Processing technologies towards novel rye products

Nordic Rye Forum Seminar 2019

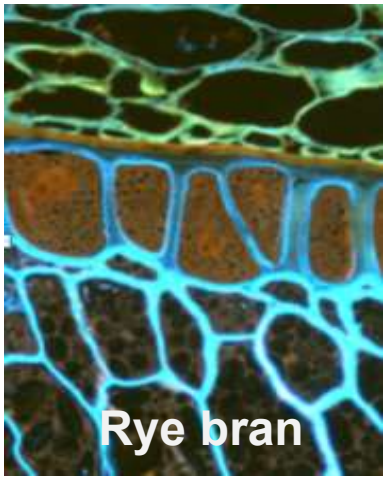
Markus Nikinmaa

How can we use natural resources in a smart way for food production?

- Current plant processing side-streams could meet the yearly protein need of over 2 billion people
- Concentration and functionalisation is often needed for plant protein use

- Instead of pure isolates, focus on the **complex food systems and hybrid-ingredients enriched in desirable components**

- **Use of cereal brans**
  - "Hybrid ingredients" **as such**
  - **Dry fractionation** (including milling and air classification) as a useful tool to produce refined hybrid-ingredients

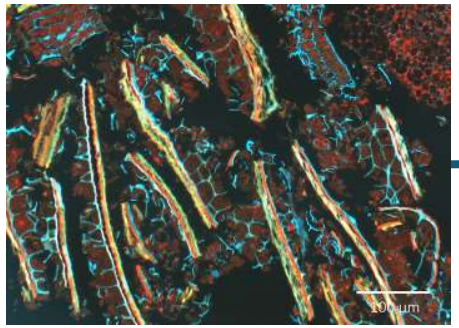


15-20% protein
40-45% dietary fibre
13-20% starch
4-5% fat

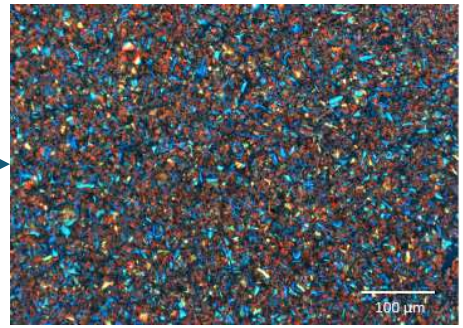
Hybrid Ingredients – protein and fibre rich ingredients with high functionality

- High protein and fibre foods with a single ingredient
- Technological and nutritional benefits from all the components

Cereal bran raw material



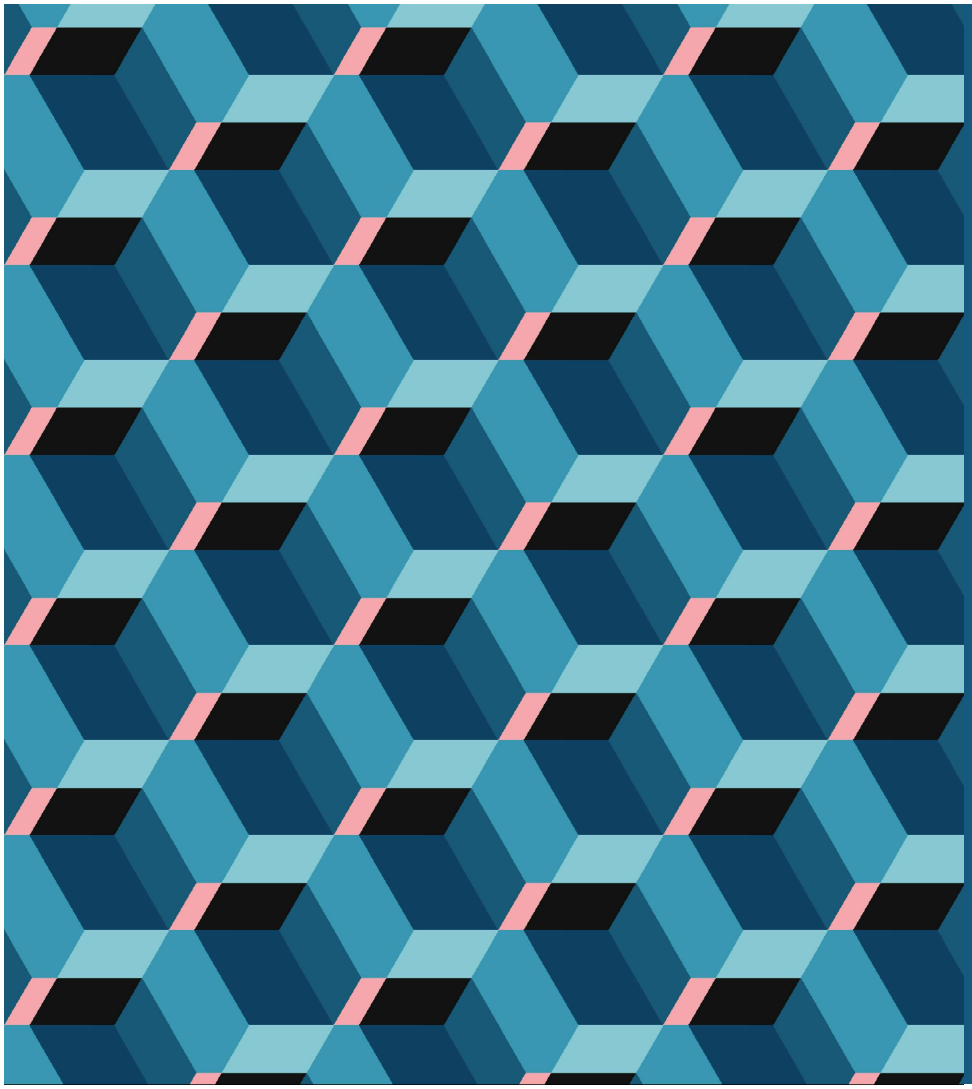
Hybrid ingredient from cereal bran



To use plant raw materials maximally and minimize waste streams we should adapt moderate fractionation concepts that ensure high functionality and nutritional quality

Rye hybrid ingredients

- How do we produce hybrid ingredients?
- Protein enriched fine-fraction
  - Use in wet foam systems
- Dietary fibre (DF) enriched coarse-fraction
  - Use in dry-brittle foam systems
- Improvement of technical functionality by various processes



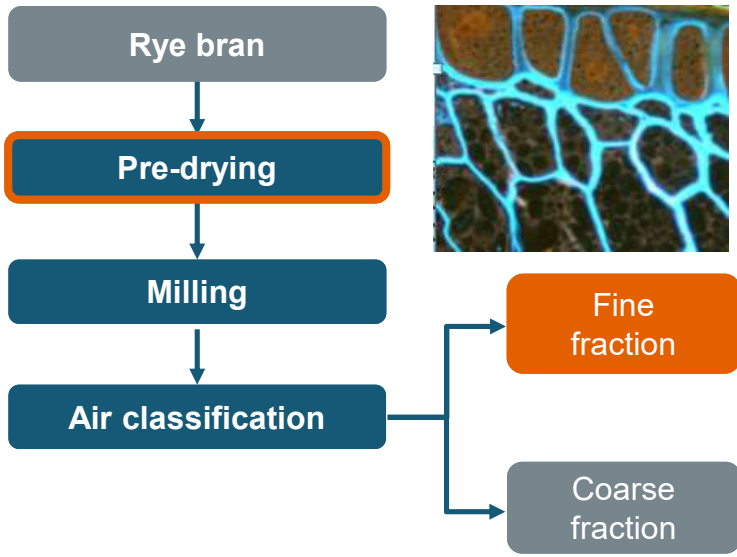
How do we produce hybrid rye ingredients?

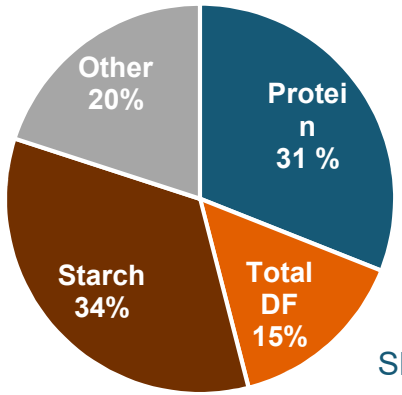
Dry fractionation is a sustainable and gentle process that enables production of hybrid ingredients

- **Fractions enriched** in desired components
  → Protein and fibre
- **Multi-functional** ingredients
- **Maximal use** of raw materials
- **No water, no heat treatment, no solvents**
- **Native properties** of the components are **retained**

Dry fractionation - Rye bran

In the raw material:
Protein: 15%
SDF/IDF:0.19

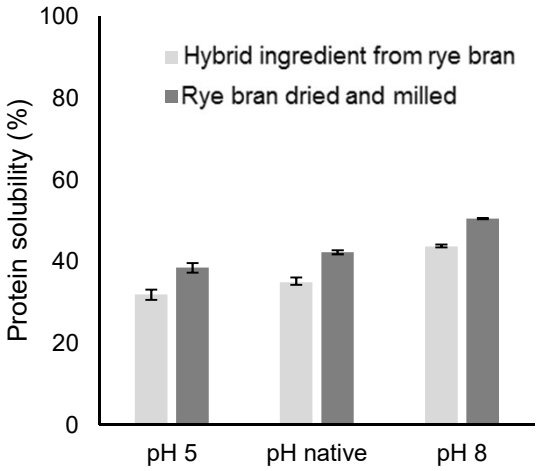




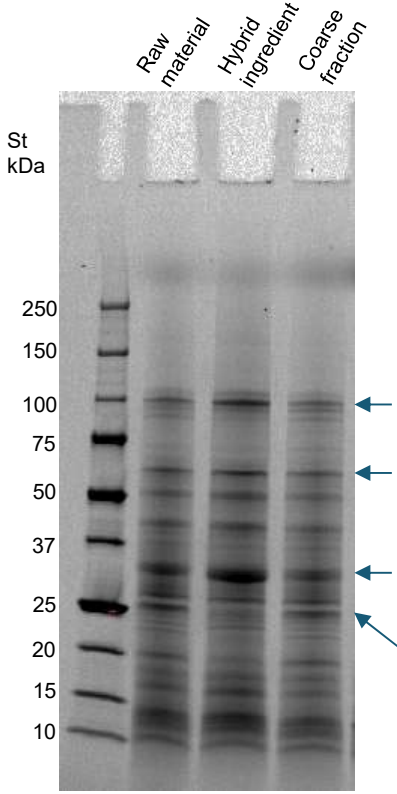
SDF/IDF: 0.62

Rye bran hybrid ingredient

Techno-functional and protein properties



	Oil binding capacity	Water binding capacity
	g/g	g/g
Milled raw material	1.0 ± 0.02	1.2 ± 0.07
Hybrid ingredient	1.4 ± 0.00	1.5 ± 0.01

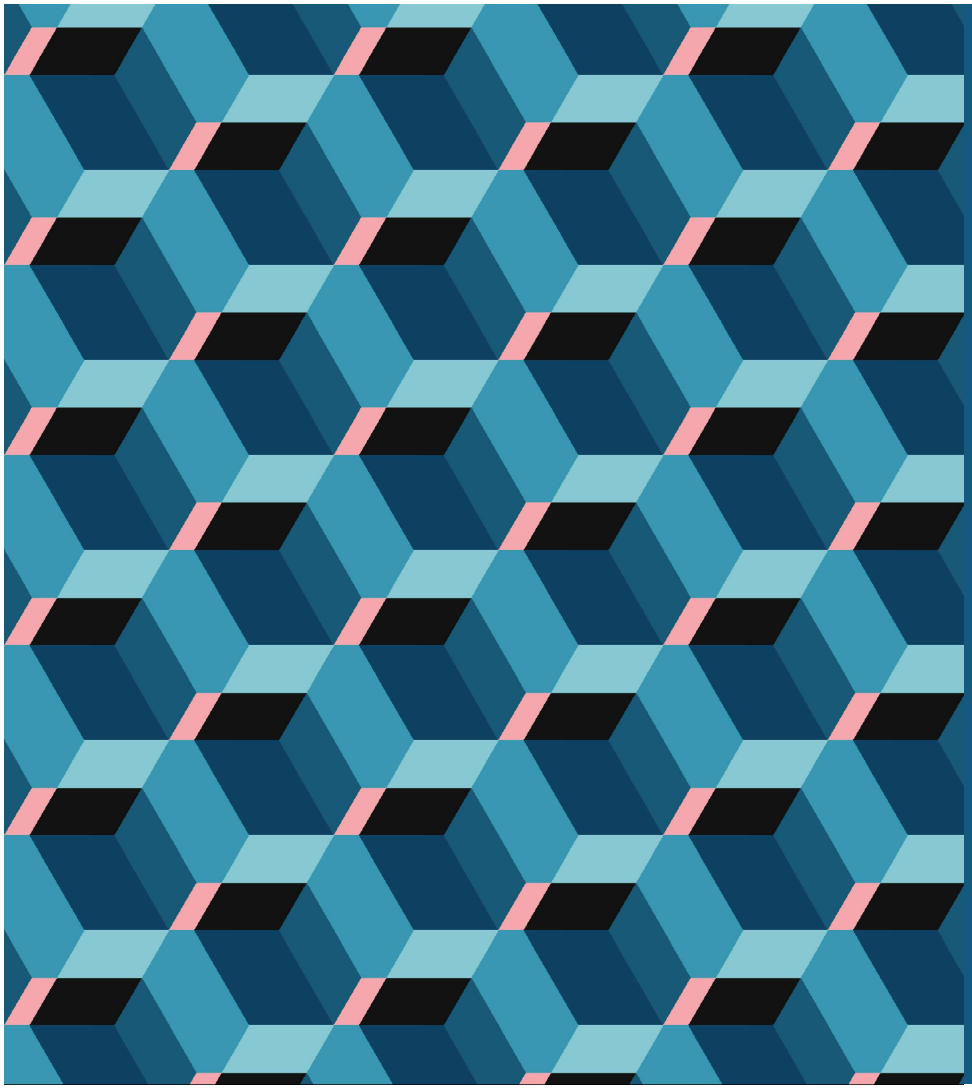


Peptides at around 100 kDa: HMW secalins→ enriched in the hybrid ingredient

Peptides at ~60 kDa can be either secalins or albumins → sligthly enriched in the fine fraction

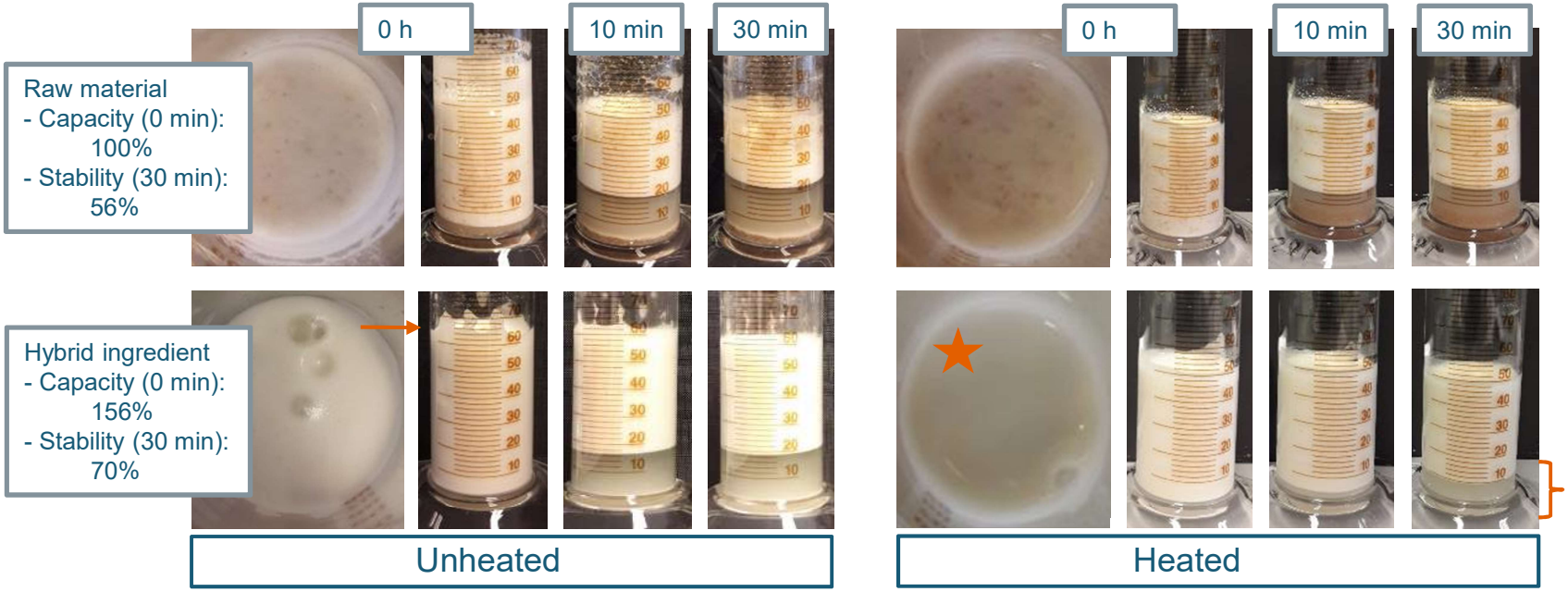
Clearest was the enrichement of a peptide at around 30kDa that can derive from albumins

The band at 25 kDa enriched to the coarse fraction and was removed from the hybrid ingredient



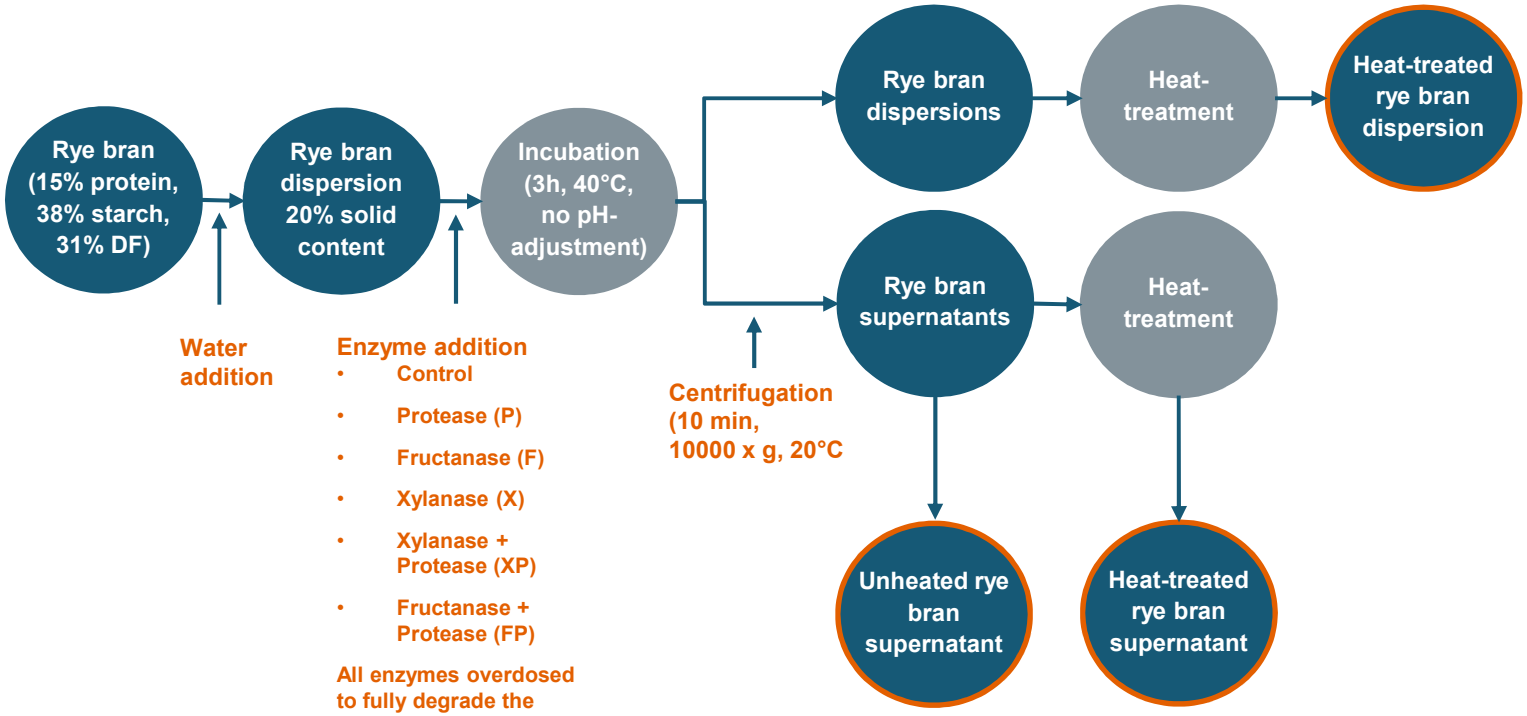
Wet foam models based on rye

Rye bran hybrid ingredient
Foaming properties



Foam preparation: 4% solid content, mixing for 1 min with Aerolatte, no pH adjustment
Heating: 10 min at 95 °C

Rye bran based foams
Materials and methods



Foams from rye bran dispersions

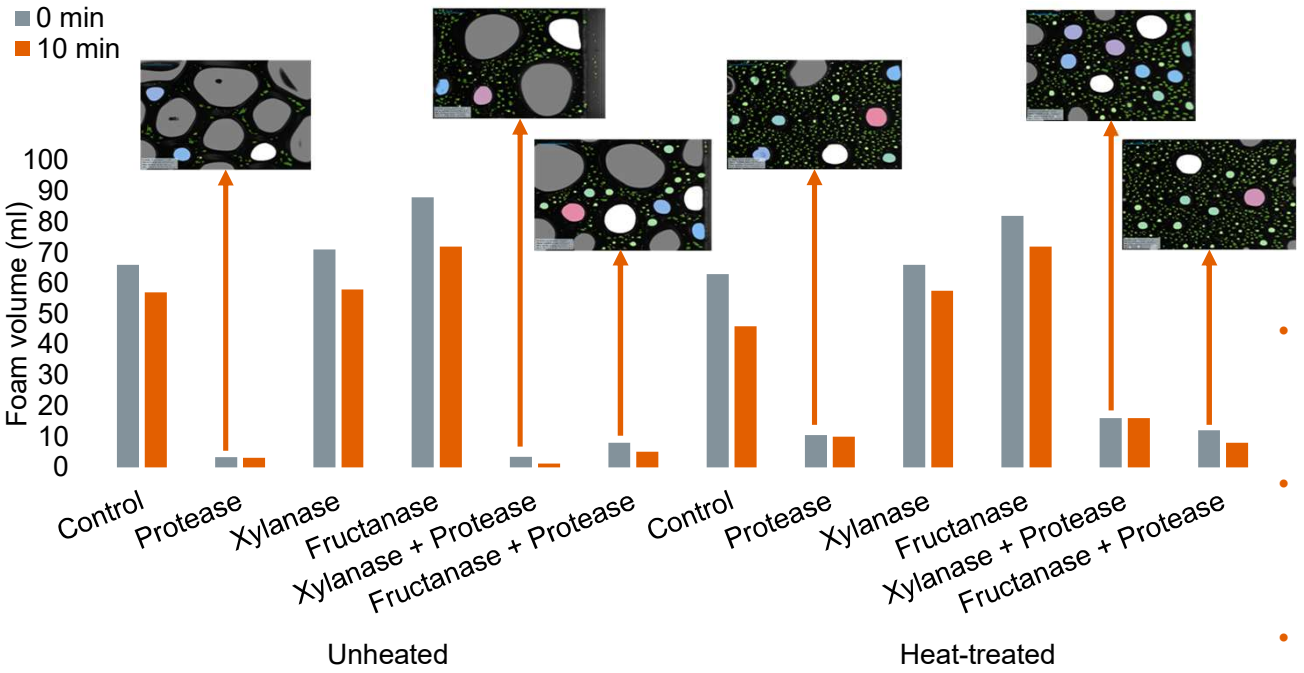
Effect of enzyme treatment on visual appearance and volume

Control | Fructanase | Xylanase | Protease | Protease & Xylanase | Protease & Fructanase

- All the enzymatic treatments decreased foam volume.
- Hydrolysis of rye bran proteins with proteases inhibited the foam formation of rye bran dispersions

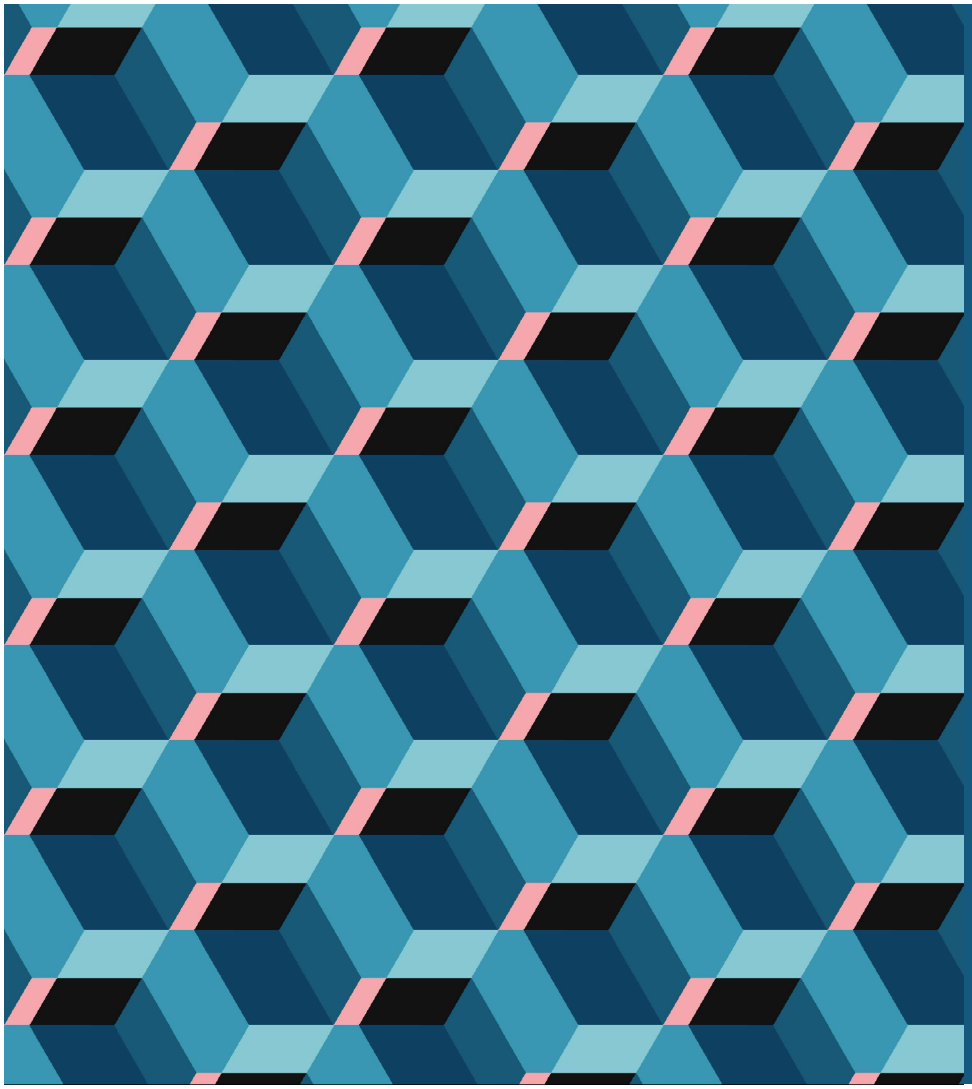
Foams from rye bran supernatants

Effect of enzyme treatment on foam characteristics



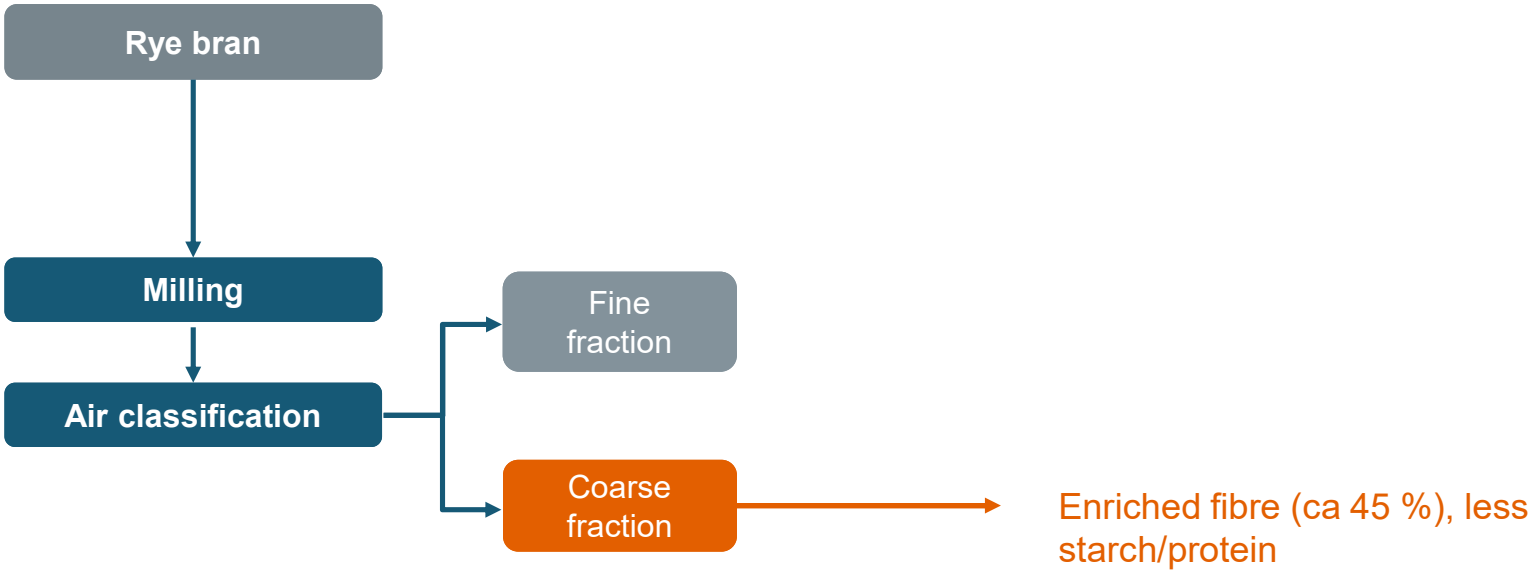
Dynamic Foam Analyzer – DFA100 - KRÜSS GmbH

- No clear impact of heat-treatment on foam capacity or stability
- Degradation of fructans and pentosans improved foam stability
- After proteolysis no foam formation



Brittle foam systems based on rye

Production of DF-enriched fraction



Need: Improve healthiness of extruded products

- Rye bran coarse fraction is an excellent source of dietary fibre

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- Rye bran coarse fraction is an excellent source of dietary fibre
- **However**:

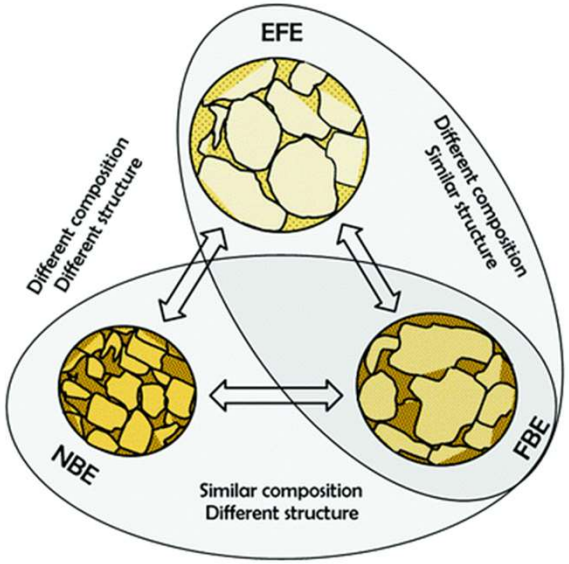
Further processing is needed!

100 % rye endosperm flour

40 % bran
60 % rye endosperm flour

Goal: Extrudates with "the best of both worlds"

Endosperm flour extrudate

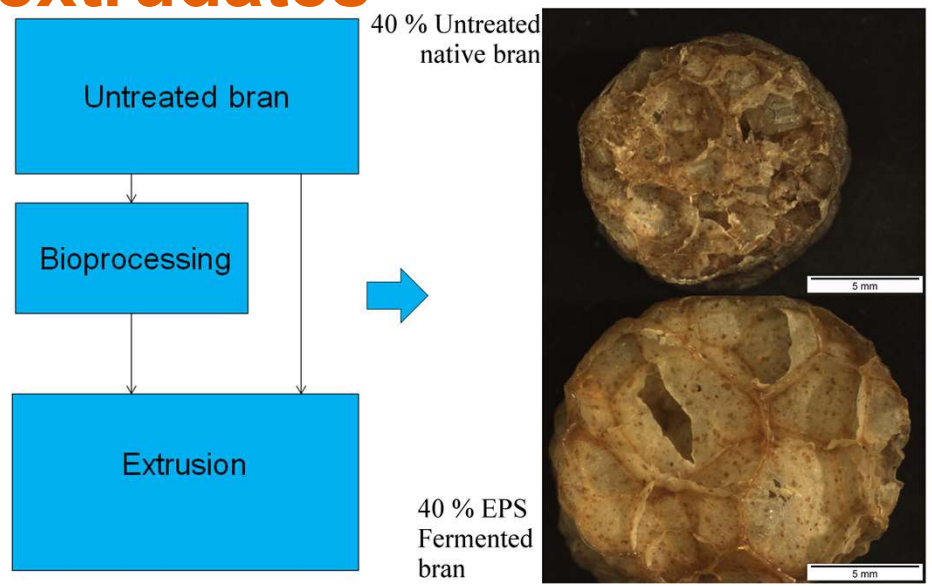


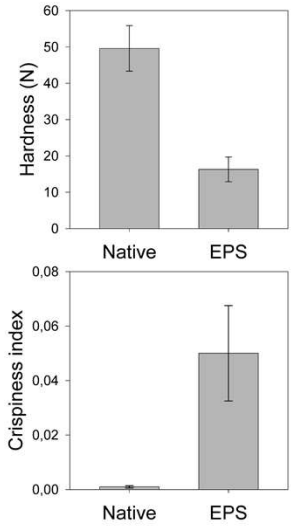
Native bran enriched extrudate

Fermented bran enriched extrudate

Figure: Alam et al. (2019)

LAB fermentation improved expansion and texture of rye bran supplemented extrudates

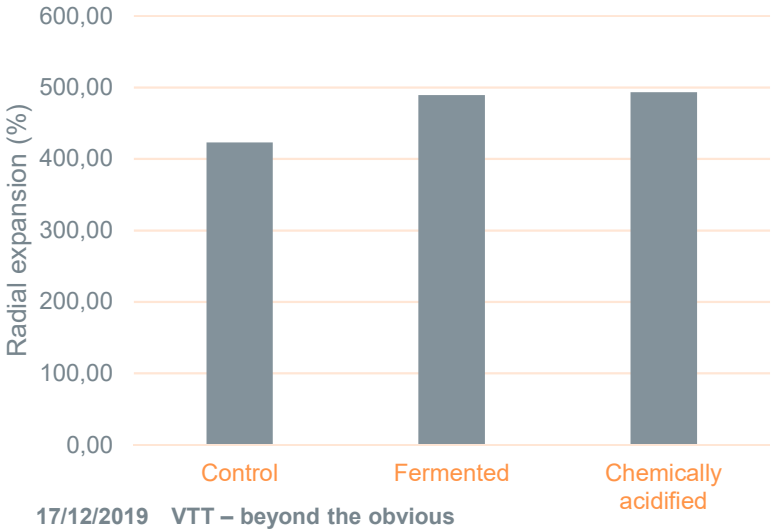


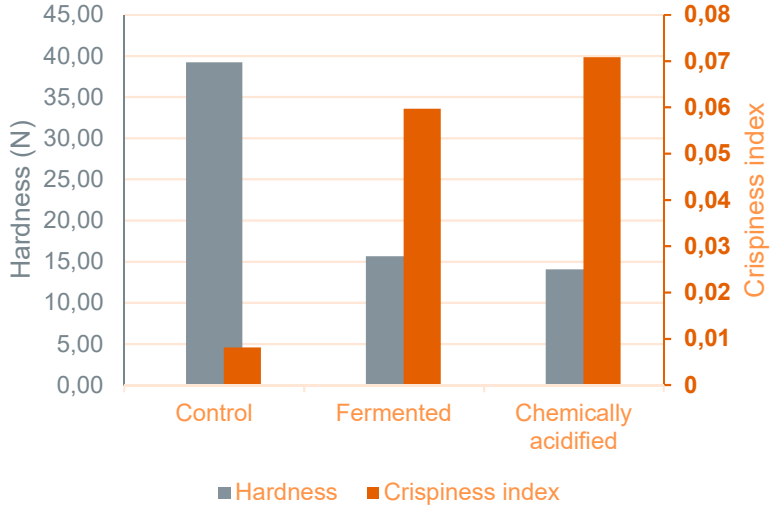


Nikinmaa et al. 2017

Mechanism: Chemical pH reduction of rye bran improved its extrusion behaviour as much as fermentation

- pH adjusted to the same pH as fermentations at 0, 10 and 15 h - end pH 4.2

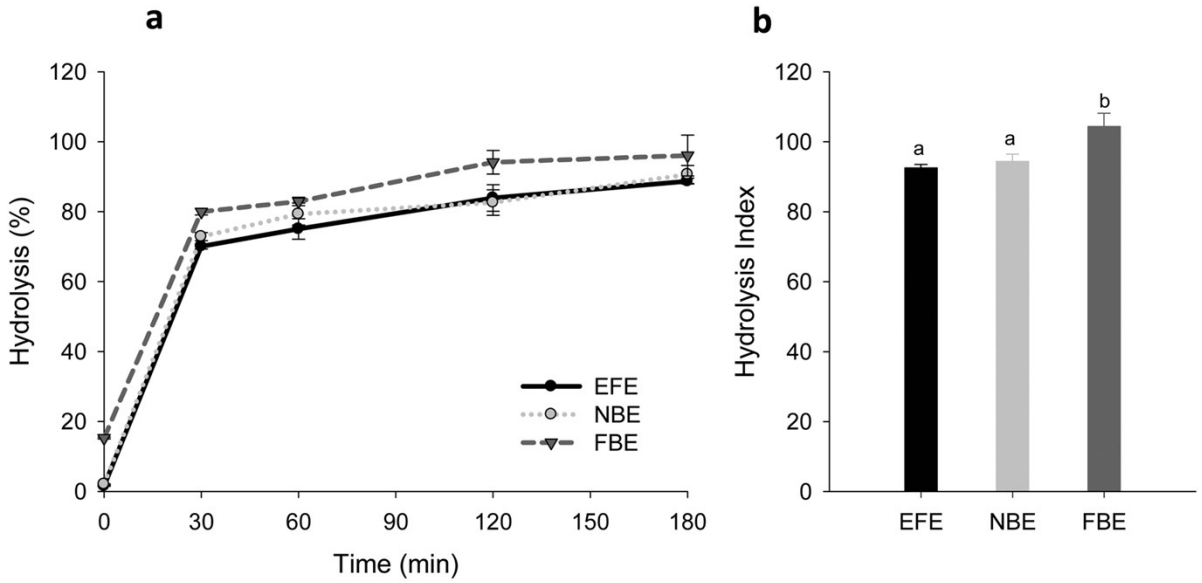




Probable mechanism

- Activation of rye grain enzymes at acidic pH
  - Hydrolysis of arabinoxylans by xylanases
  - Proteolysis by proteases.
- Higher degree of proteolysis in fermented samples than chemically acidified could indicate bacterial protease activity

Drawback: Structure improvement increases hydrolysis index of starch.



Alam et al. 2019

Conclusions

- Mild processing technologies such as combined milling and air classification enables production of novel hybrid ingredients from rye.
- Bioprocessing of hybrid ingredients further improves food applicability via improved technological, nutritional and sensory properties.

Acknowledgements

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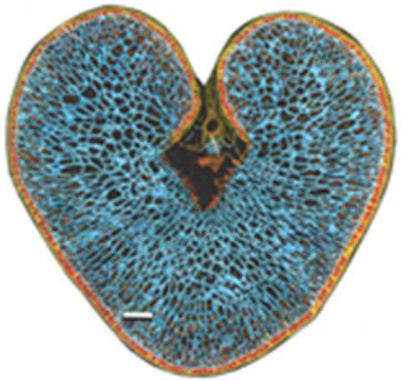

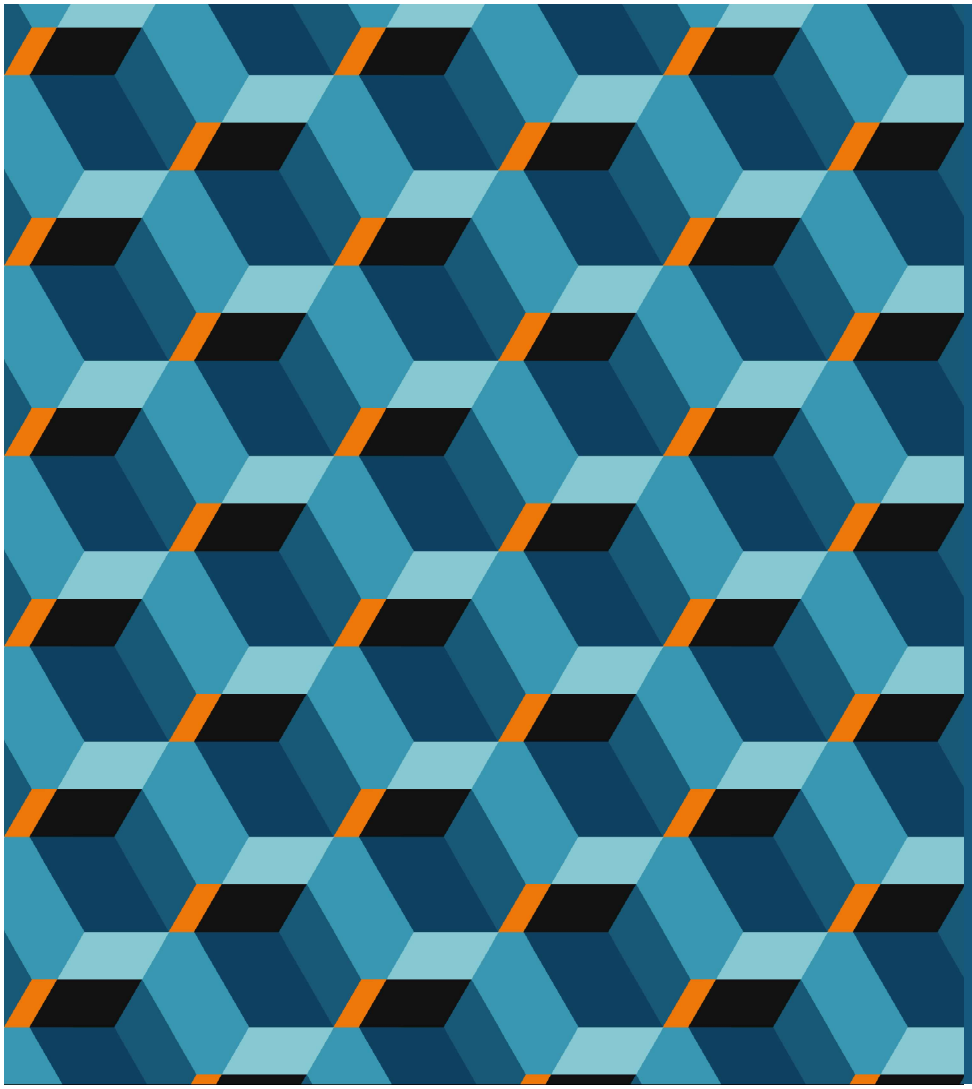

Thank you!

Let’s venture beyond the obvious

Contact:
Markus Nikinmaa
Research Scientist
p. +358 40 1681265
markus.nikinmaa@vtt.fi

www.vttresearch.com
#vttpeople / @VTTFinland

Foams from rye bran supernatants

Chemical characteristics of the supernatants

	Pentosan content (water soluble AX content) (% dm)	Fructan content (g/100 g)	Total protein content (mg/ml)
Control	3.3 d	5.5 c	14.3 d
Fructanase-treated	4.2 c	0.6 f	14.6 d
Xylanase-treated	6.8 b	5.2 d	14.8 d
Protease-treated	3.3 d	7.4 a	33.7 c
Protease- & xylanase- treated	7.7 a	6.7 b	34.9 a
Protease- & fructanase-treated	4.0 c	1.5 e	34.1 b