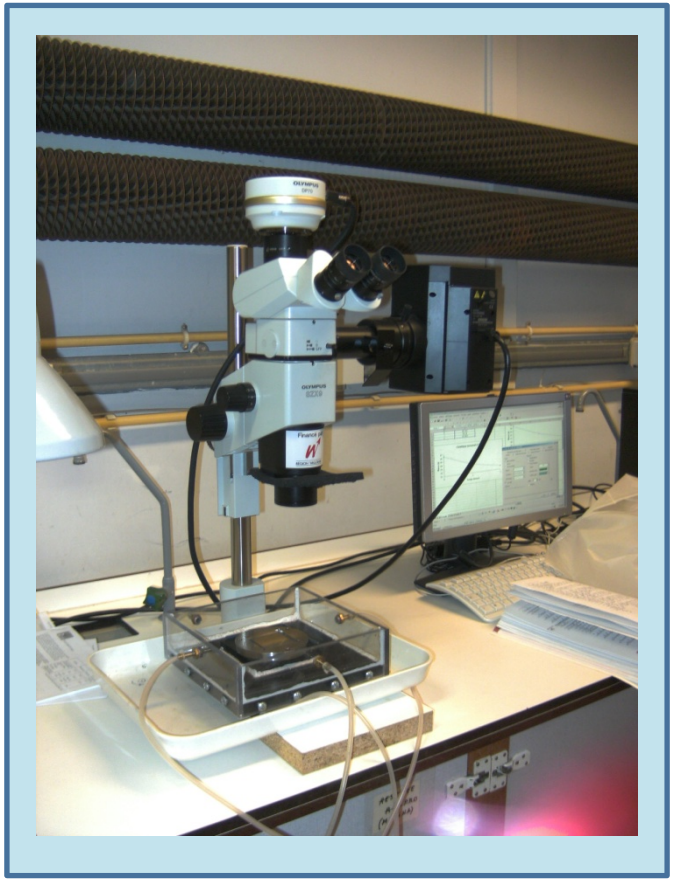
Texturometer



Beckman coulter-Delsa Nano

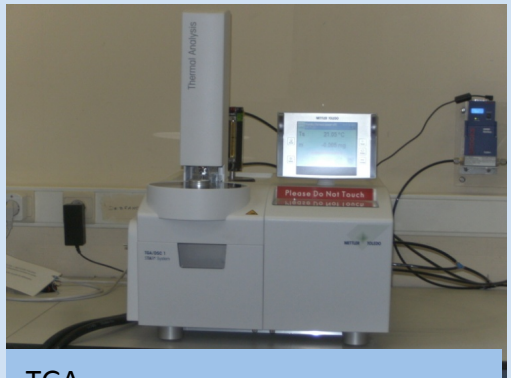
Equipment (4)

- **Microscopy:**



Equipment (5)

- **Thermal properties:**



TGA

MDSC Q1000

MDSC TA2920

Equipment (6)

- **Oils & fats :**

P NMR

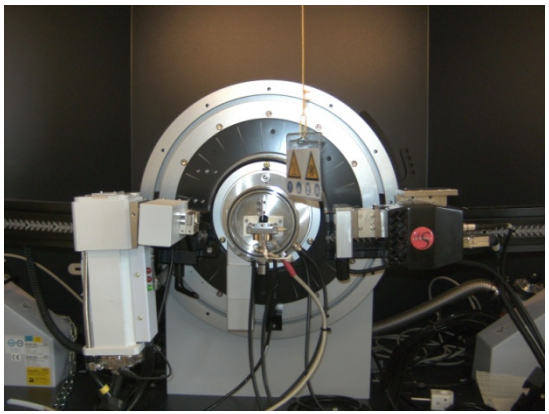
Mettler (CP-DP-…)

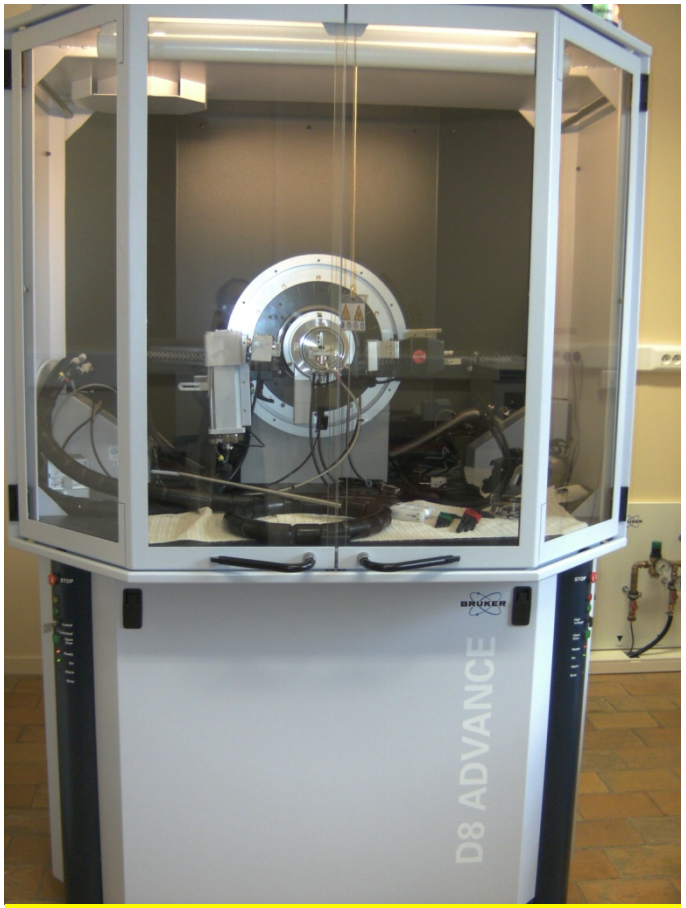
Rancimat

Equipment (7)

Oils & fats :

polymorphism



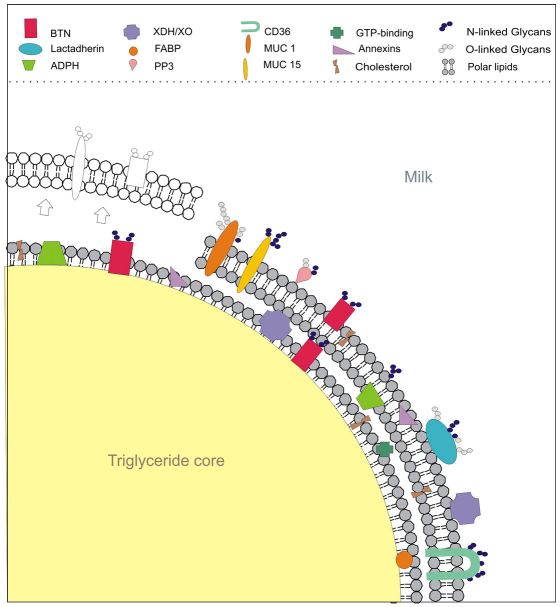


XRD with controlled temperature

From **Fundamental research** To **Applications**

Example : MFGM

- Fundamental understanding : last MFGM models (2000 & 2010)



- Specific research towards purification & fractionation to get new products with added value

- Scaling-up (industrial level)
- By-product valorization (buttermilk)
- Formulation of new products
- Patent : Dalemans D., Blecker C., Bodson P., Danthine S., Deroanne C., Paquot M. (2008). Milk ingredient enriched in polar lipids and uses thereof. International Patent, WO/ 2008/009636

« Extraction, transformation, valorization and utilization of lipids (& by or co-products) »



Fundamental understanding of lipid crystallization (phase behavior diagrams…)
Fundamental understanding of lipid networks building
Elucidation of lipid structures for diversified physical functionalities

Development and/or improvement of soft modification processes (physical/enzymatic) directed towards modulation of lipids functionality

Studies of extraction and refining practices (with valorization of co-products).
Preservative strategies (oxidation)

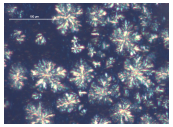





Extraction

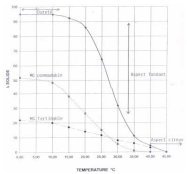
Refining


Crystallization

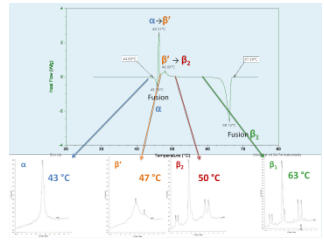


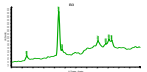
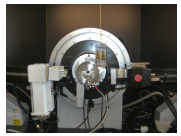
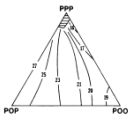
Thermal properties


Fat modifications

Polymorphism



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Example : Puff pastry margarines

Margarines

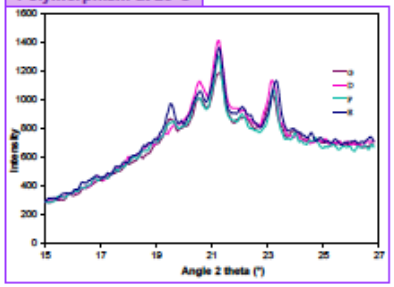
Dropping point (°C)

	Samples	Dropping point (°C)
Commercial	D (TFA 2.9%)	45.6
	E (TFA 4.4%)	45.4
	F (TFA 0.7%)	47.9
	G (TFA 0.9%)	49.8
Laboratory	1	49.7
	2	47.1
	3	47.0
	4	48.7

Hardness at 20°C

	Samples	Hardness (g)
Commercial	D	395.8
	E	237.9
	F	239.6
	G	428.6
Laboratory	1	615.7
	2	563.5
	3	451.4
	4	495.1

Polymorphism at 20°C

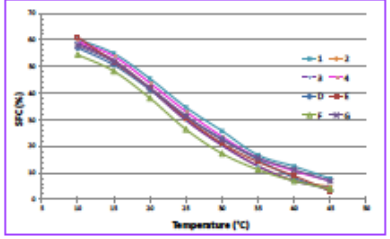


Margarines fat phases

Polymorphism at 15°C

	Samples	Polymorphism (after 3 weeks)
Laboratory	1	β'+ β (<10%)
	2	β'+ β (<<10%)
	3	β'+ β (<<10%)
	4	β'+ β (<10%)

Melting profile (pNMR)



Baking ability


D

G

	Samples	Plasticity	Height development
Commercial	D	brittle	5.3
	E	very good	7.7
	F	soft and sticky	4.2
	G	very hard and brittle	5.2
Laboratory	1	hard	4
	2	good	3.5
	3	hard	3.5
	4	good	3
	Same as D	good	3


Laboratory D


1


2

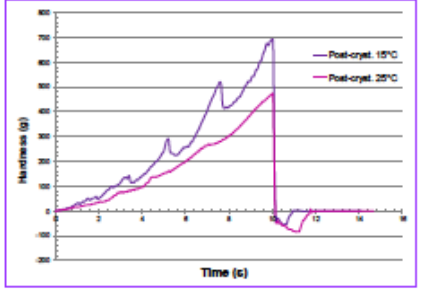

3


4

Post-crystallization influence

One of these formulations has been produced on a pilot scale (Schroëder apparatus with a scraped surface heat exchanger) in order to study the post-crystallization influence. A part of the produced sample has been post-crystallized at 15°C for 48h and another part at 25°C for 48h. After post-crystallization all the samples have been stored at 15°C.

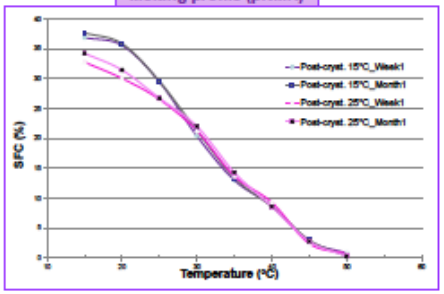
Post-crystallization effect on hardness at 15°C



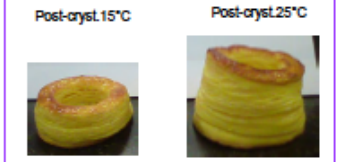
Hardness at 20°C

Storage	Post-cryst.15°C	Post-cryst. 25°C
1 week	542,6	338,5
1 month	516,6	325,4

Melting profile (pNMR)



Baking ability



Polymorphisme at 15°C

Storage	Post-cryst.15°C	Post-cryst. 25°C
1 week	β'_1	β'_1
2 weeks	β'_1	β'_1

⇨Post-crystallization effects are important on the product properties:

- margarines are harder after a post-crystallization at 15°C for 48h (after 1 week, ~630g against ~460g for a 25°C post-cryst.)
- after a post-crystallization of 48h at 25°C margarines present a lower melting profile before 30°C
- margarine's plasticity is different : a post-crystallization at 15°C makes margarine brittle as observed in texture profiles and by preparing the puff pastries. This poor plasticity negatively influences baking ability of the 15°C post-crystallized margarine.

Conclusion

- We can do :
  - Food technology
  - Pilot-scale development
  - Formulation
  - Physico-chemical analysis

- We can not do :
  - Chemical analysis (chromatography)
  - Nutrition

Link to full publications report

http://orbi.ulg.ac.be/orbi-report?query=%28%28uid%3Au300145%29%29&model=a&format=apa&data=metric&data=metrics&data=pr&sort_by0=1&order0=DESC&sort_by1=3&order1=ASC&sort_by2=2&order2=ASC&output=html&language=fr&title=Publications+et+communications+de+Christophe+Blecker+%5Bu300145%5D

We are open to international collaborations

Publications this year with

University of Ghent, Catholic University of Leuven, University of Sfax, University of Tunis, University of Cluj-Napoca