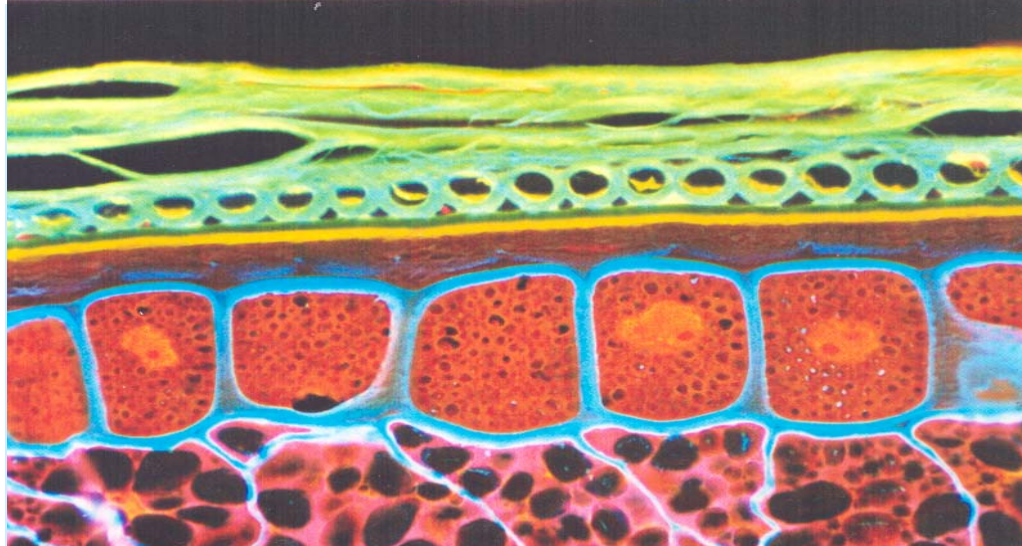


Bioprocessing of bran for improved functionality

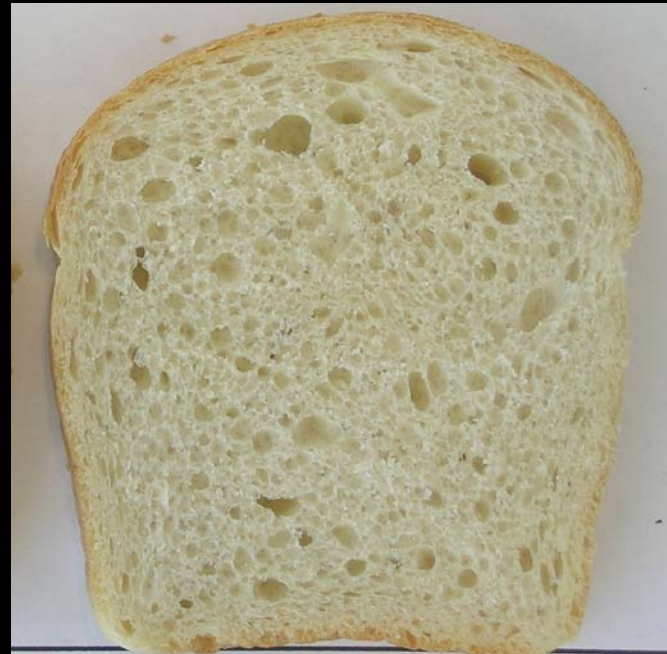
Kati Katina

BRAN IS A RICH SOURCE OF DIETARY FIBRE AND CO-PASSANGERS

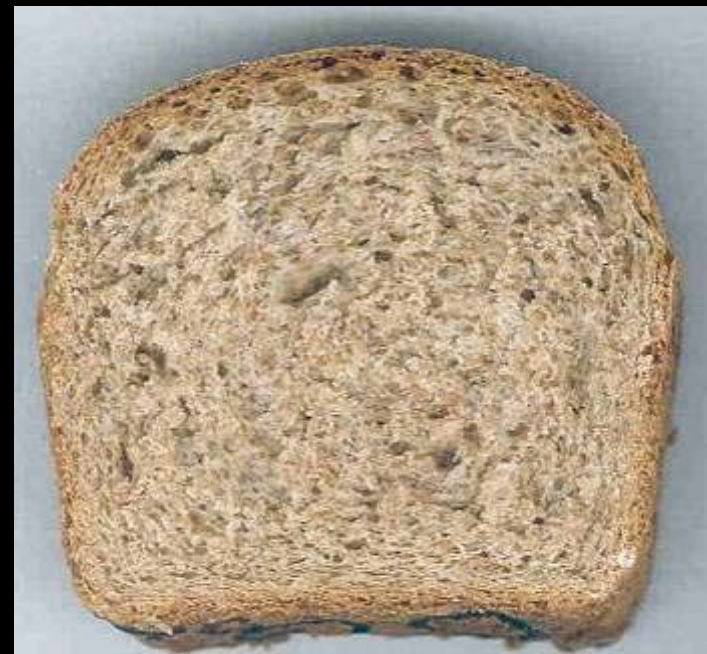


- × FIBRE 30 - 50 %
- × MINERALS
- × VITAMINS
- × PHYTOCHEMICALS

BRAN ADDITION CAUSES INFERIOR VOLUME, SHELF LIFE AND FLAVOUR OF BREAD



**Regular white
wheat bread**



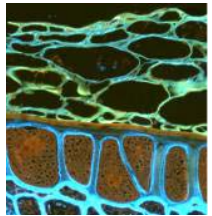
**Regular white wheat
bread supplemented with 20 %
of untreated bran**

STATE OF ART IN BRAN FERMENTATIONS BEFORE HG PROJECT: BRAN SOURDOUGH PROCESS IMPROVES TECHNOLOGICAL QUALITY

- Fermentation of bran improves its technological functionality in wheat baking (*Salmenkallio et al. 2001, Katina et al. 2006*)
- Cereal products (such as wheat bread) containing fermented bran provides many benefits of wholegrain breads without distinctive and strong flavour typical for e.g rye bread



Microbes



Bran



Bran sourdough



High-fibre wheat bread



OBJECTIVES OF BRAN BIOPROCESSING IN HEALTHGRAIN

- To understand which role the type of fermentation and properties of raw material have in modification of bran
- To ensure microbiological safety of bran fermentations
- To enhance levels of bioactive compounds of wheat bran and improve their bioavailability
- To understand improved technological properties of fermented bran



Experimental

- **Brans**

- State of art samples: native bran and bran from peeled **rye** kernels
- Native **wheat** bran
- peeled **wheat** bran
- Native **wheat** bran

- **Microbes**

- Yeast
- Spontaneous fermentation

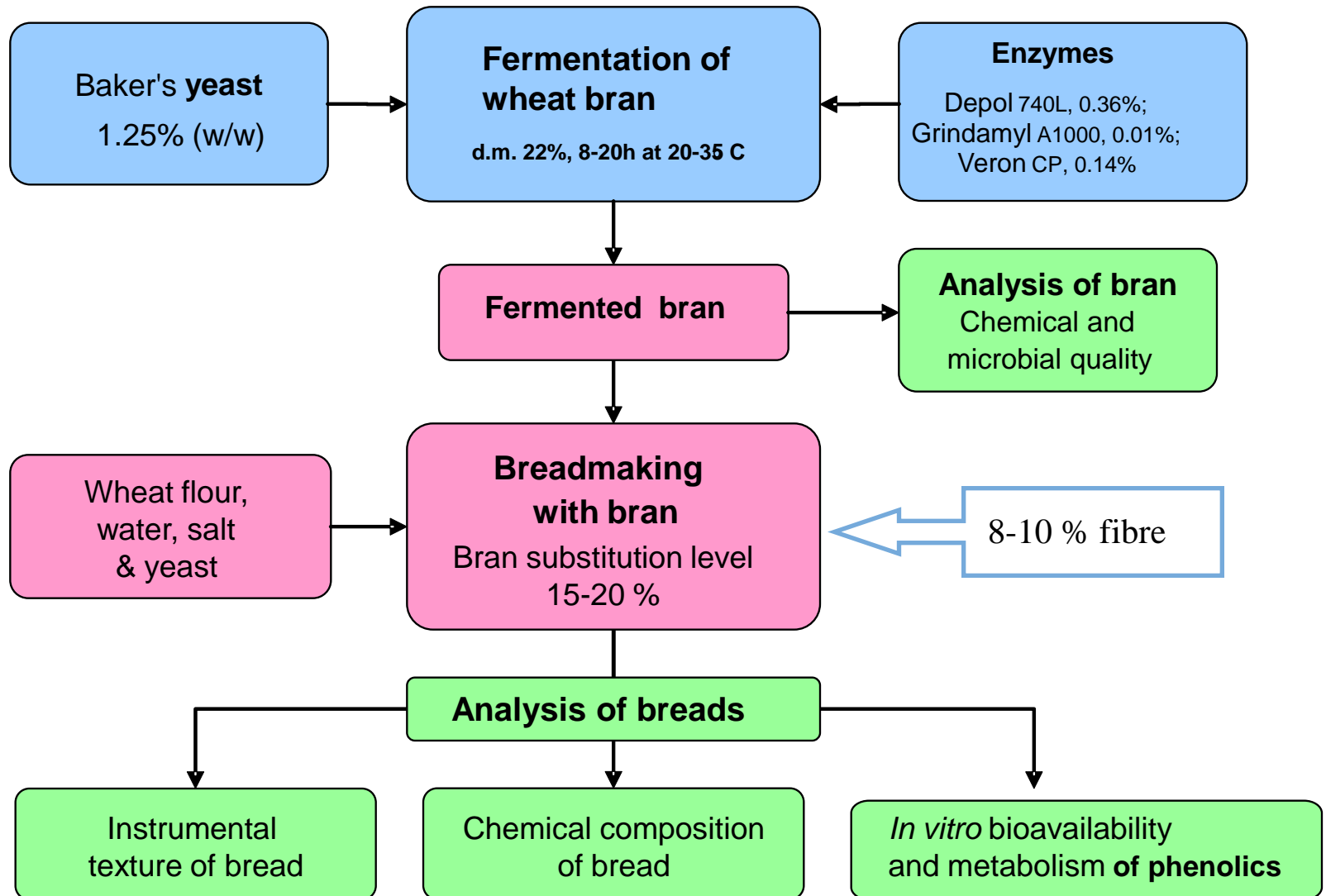
- **Enzymes**

- α -amylase, Grindamyl A (Danisco)
- Xylanase, Pentopan mono BG (Novozymes)
- Mixture of cell wall degrading enzymes, xylanase, cellulase, β -glucanase (Econase , Depol 740 L, Veron CP...)

- **Fermentation parameters**

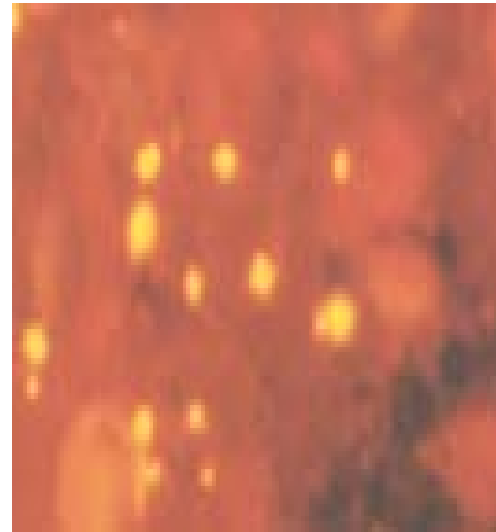
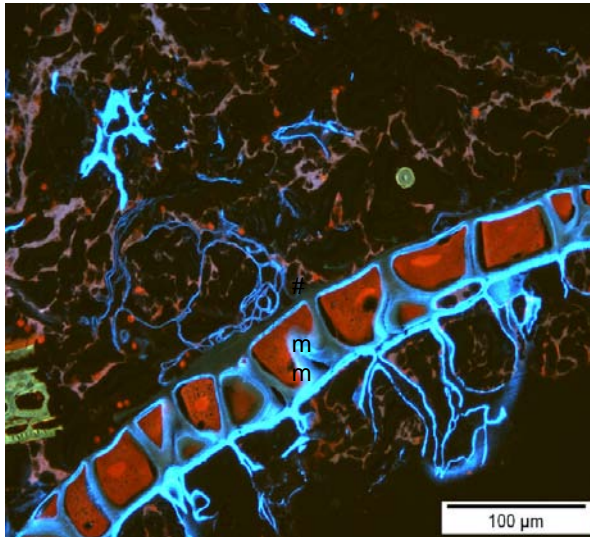
- Time (for rye bran fermentations)
- Temperature 20-35 C







Main results





Main results 1/4

Native bran and bran from peeled kernel have different microbiological quality

- Fermentations started with $1-2 \times 10^7$ cfu/g of commercial baker's yeast
 - a significant source of lactic acid bacteria (10^6 cfu/g)
- Microbiological quality of unfermented brans

Microbial group (cfu/g)	Native	Peeled
Total aerobic heterotrophic bacteria	8×10^5	$< 5 \times 10^4$
Aerobic sporeforming bacteria	2×10^2	1×10^2
Lactic acid bacteria	2×10^2	2×10^2
Yeasts	1×10^3	1×10^2
Moulds	9×10^2	$< 5 \times 10^1$



Fermentation induces changes in the microbiological quality of brans

- Peeling of wheat bran and the use of the yeast starter limited growth of potentially harmful aerobic bacteria during fermentations.
- The brans contained low levels of aerobic spore-forming bacteria ($\sim 10^2$ cfu/g) but their number was not increased during any of the fermentations
 - Potential rope-forming bacteria, health risk
- Native bran contains significantly higher amount of different microbes after fermentation
- Microbial population is much more versatile in native bran after fermentation

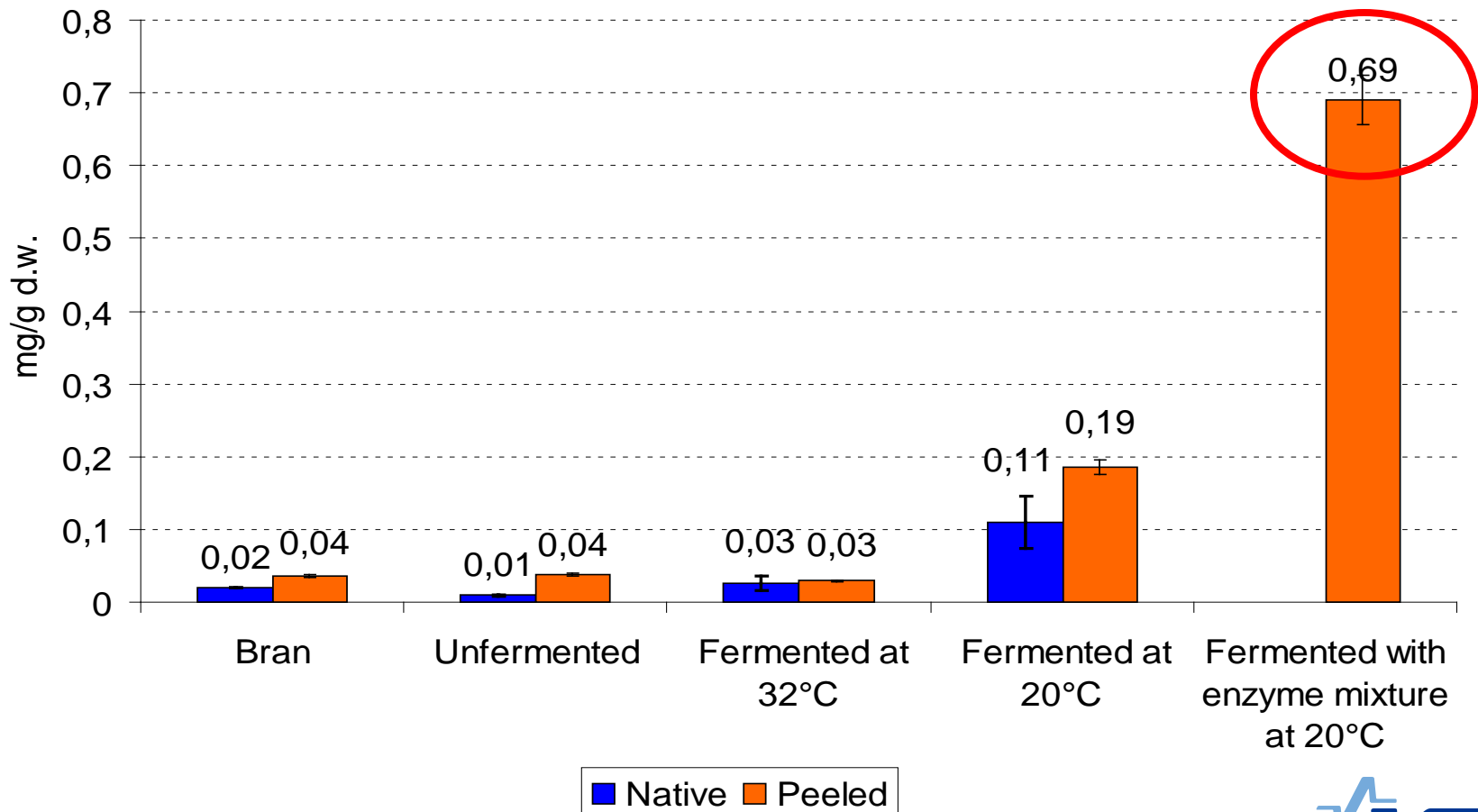




Main results 2/4

Bioprocessing increases solubilisation of arabinoxylans, level of folates and free ferulic acid

Free ferulic acid

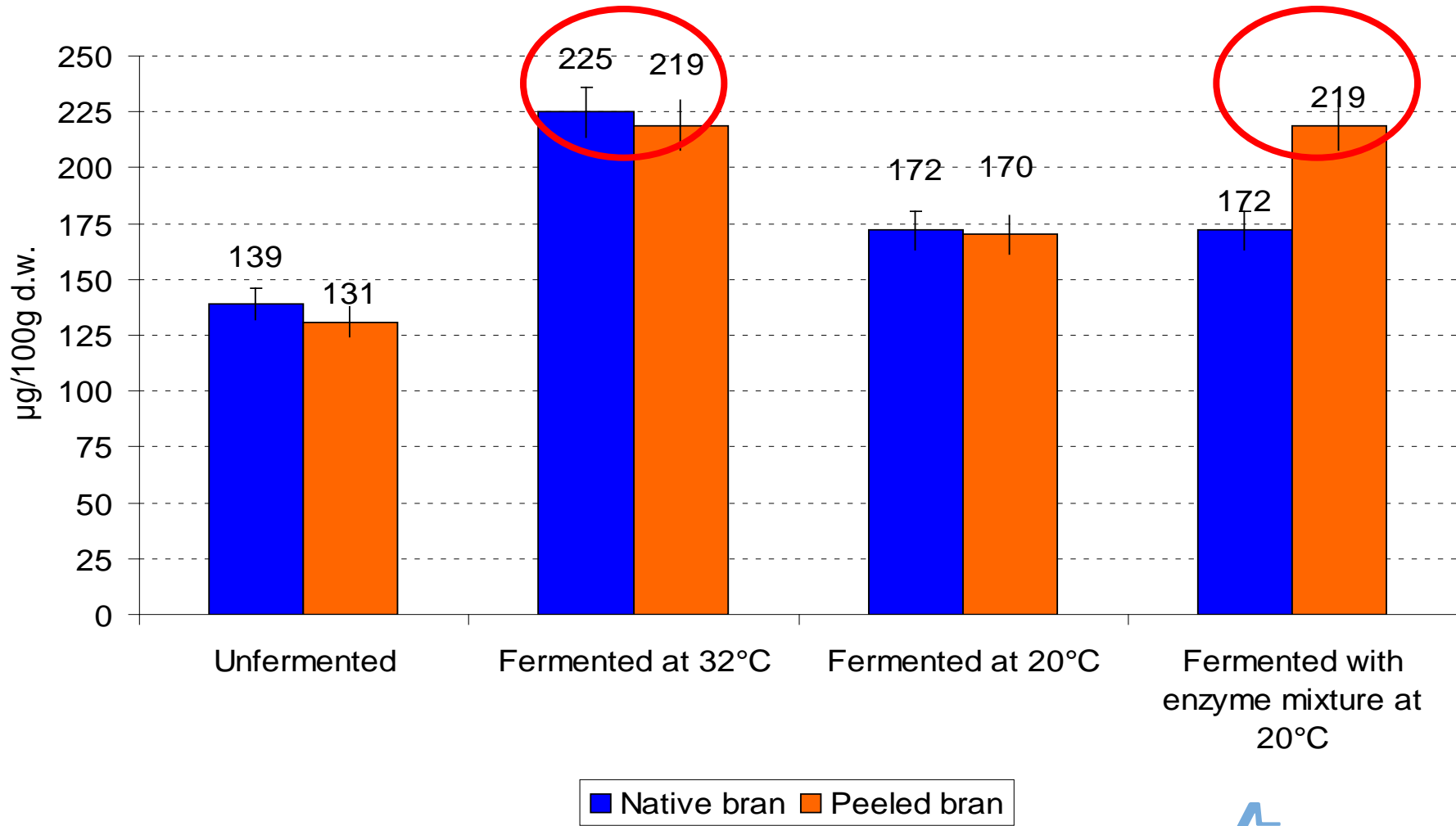


Enzyme mixture = Econase CE, Depol 740 L and Grindamyl A 1000

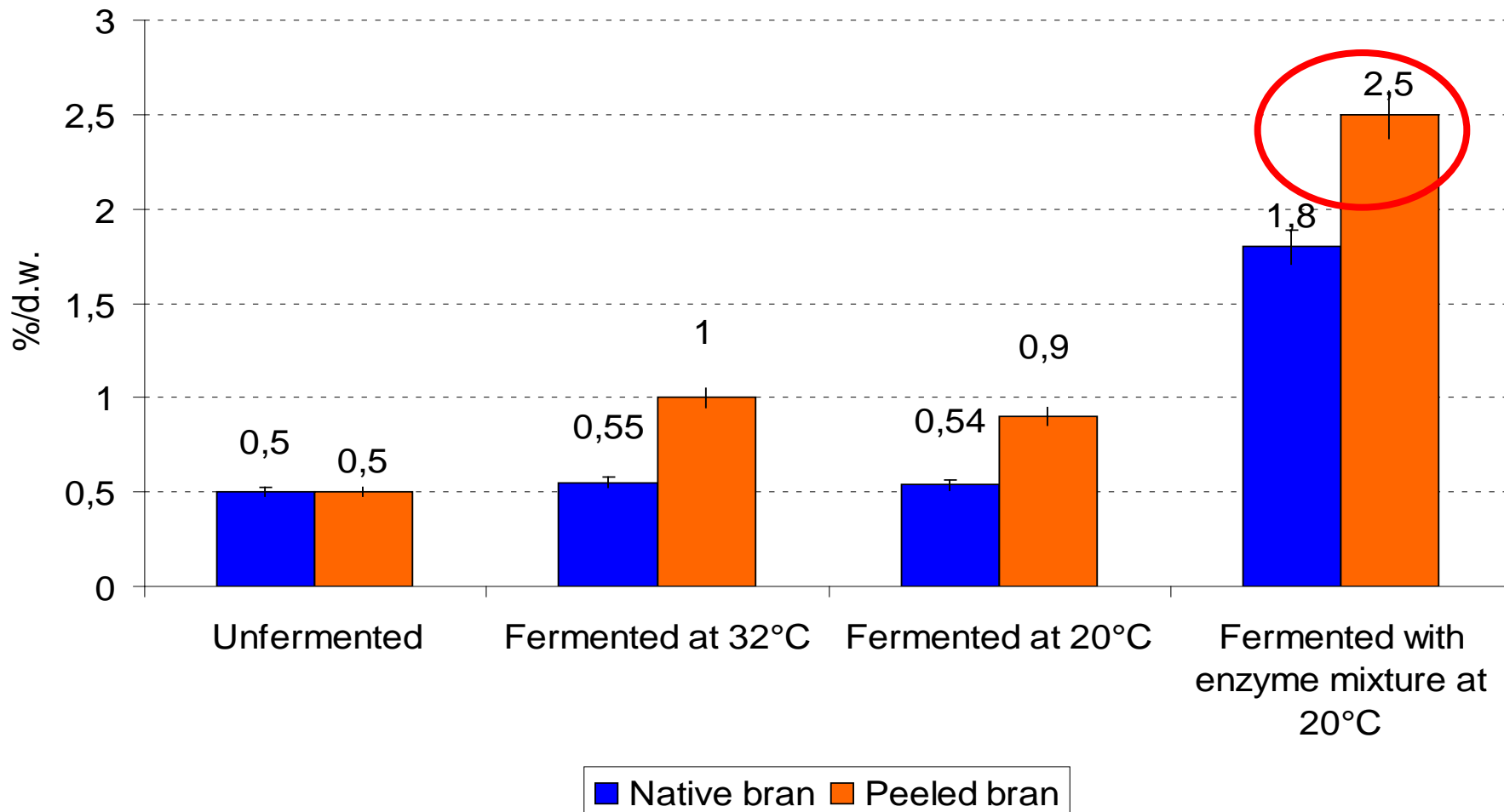




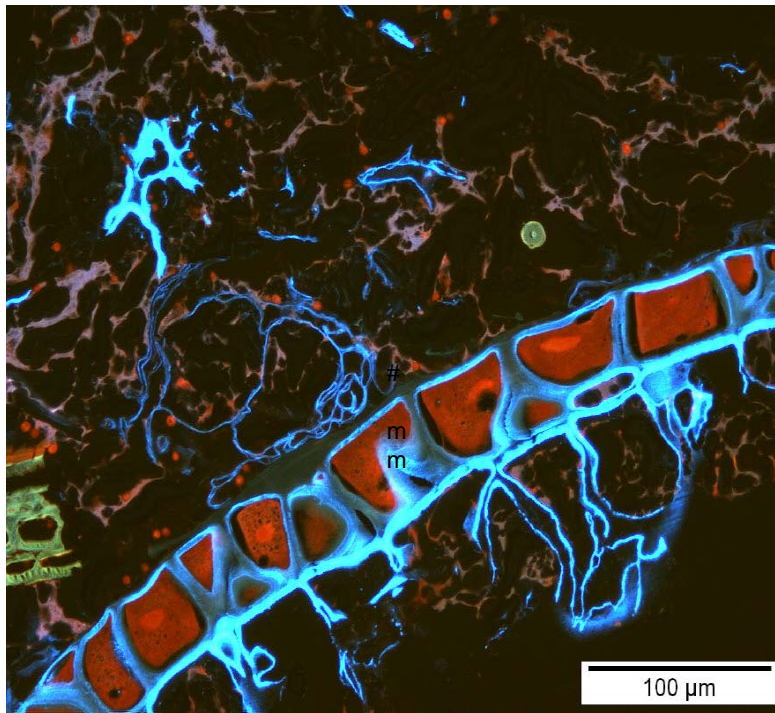
Folates



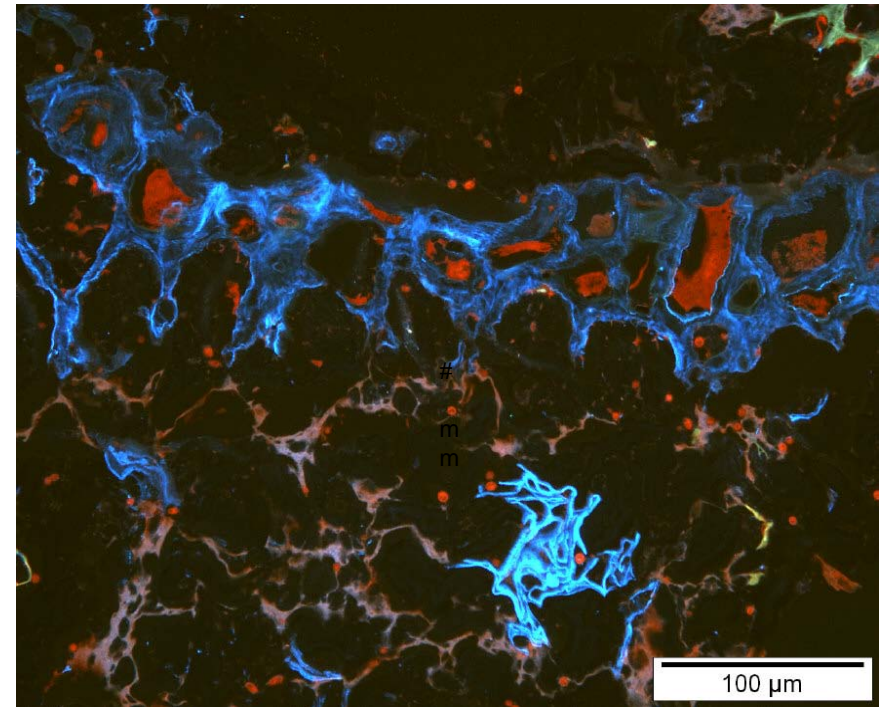
Soluble arabinoxylans



Main results 3/4 Fermentation of bran modifies microstructure of bran



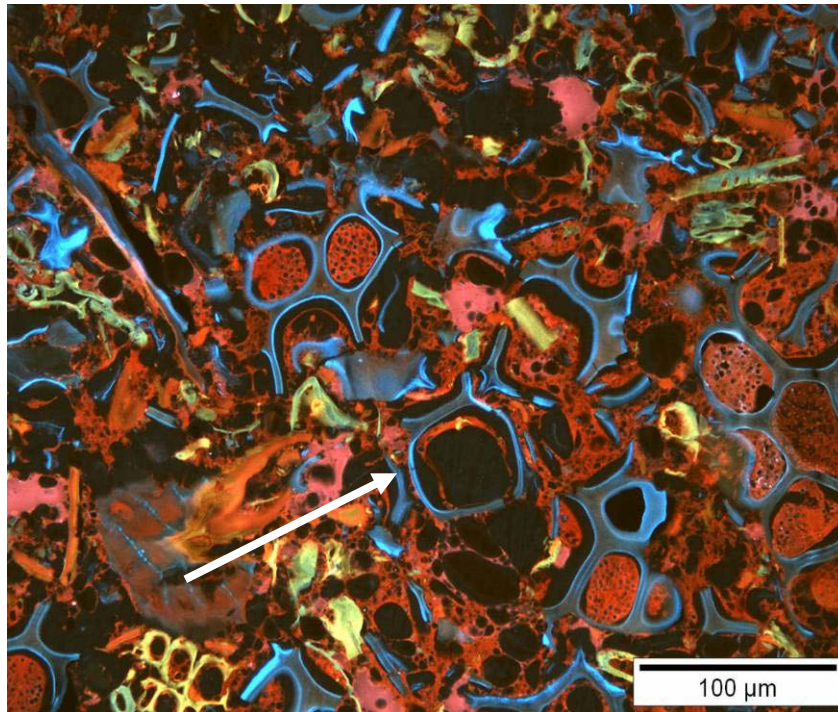
Control, unfermented **rye** bran



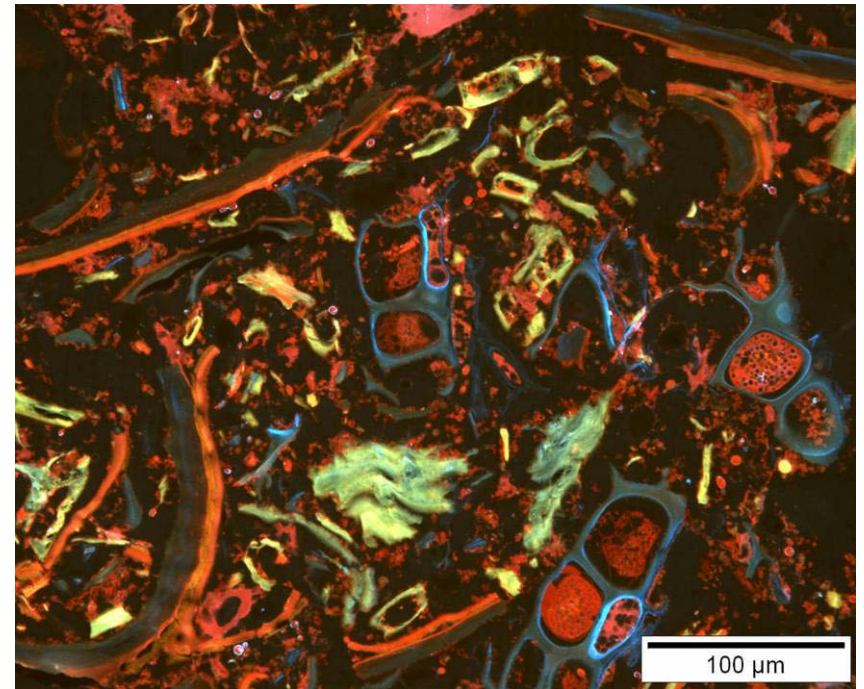
Yeast fermented **rye** bran



Wheat bran



Control, unfermented bran



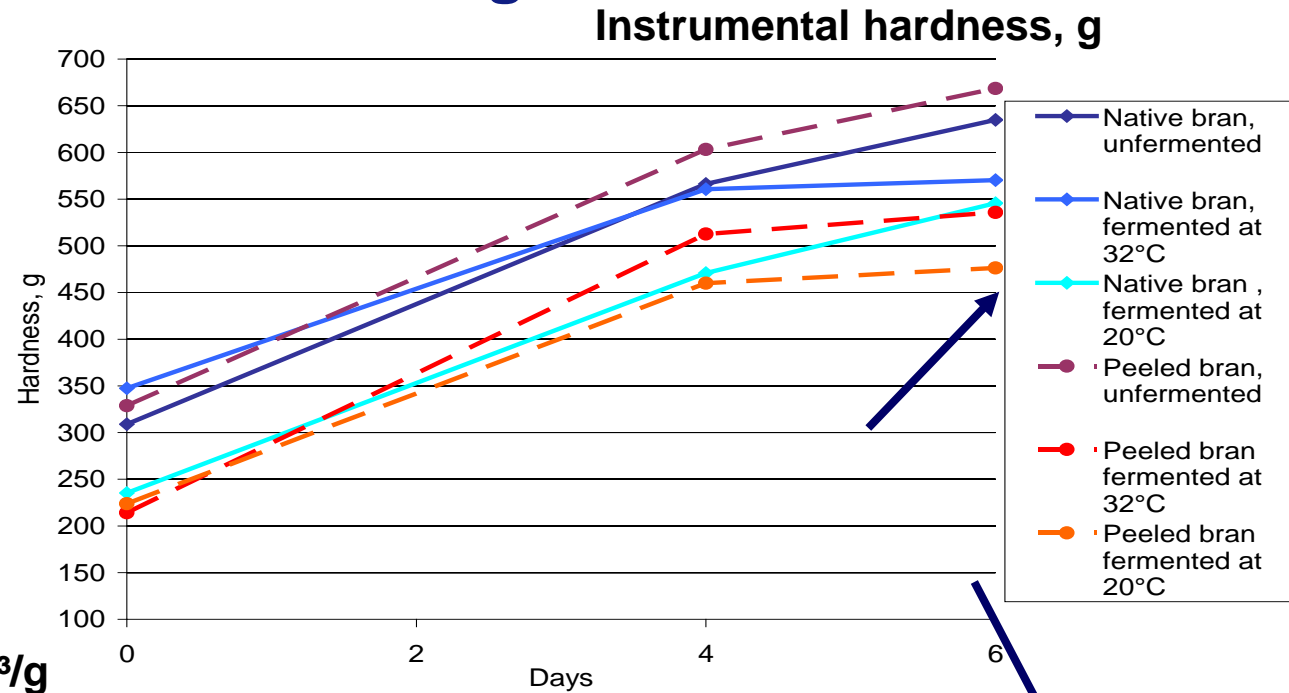
Yeast fermented bran



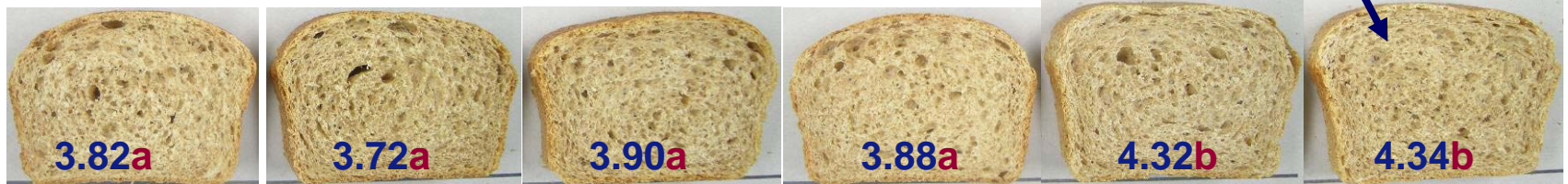
Main results 4/4

Fermentation of bran improves its usability in wheat baking

Highest specific volume and softest bread with peeled bran fermented at 20 °C → high soluble arabinoxylan content and low acidity



Specific volume, cm³/g



Native bran, unfermented

fermented at 32 °C

fermented at 20 °C





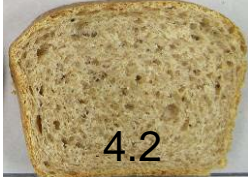
Peeled bran, unfermented

fermented at 32 °C

fermented at 20 °C



Addition of enzymes enhances effects of fermentation

	Unfermented bran	Fermented bran	Fermented with enzmix min	Fermented with enzmix med	Fermented with enzmix max
Soluble arabinoxylan % db	0.50±0.01	0.55±0.01	0.98±0.02	1.78±0.03	1.80±0.02
Specific volume, cm³/g	 3.9	 4.1	 4.3	 4.4	 4.2
Hardness, kg, 0 d after 6 d	0.27 0.67	0.23 0.57	0.18 0.44	0.16 0.42	0.18 0.45

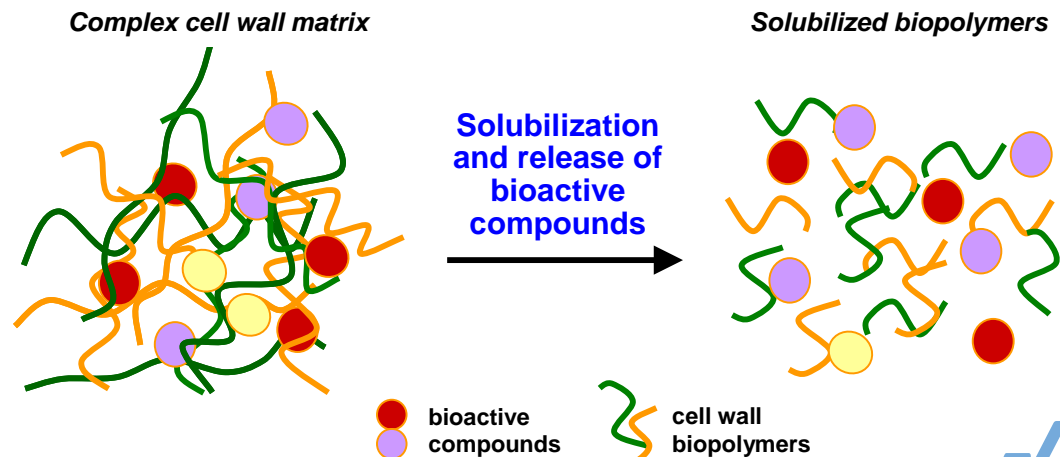
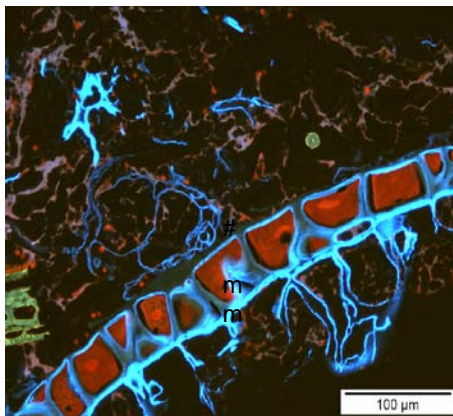
Enzyme mixture: Econase CE, Depol 740 L and Grindamyl A 1000 Dosages according to xylanase activities of Econase and Depol: min: 50 nkat, med: 400 nkat, max: 1000 nkat/g bran

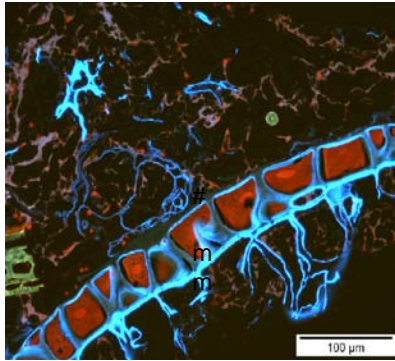
Mixture of Econase and Depol (cellulase, xylanase, betaglucanase, phytase, feruloyl esterase) increased the content of soluble arabinoxylans as well as volume and softness of the breads significantly



CASE STUDY: *in vitro* bioavailability of ferulic acid of bioprocessed wheat bran

- The aim of the study was to improve the biological availability of phenolic acids of wheat bran by bioprocessing, using a combined treatment of cell wall degrading enzymes and yeast fermentation
- The changes in bioavailability of processed bran were assessed in a wholegrain wheat bread





Experimental

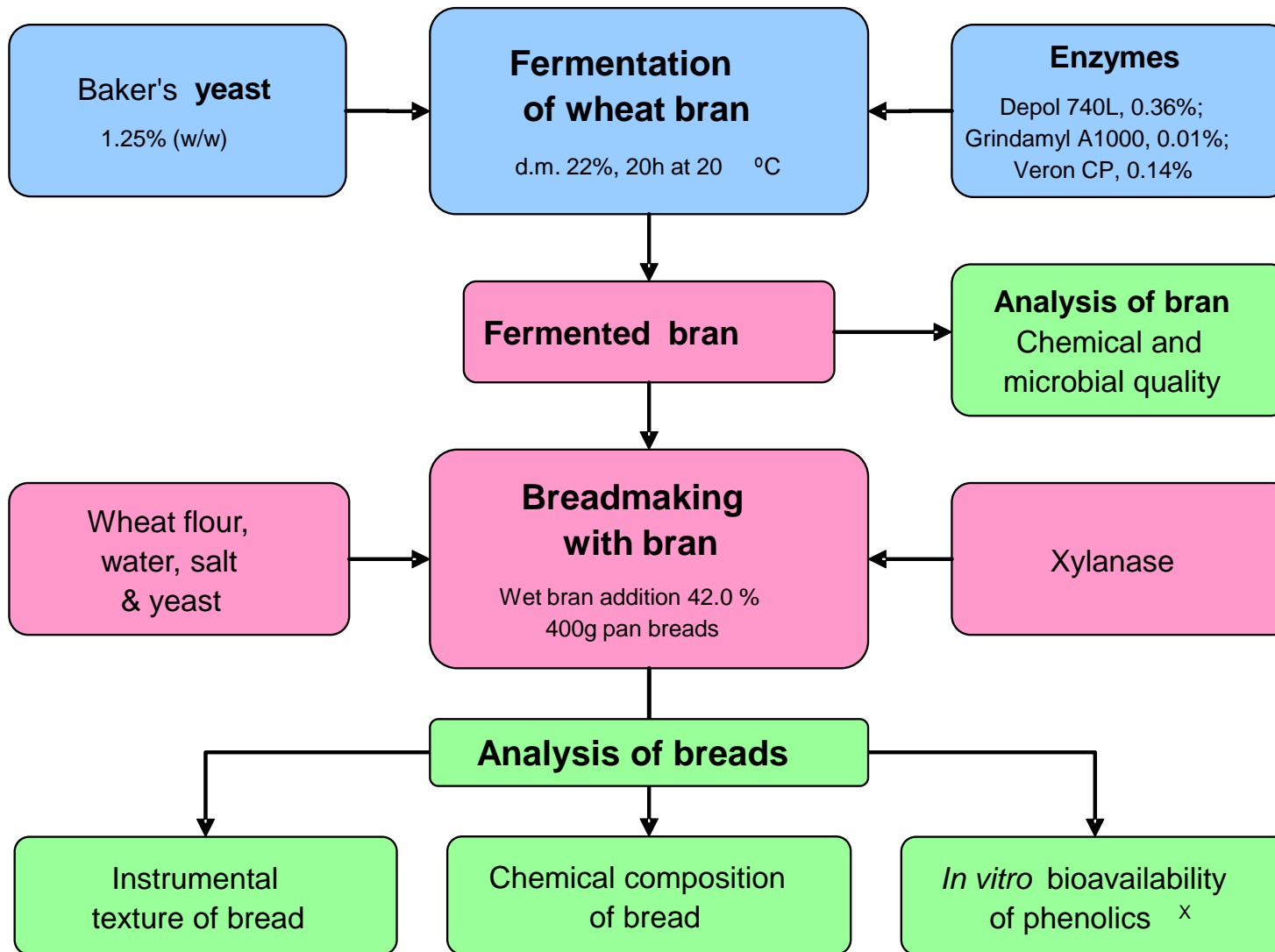
Bioprocessed bran samples

1. *S. cerevisiae* fermented bran
2. *S. cerevisiae* fermented bran + hydrolytic enzymes (Depol 740 L, Grindamyl A 1000, Veron CP)

Bread types

- Control wheat bread
- Control wholegrain bread
- Wholegrain bread with native bran
- Wholegrain bread with bioprocessed bran 1
- Wholegrain bread with bioprocessed bran 2





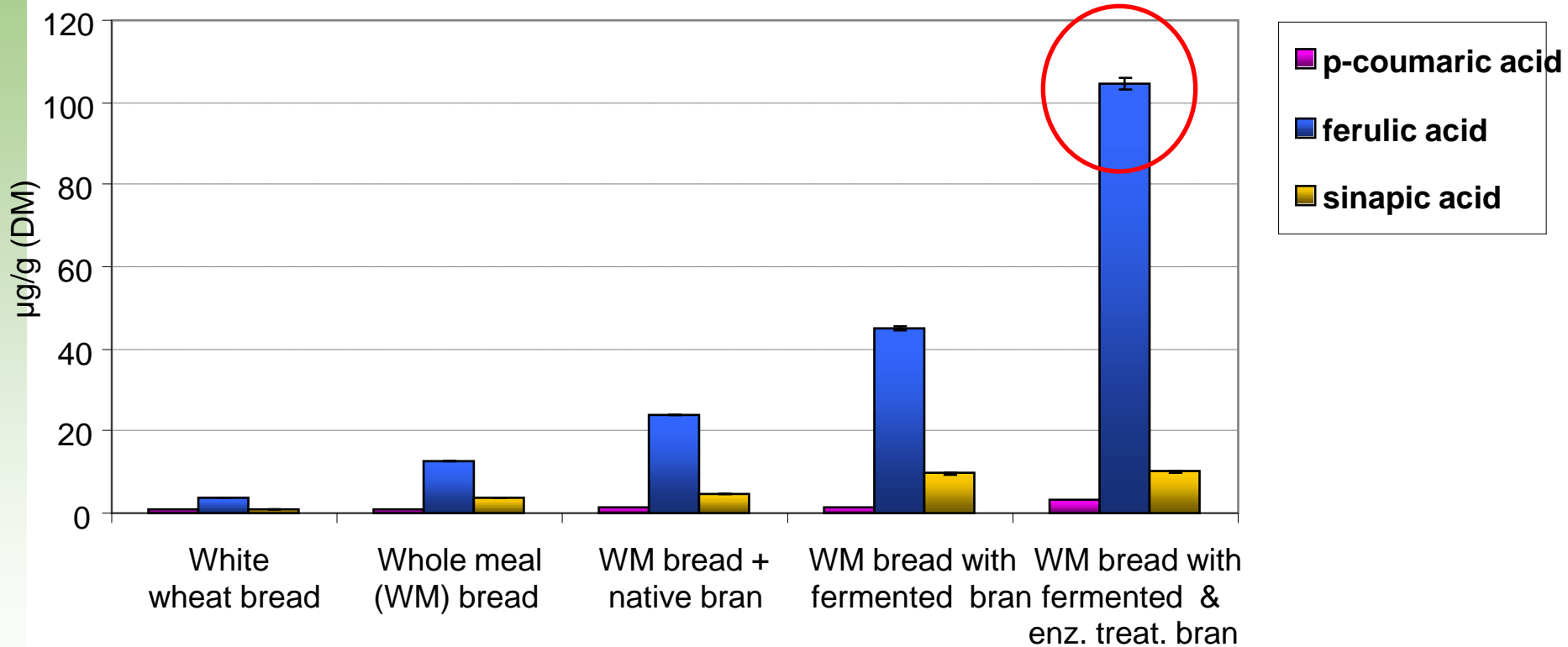
• a dynamic *in vitro* model of upper gastro-intestinal tract (TIM 1) and human colon (TIM-2)





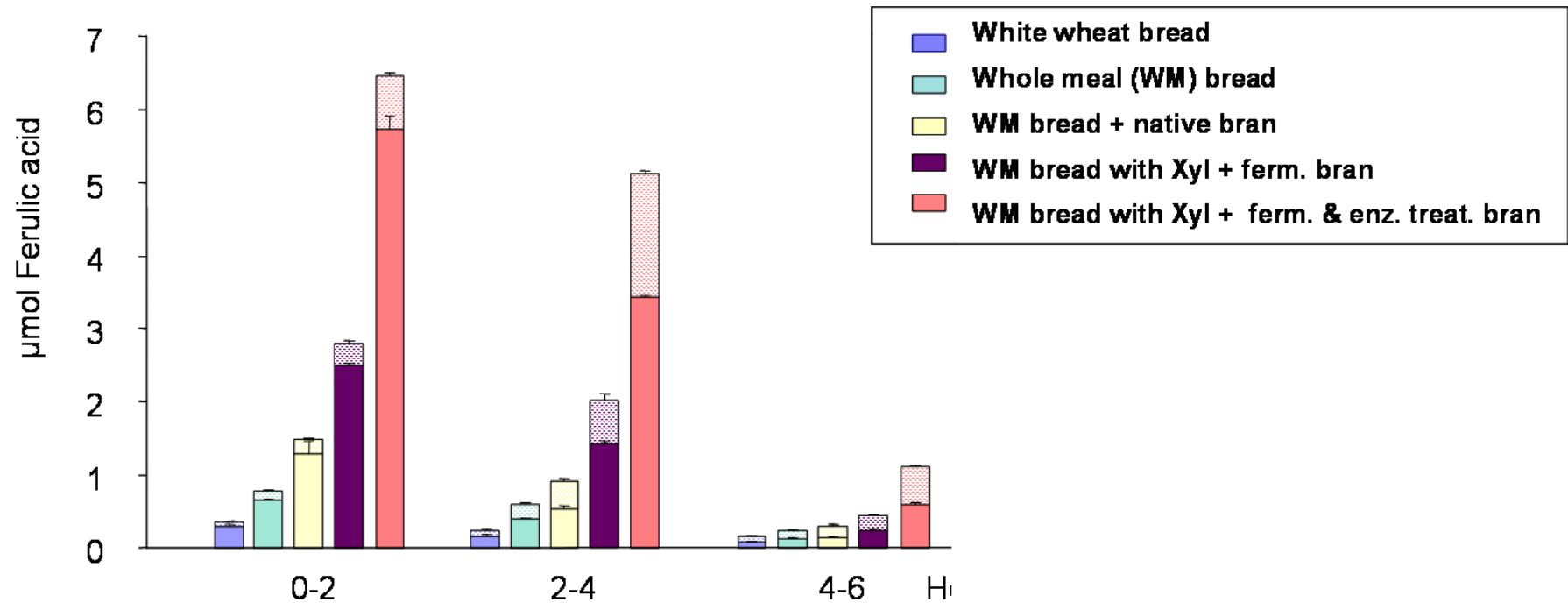
Results 1/ Amount of phenolic acids in the breads supplemented with bran

5-time increase in FA





Results 2/ TIM1 (upper gut) - Bioaccessability of FA of bran breads*

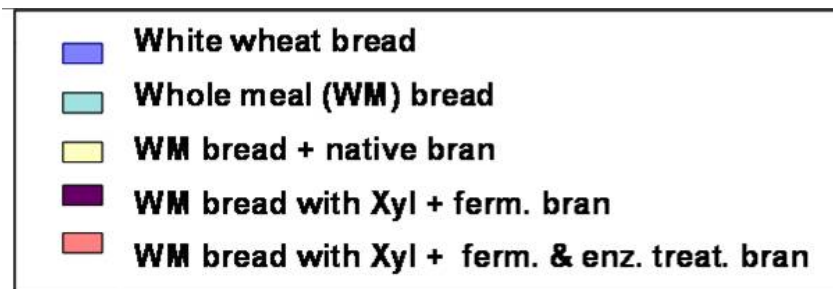
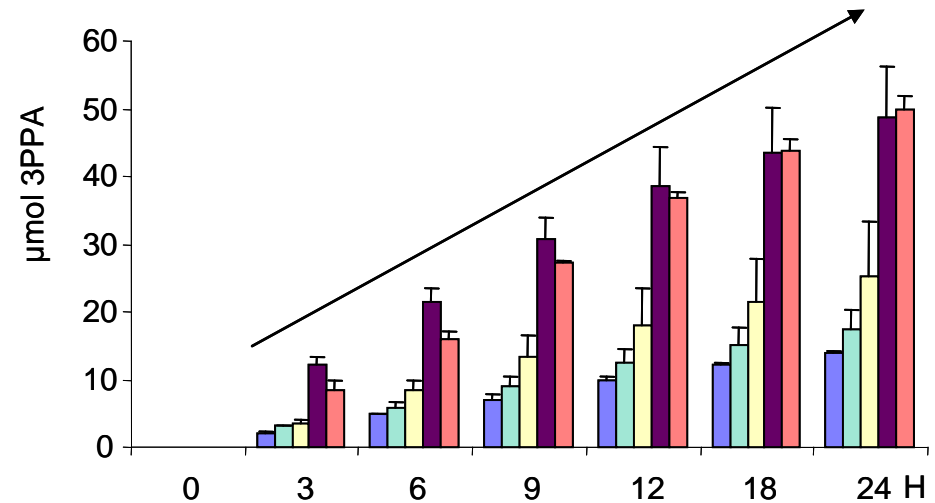
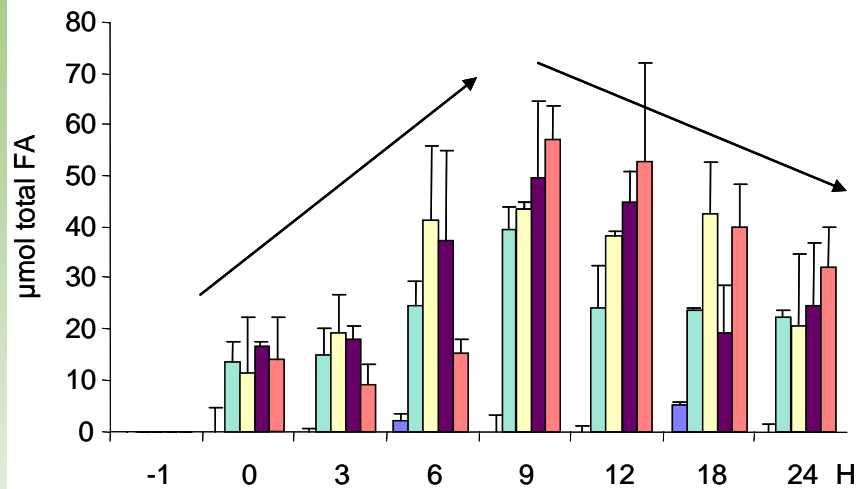


Mateo Anson et al. 2009





Results 2/ TIM2 (colon) - Bioaccessability of FA of bran breads*



Summary

Bioprocessing of bran with yeast and enzymes

- **modifies bran components (cell wall structures and solubility, levels and bioavailability of phytochemicals)**
- **provides microbiologically safe, mildly flavoured fibre ingredient**
- **improves technological functionality in baking**
- **enhances bioaccessibility and conversion of phenolic acids to their microbial metabolites in a colon model**
- **Bioprocessed bran - nutritionally boosted cereal ingredient, which is a well applicable for different foods**





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