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

Christophe BLECKER

Full Professor, University of Liège
Gembloux Agro-Bio Tech

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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
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 equipments: 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)
Cracking and valorisation of bioproducts (biorefinery concept)

Oils and fat processing

Downstream 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

Final products

• Formulation engineering
  • Study of interactions between ingredients
  • Food model development
  • Full characterisation (physico-chemical and sensory analysis)
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
Cracking: what does it mean?

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

- **Dry Pea Seeds**
  - Cleaning
  - Classification
  - Dehulling
  - Grinding
  - Extraction
  - Sieving
  - Decantation
  - Pasteurization
  - Ultrafiltration
  - Concentration
  - Drying
  - Bagging

  **External Pea Fibre**

  **Pea Protein Isolate**

  **Grinding**
  **Bagging**

- **Purification**
  - Concentration
  - Drying
  - Bagging

  **Native Starch**
  - Heat treatment

  **Instant Starch**

- **Concentration**
  - Drying
  - Bagging

  **Internal Pea Fibre**
  **Grinding**

  **Micronized Fibre**
Industrial valorisation of our research

Mission statement
"To contribute towards safe and healthy food by developing locally grown vegetable crops. To develop exclusive new ingredients from the product line business know-how and tastes for innovation. To improve the health and well-being of each and every person."

Start of pea processing facility
Launch of pea protein Pisane®, pea fibres Swelite® and Exafine® and pea starch Nastar®
Product characterization

- Techno functional properties
- Physical state of powders
- Interfacial properties
- Physico-chemical properties of lipids
Equipment (1)

- **Interfacial properties**
  - Adsorption kinetics, monolayers, CMC...
- Emulsions, foams,...

Equipment (2)

Turbiscan

Foam scan
Equipment (3)

- Rheology, texture analysis, particule/globule sizer,

...
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
Extractions, 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**

sabine.danthine@ulg.ac.be
Example: Puff pastry margarines

### Margarines

<table>
<thead>
<tr>
<th>Samples</th>
<th>Dropping point (°C)</th>
<th>Hardness at 20°C</th>
<th>Polymorphism at 20°C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td></td>
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<td>E</td>
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<td>F</td>
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<td></td>
<td></td>
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<tr>
<td>G</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Samples</th>
<th>Polymorphism (after 3 weeks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>α + β (~10%)</td>
</tr>
<tr>
<td>2</td>
<td>α + β (~10%)</td>
</tr>
<tr>
<td>3</td>
<td>F + β (~12%)</td>
</tr>
<tr>
<td>4</td>
<td>F + β (~12%)</td>
</tr>
</tbody>
</table>

### Baking Ability

<table>
<thead>
<tr>
<th>Samples</th>
<th>Polymorphism</th>
<th>Height development</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td></td>
<td>Good</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>Good</td>
</tr>
<tr>
<td>F</td>
<td></td>
<td>Very hard and brittle</td>
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<td>G</td>
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### Post-crystallization Influence

One of these formulations has been produced on a pilot scale (Schroeder 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.

### Polymorphism effects on hardness at 20°C

<table>
<thead>
<tr>
<th>Samples</th>
<th>Hardness at 20°C</th>
</tr>
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<tbody>
<tr>
<td>D</td>
<td>516.5</td>
</tr>
<tr>
<td>E</td>
<td>502.3</td>
</tr>
<tr>
<td>F</td>
<td>461.4</td>
</tr>
<tr>
<td>G</td>
<td>496.1</td>
</tr>
</tbody>
</table>

### Melting profile (pHMR)

<table>
<thead>
<tr>
<th>Samples</th>
<th>Post-eut. 10°C</th>
<th>Post-eut. 20°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td></td>
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<tr>
<td>E</td>
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</tr>
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<tbody>
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<td>D</td>
<td></td>
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<td>E</td>
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Post-crystallization effects are important on the product properties:
- Margarines are harder after a post-crystallization at 15°C for 48h (after 1 week, ~516.5 against ~502.3 for a 25°C post-crystallized)
- 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=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