New technological concepts for more healthy and sustainable foods

Atze Jan van der Goot

12 October 2015
Raw materials are high tech systems

- Raw material have two main characteristics
  - Composition
  - Structure

- Combination gives biological activity
## Plant materials as a source for ingredients

<table>
<thead>
<tr>
<th>Crop, DM%</th>
<th>Protein</th>
<th>Carbohydr.</th>
<th>Lipids</th>
<th>Ash</th>
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<tbody>
<tr>
<td>Lupine</td>
<td>40.4%</td>
<td>45.1%</td>
<td>10.9%</td>
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</tr>
<tr>
<td>Soybean</td>
<td>39.9%</td>
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<td>Potato</td>
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Raw material have two main characteristics:

- Composition
- Structure
Forgetting structure: inefficient

- Eco-exergy
  - Living organisms contain more work energy than just the chemical energy of their components
  - Components have to be organized (contain information via genomes) to allow biological activity

- Beta-factors: ratio work energy/chemical energy
  - Algae: 20
  - Plant: 275
  - Fish: 500
High-tech in non-bio industry

- Creating structured materials using unstructured materials
  - Chips (nano- and microstructuring) ASML
  - Assembly industry (cars)
But still: focus on single ingredient purity

Raw material → Pure ingredient → Product

- Protein Isolate
- Oil
- Carbohydrates

Rest: to non-food applications

Isolation & stabilizing

Mixing with water and heat
The dilemma: yield and purity

- Plant materials contain a wide variety of ingredients.

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(Ingredient) production

- 1ᵉ generation
  Production of one single ingredient; remaining material was waste

- Advantages
  - Well-defined ingredients
  - Global sourcing and exchangeability
  - Safe
Food (ingredient) production

- 1\textsuperscript{st} generation
  Isolation of primary product, disposal of all other components with waste water

- 2\textsuperscript{nd} generation
  Waste water \textit{treatment} through anaerobic/aerobic digestions

- 3\textsuperscript{rd} generation
  Isolation of all components for high-value products
Ingredient production

- **1<sup>st</sup> generation**
  Production of single ingredient; rest is waste

- **2<sup>nd</sup> generation**
  Production of single ingredient + waste (water) treatment

- **3<sup>rd</sup> generation**
  Use of all (at least more) ingredients from one single source
  - Starch and proteins
Pure ingredients do not supply sufficient functionality

Mixing of ingredients as alternative to separation?
Do we need pure ingredients for food production?

- It is convenient during production
  - Well-defined, stable ingredients
  - Quality control and food safety
  - Supply chain management

- But:
  - Hardly any food product consists of 1 single pure ingredient
  - Structures present in natural materials and presence of complex molecules might possess interesting properties
    - Carbohydrate-protein complexes for emulsification
Emulsion stabilisation using polysaccharide–protein complexes

M. Evans, I. Ratcliffe, P.A. Williams *
Centre for Water Soluble Polymers, Glyndwr University, Plas Coch, Mold Road, Wrexham LL11 2AW United Kingdom

Abstract

There is a great deal of interest in the Food Industry in the use of polysaccharides and proteins to stabilise oil-in-water emulsions and there is a particular interest nowadays in the use of polysaccharide–protein complexes. There are three classes of complexes namely; (a) naturally-occurring complexes in which protein residues are covalently attached to the polysaccharide chains as is the case, for example, with gum Arabic; (b) Maillard conjugates, which are formed by interaction of the reducing end of a polysaccharide with an amine group on a protein forming a covalent bond; and (c) electrostatic complexes formed between a polysaccharide and a protein with opposite net charge. This review sets out our current understanding of the nature of these different polysaccharide–protein complexes and their ability to stabilise oil-in-water emulsions.
Towards functional ingredients

Raw material → Functional fraction → Product

Fractionation

Structuring
Classical processes make use of structure properties

- From wheat flour to bread
  - Dry fractionation
  - Dough making (wheat flour fraction, water + salt)
  - Drying through baking

- From barley to beer:
  - Barley is used for ingredients + enzymes
Modern technology: Gluten-free breads

- Many ingredients
- Not as tasty as regular bread
- Very expensive
- Not sustainable

…..other approach might be necessary
A closer look at the meat alternative ingredients

- **SPC + water**
  - Obtained through removal of oil and soluble ingredients
  - Fibrous structures in shearing device and extruders

- **SPI + water**
  - Extensive purification procedure
  - Does not give fibrous structures in shearing device or extruder
  - Functional properties for structuring are less good than SPC

Less purified ingredients have better functional properties for making meat alternatives!
Health and meat alternatives

- Health benefits
  - More fibres
  - Less (animal) proteins
    - Actual consumption of protein exceeds the need (about 30%)
- Polysaccharide advantages in structuring processes
- Soy concentrate in stead of soy protein isolate
- Towards functional fractions rather than pure ingredients
Dry fractionation: focus on functionality

Maarten Schutyser
Potential applications of functional fractions

- Pea concentrate in fish feed:
  - Protein nutrition; starch binder
- Plant concentrates in low fat mayonnaise
  - Protein surfactant, starch thickener
  - Carbohydrate-protein complexes
- Soy concentrate as meat alternative
  - Protein replacement
  - Carbohydrate structuring agent
- Gluten-enriched wheat flour
  - Bread improver
Food Emulsions

- Created by mixing water, oil and surfactants and thickening agents

- Challenge
  - making small (oil) droplets
  - making stable droplets
Oil bodies

cryo-SEM (*sunflower cell*)

Schematic representation of an oil body analyzed by Small Angle Neutron Scattering -preliminary data-
Oil bodies

Aqueous extraction of proteins and oil bodies

Sunflower seed cell

Advantages
• No organic solvents to extract oil
• No emulsification step
• High physical stability

Applications
• Plant-based dairy-like products
• Beverages, mayonnaise, salad dressings
• Plant-based ice-creams

Costas Nikiforidis
Food (ingredient) production

- 1st generation
  Isolation of primary product, disposal of all other components with waste water

- 2nd generation
  Waste water treatment through anaerobic/aerobic digestions

- 3rd generation
  Isolation of all components for high-value products

- 4th generation...
  Functional fractions
  No dilution, milder conditions, less focus on purity, more focus on structure: possibly healthier ingredients
Towards high tech systems in foods

- Raw materials are high-tech systems
  - Structure provides new properties
  - Bio-material differs from fossil raw material
    - High water content and contain structure

- Food Processes should therefore be mild and designed such that structure is preserved or used in better manner
  - Dry Fractionation
  - Aqueous fractionation

- Requires significant scientific efforts to understand the behaviour of those complex food and biomaterials

WAGENINGEN UNIVERSITY
Food Valley Expo’15: High tech systems in food

New technological concepts for more healthy and sustainable foods

Atze Jan van der Goot

12 October 2015

Remko Boom
Albert van der Padt
Pascalle Pelgrom
Costas Nikiforidis

Maarten Schutyser
Jacqueline Berghout
Marlies Geerts