4th international conference on Food Processing and Technology

Concepts for more healthy and sustainable food (ingredients)

Atze Jan van der Goot

London, 11 August 2015

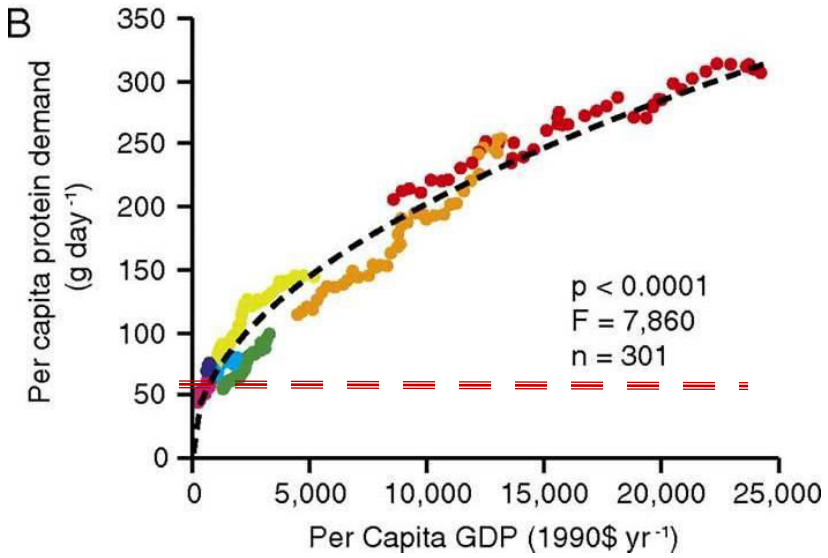


WAGENINGEN UNIVERSITY
WAGENINGEN UR

Food production today



- Food industry[1]
  - 14% of all energy use
  - 10% of all water
  - Produces 10% of all waste



- Diet becomes more inefficient with increasing welfare with respect to energy consumption and raw material use



Tilman, 2011

[1]Poynton, 2006

Causes of inefficiencies

- Consumption of animal products and use of components from animal origin
  - Protein conversion from plant to animal is not efficient

- Production of highly refined ingredients
  - Low yield (60%), energy, water and chemicals consumption

- Waste production





WAGENINGEN UNIVERSITY
WAGENINGEN UR

Solutions

- Towards reduced consumption of products from animal origin
  - Direct replacement by plant-products
  - Role of structured plant-based products

- Towards ingredient production with higher efficiency
  - Reduced use of energy, water and chemicals
  - Making the right ingredients instead of ingredients with general applicability
  - Smaller and dedicated processes

- Producing less waste
  - presenting food in a different manner

WAGENINGEN UNIVERSITY
WAGENINGEN UR



A fibrous materials to mimic meat

- Extrusion





- Alginate technology
  - $CaCl_2$ addition upon mixing

- Methods based on mixing process





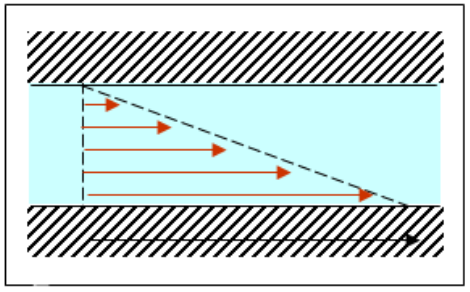




- Making structures is not the same as mixing ingredients

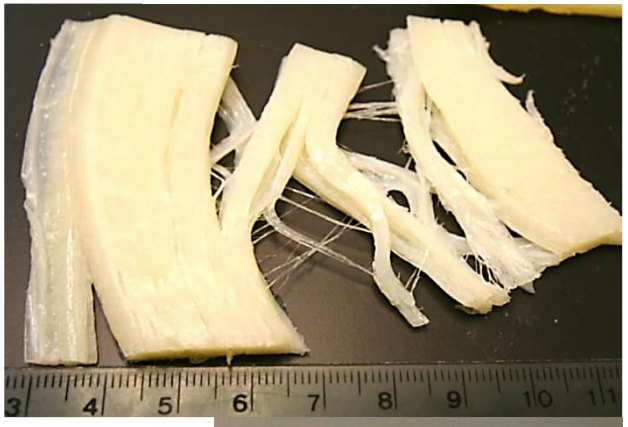
WAGENINGEN UNIVERSITY
WAGENINGEN UR

Shear-induced structuring is a tool to make fibrous protein structures













WAGENINGEN UNIVERSITY
WAGENINGEN UR

Summary production meat alternatives



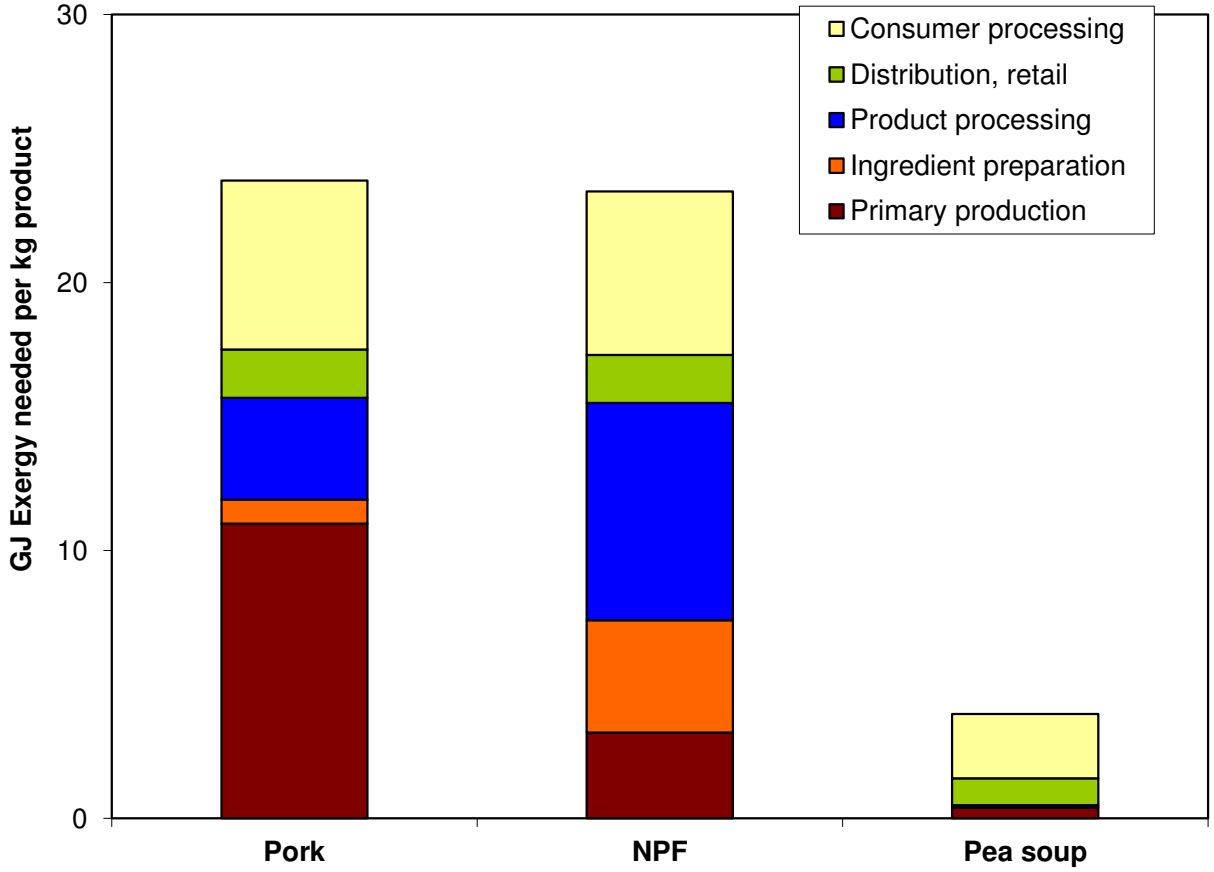
- Current products made by extrusion are of high quality
  - Structure resembles meat already
- Shear-induced structuring is a promising method to make anisotropic and fibrous materials from dairy and plant proteins
  - Energy efficient
    - Structuring rather than modifying a mixing process
    - Mild process
- Not all ingredients have good structuring potential (also for extrusion)
  - SPC soy protein concentrate
  - SPI-WG soy protein isolate – wheat gluten



Are plant based protein foods sustainable?



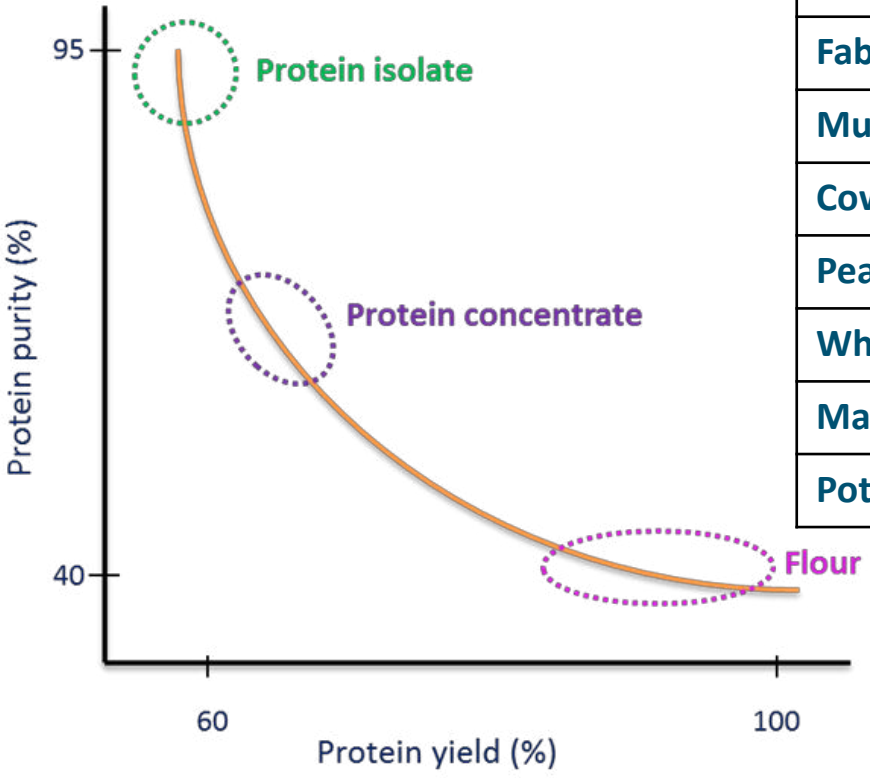
- *Exergy* consumption in production of 1 kg
- A meat analogue is not always more sustainable than meat
- Outcomes confirmed in other studies



(Apaiah et al., 2006)

Plant materials as a source for ingredients

- Plant materials contain a wide variety of ingredients.
- Animal products: protein-fat



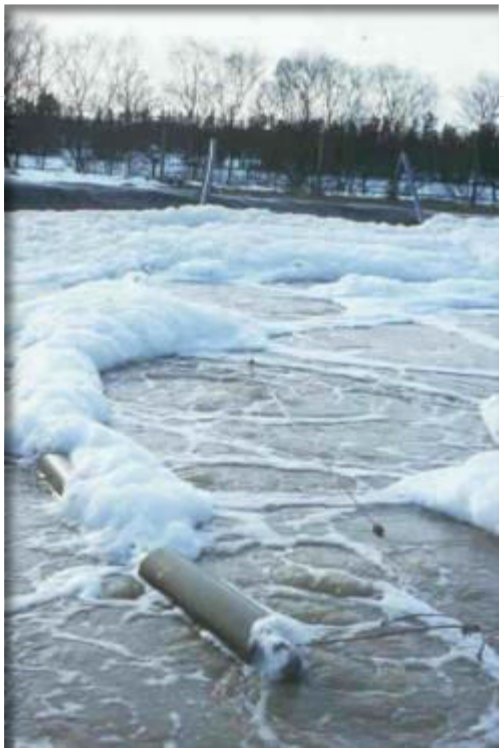
Crop, DM%	Protein	Carbohydr.	Lipids	Ash
Lupine	40.4%	45.1%	10.9%	3.7%
Soybean	39.9%	33.0%	21.8%	5.3%
Fababean	29.3%	65.5%	1.7%	3.5%
Mung bean	28.3%	66.1%	1.8%	3.8%
Cowpea	26.7%	68.2%	1.4%	3.7%
Pea	25.6%	68.4%	1.9%	4.1%
Wheat	15.4%	79.9%	2.8%	2.0%
Maize	10.5%	82.9%	5.3%	1.3%
Potato	9.8%	84.6%	0.4%	5.2%





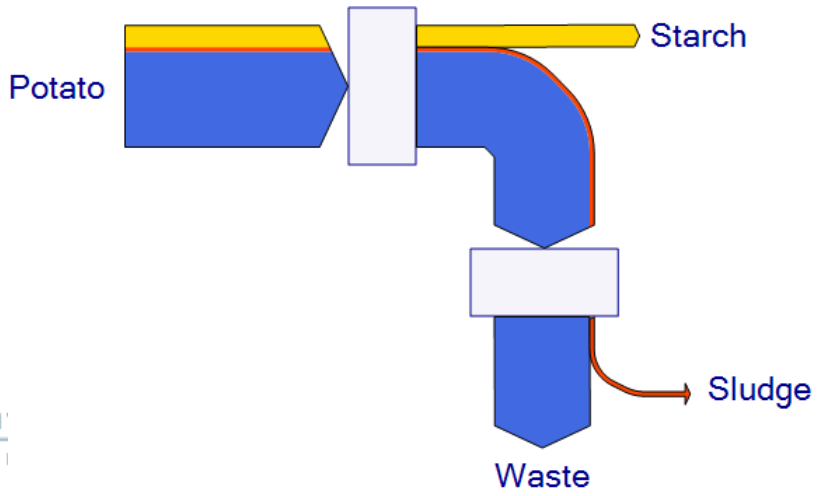
WAGENINGEN UNIVERSITY
WAGENINGEN UR

(Ingredient) production



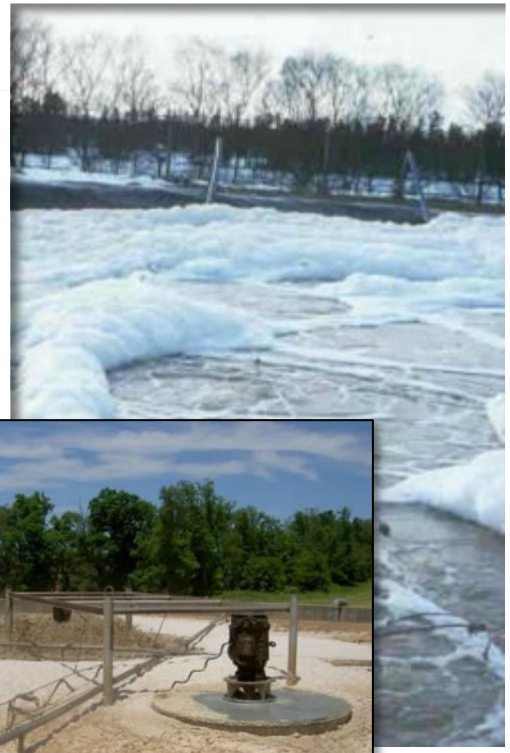
- 1e generation
  Production of one single ingredient; remaining materials was waste

- Advantages
  - Well-defined ingredients
  - Global sourcing and exchangeability
  - Safe



Ingredient production

- 1st generation
  Production of single ingredient; rest is waste
- 2nd generation
  Production of single ingredient + waste (water) treatment)
- 3rd generation
  Use of all (at least more) ingredients from one single source
  - Starch and proteins



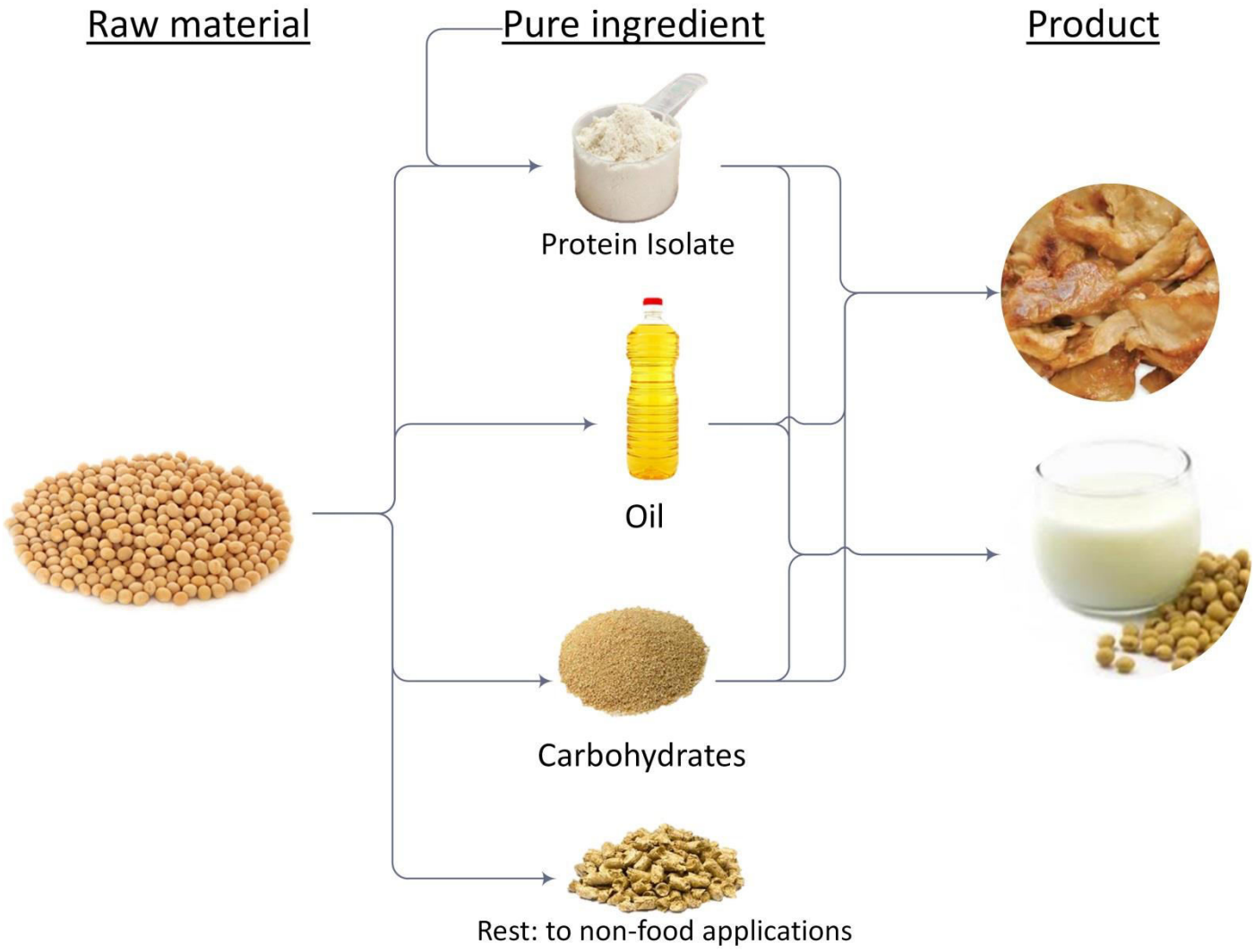
solanic

WAGENINGEN UNIVERSITY
WAGENINGEN UR





But still: focus on purity



Isolation & stabilizing

Mixing with water and heat

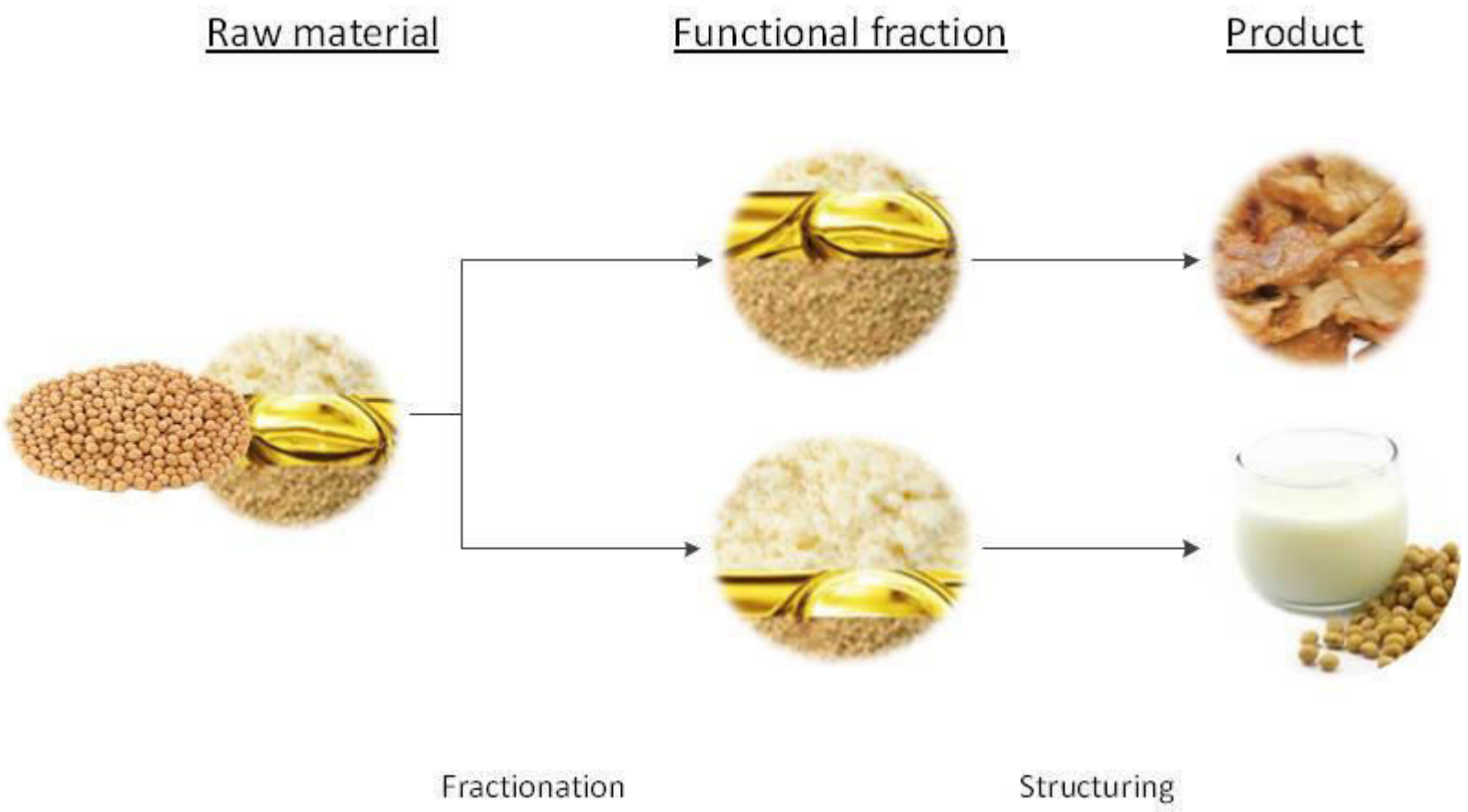
Do we need pure ingredients for food production?

- It is convenient during production
  - Well defined, stable ingredients
  - Quality control
  - 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



Towards functional ingredients



A closer look at the meat alternative ingredients





- SPC (65% protein+35 % carbohydrates) + water
  - Obtained through removal of oil and soluble ingredients
  - Fibrous structures in shearing device and extruders

- SPI (>90% protein)+ 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!

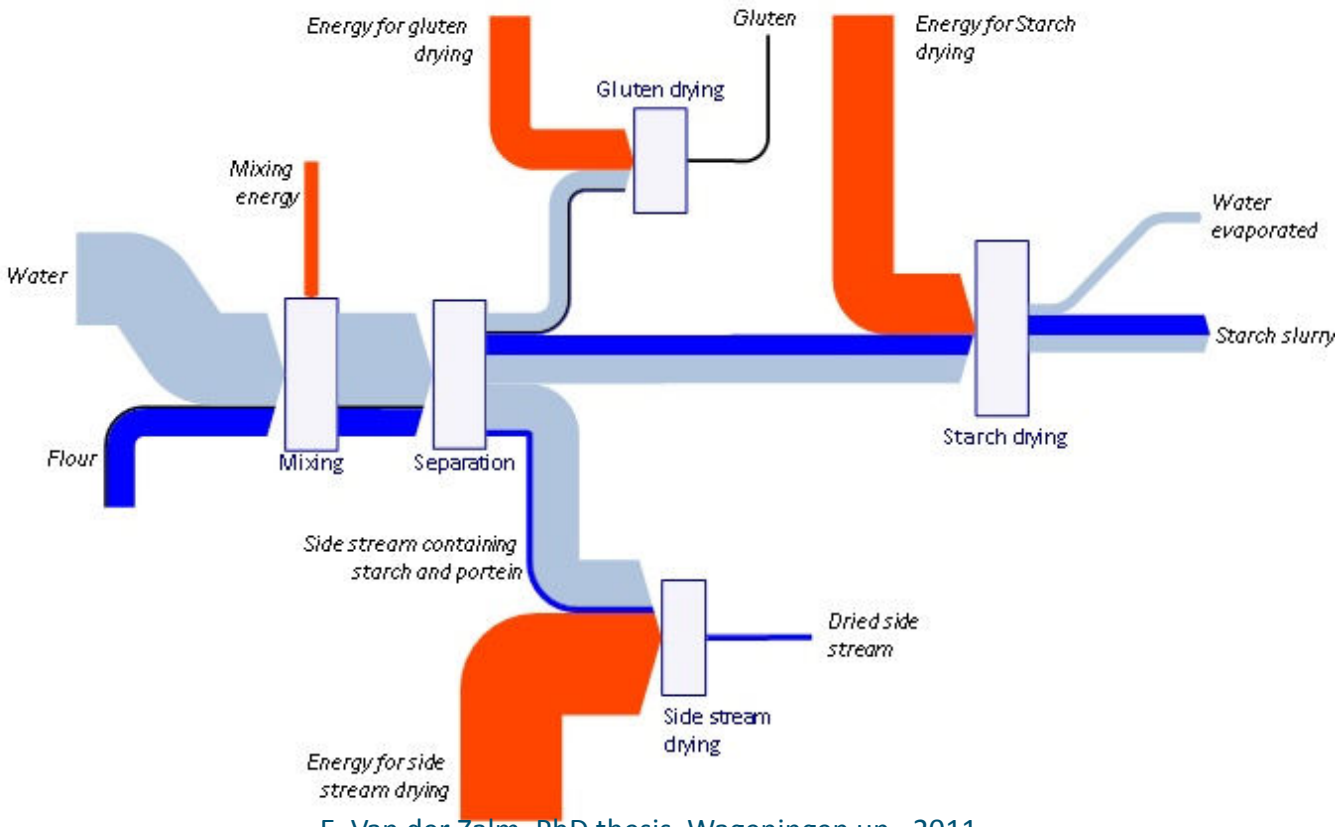
Less focus on purity: new processing options

Wheat fractionation

- High in water and thus in energy
- Part of flour lost in waste water → waste water treatment and loss of raw material

Simplified process lay-out

Width of the arrows indicates size of the streams



E. Van der Zalm, PhD thesis, Wageningen un., 2011

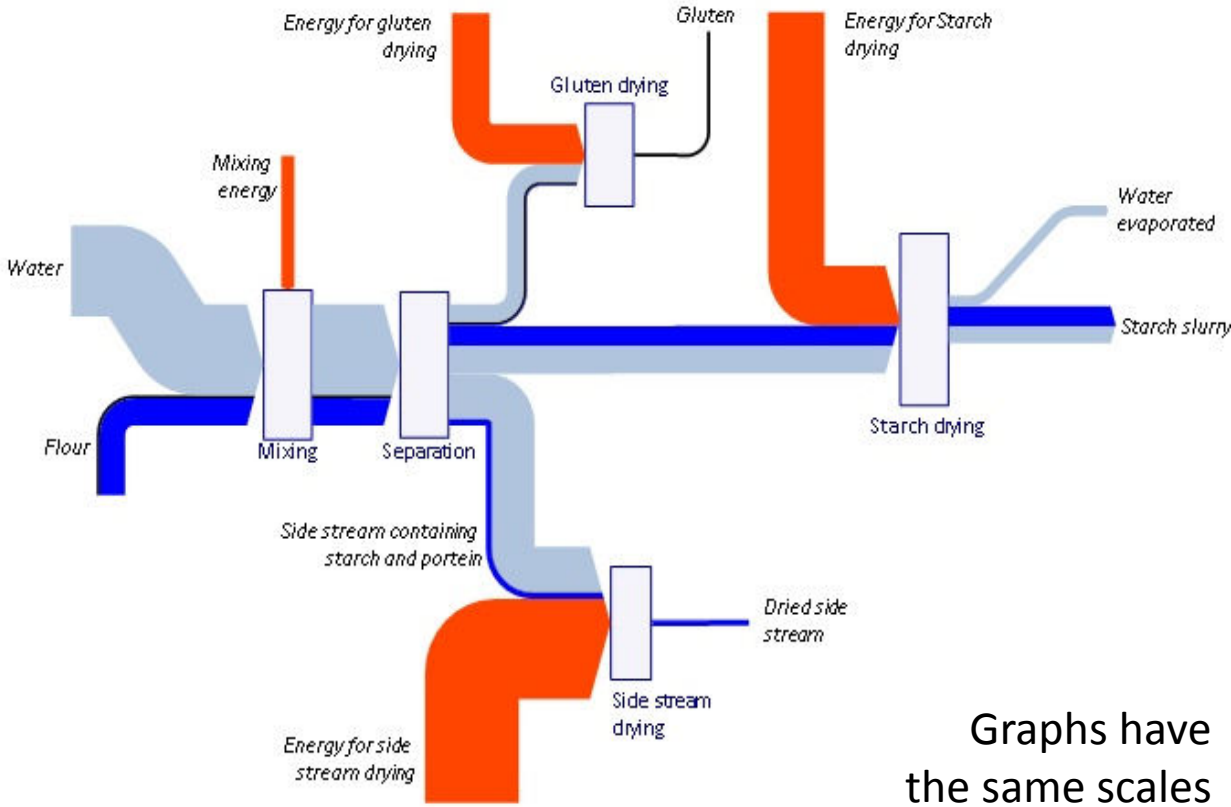
A new method



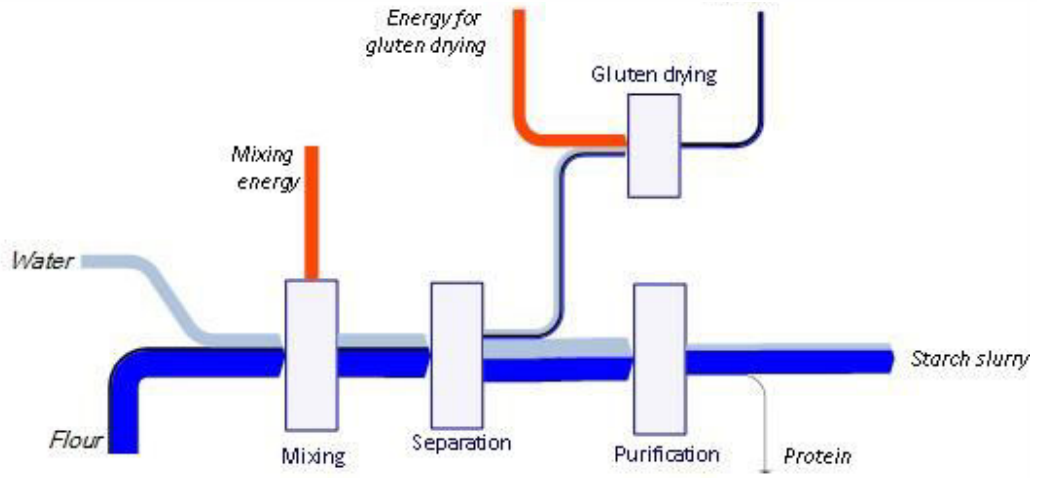
E. Van der Zalm, PhD thesis, Wageningen Univ., 2011



WAGENINGEN UNIV
WAGENIN

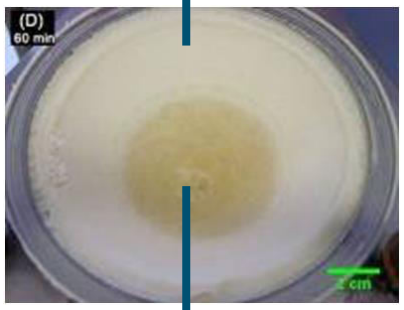


Graphs have the same scales



And coupling to application



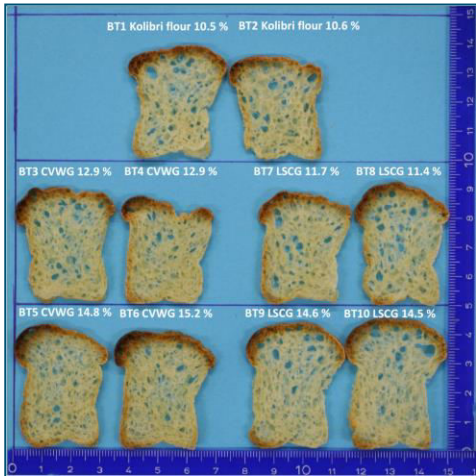




Shear separation leads to
- 60% Protein (vs 80% vital wheat gluten)
- Starch with 2% protein (vs 0.2 commercial starch)
- Much better functional properties

Separation near application
- efficient use of material
- less drying
- water used in separation can be used in application

Focus on functionality rather than purity



WAGENINGEN UNIVERSITY
WAGENINGEN UR

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: possibly healthier ingredients
  - Dedicated, smaller processes close to application





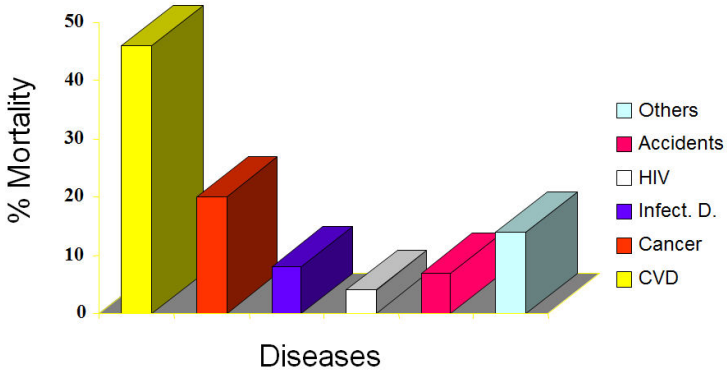


Staple foods and highly refined ingredients

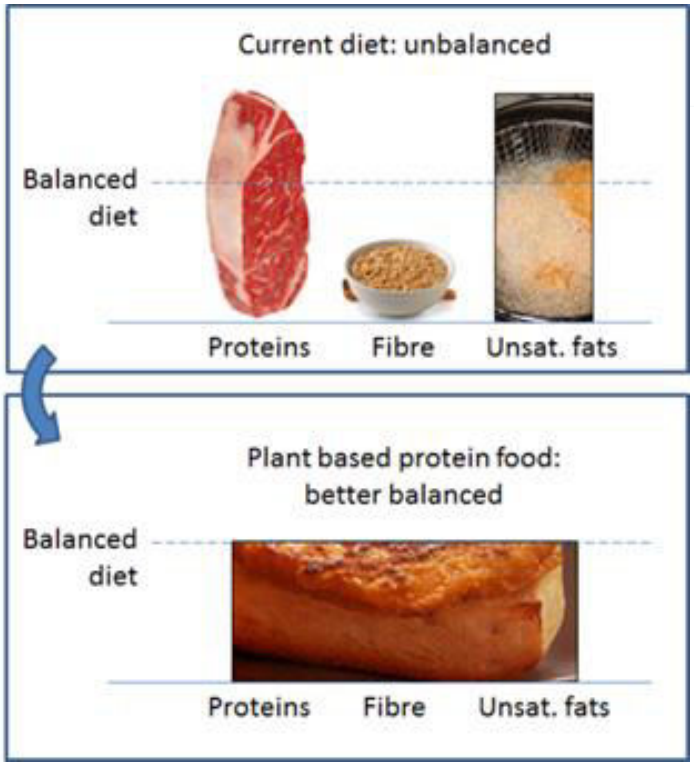
- Production of agro products is focused on yield rather than nutritional value
- Highly refined ingredients lack micronutrients
- Malnutrition and obesity



- Starch as thickener
  - Highly refined: loss of nutritional value "empty calories"
  - Less purification
    - Fibres, vitamins, minerals
    - Overall health effect to be determined



Health and meat alternatives



- Soy concentrate in stead of soy protein isolate
- Health benefits (?)
  - More fibres
  - Less (animal) proteins
    - Actual consumption of protein exceeds the need (about 30%)
- Polysaccharide advantages in structuring processes

- Towards functional fractions rather than pure ingredients

Products and Processes of the Future

- A need exists for more healthy products produced in a sustainable manner
- Positive developments plant-based meat alternatives
  - Alternatives for cheese, egg, fish etc
  - Ingredient production should be sustainable
- Production of healthy food ingredients in a sustainable manner is possible!
  - Less focus on purity (functionality, mixing flours instead of separation)
- Large changes in process chain design and increased interaction between ingredients production and structuring/assembly process
- Requires significant scientific efforts to understand the behaviour of those complex food and biomaterials





WAGENINGEN UNIVERSITY
WAGENINGEN UR

Towards sustainable and healthy foods

Thanks to:

TU Delft

The Peas Foundation

ISPT

Sustainability by Innovation in Processing

Unilever

Remko Boom
Georgios D. Stefanidis
Costas Nikiforidis
Kasia Grabowska
Pascalle Pelgrom
Birgit Dekker
Jarno Gieteling
And others..
Workshop WU and TU Delft
Many MSc and BSc students

Maarten Schutyser
Jaap Keijer
George Krintiras
Jacqueline Berghout
Marlies Geerts
Lena Jankowiak
Jos Sewalt



WAGENINGEN UNIVERSITY
WAGENINGEN UR

www.wageningenur.nl/foodstructuring
Atzejan.vandergoot@wur.nl