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Potential of different rye arabinoxylans to improve the functional properties of gluten-free bread

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Introduction

Gluten vs. Gluten-free

- Baking quality
- Viscoelastic properties

Nutritional properties

Technological properties

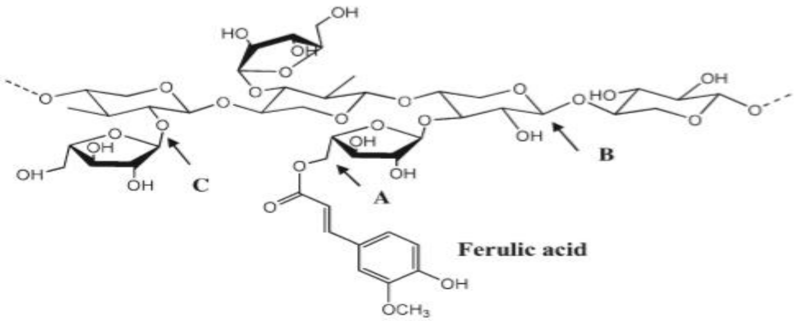
Sensory properties

No baking additive has been able to **FULLY** match gluten‘s performance

Promising: Rye bread-like structure

Introduction

Arabinoxylans (AXs)



Application in rye bread[1]:

Next to gluten ⇒ AX plays dual role ❯ Dough
Bread quality

- Increases µ and H_2O absorption in dough
- Cross-linking of AXs

} Oxidative gelation → **Oxidation of F.A.**

Hemicellulose network

★ Transfer principle to GF-breads

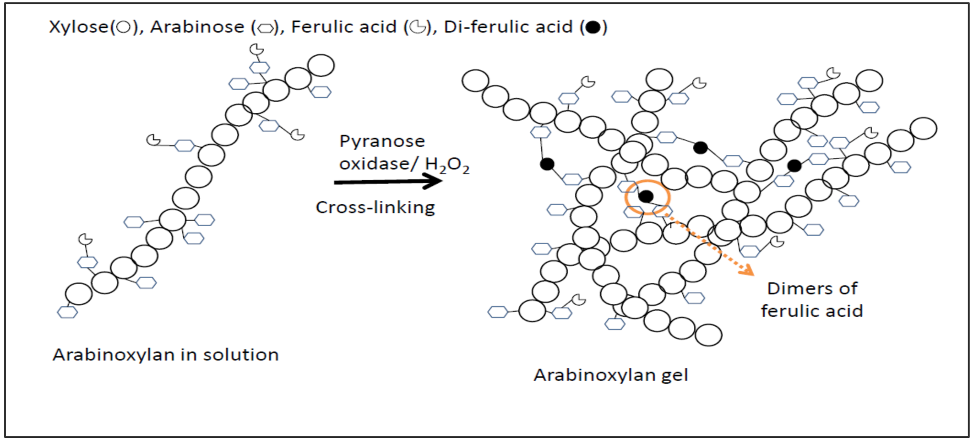
[1]Hartmann *et al.*, 2005

Approach

a. Production of highly functional tailored **rye arabinoxylans**

b. Addition of cross-linking enzyme pyranose 2-oxidase **(POx)** to support network formation

c. **Sourdough technology**
   - ✓ sensory perception
   - ✓ functional properties
   - ✓ optimal conditions for AX gelation



Oxidative gelation of arabinoxylans

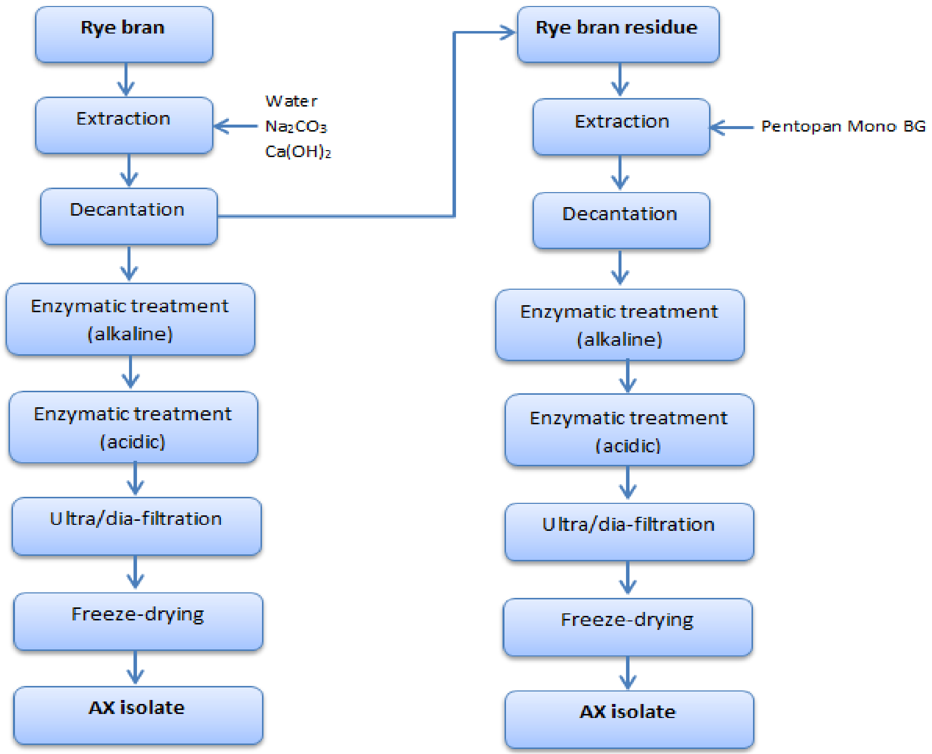
AX extraction from rye bran

Two-step extraction

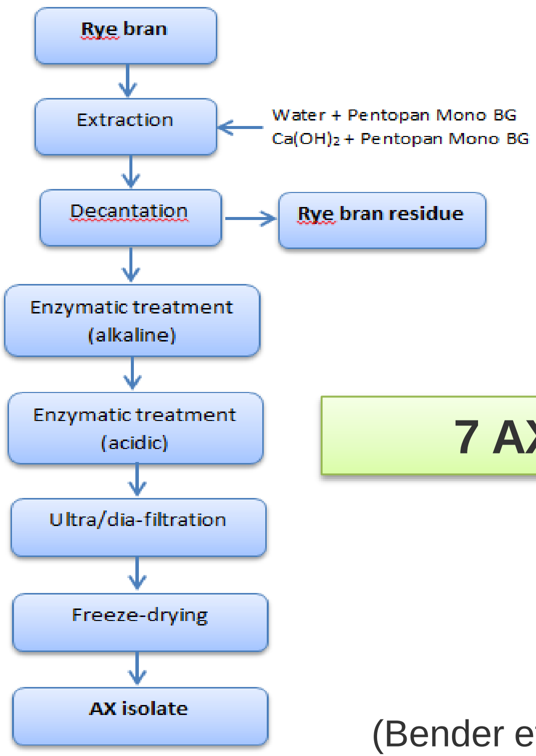
Successive extraction

Solvent extraction

Enzymatic extraction



Solvent + Enzymatic Extraction



7 AXs

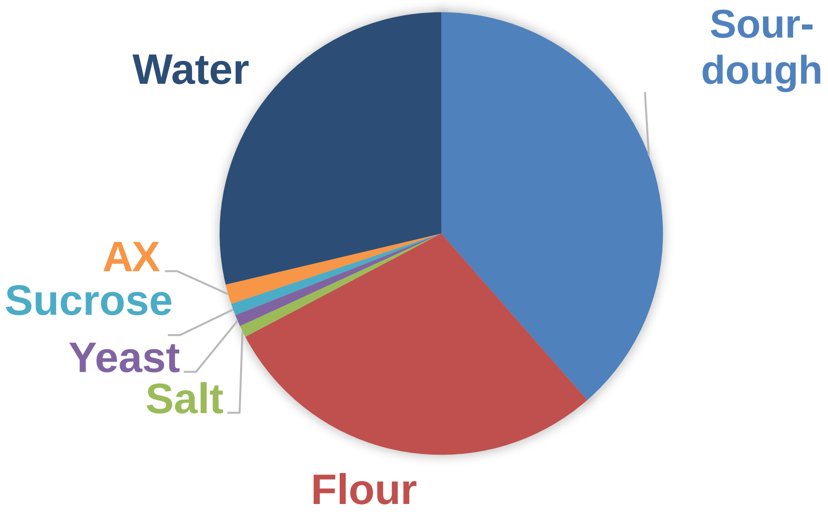
(Bender et al., 2017)

AX properties

AX extraction	Ferulic acid (mg/100g AX)	AX purity (%)	A/X ratio	Protein (%)	Glucose (%)
Two-step extractions					
Water	356.01 ± 52.82 [d]	38.57 ± 0.8 [c]	0.48	10.99 ± 0.86 [a]	22.46 ± 0.54 [d]
Na_2CO_3	259.15 ± 34.59 [c]	41.80 [d]	0.53	12.46 ± 0.17 [b]	25.98 ± 1.00 [e]
$Ca(OH)_2$	209.35 ± 16.79 [b]	63.82 [e]	0.57	11.37 ± 0.00 [a]	10.29 ± 0.12 [a]
Pentopan	25.90 ± 1.20 [a]	37.89 ± 2.44 [c]	0.49	13.14 ± 0.13 [b]	14.38 ± 0.03 [b]
Successive extractions					
Water + Pentopan	177.78 ± 4.25 [b]	33.82 ± 0.38 [b]	0.61	20.43 ± 0.00 [c]	17.47 ± 0.10 [c]
$Ca(OH)_2$ + Pentopan	32.10 ± 2.57 [a]	22.76 ± 0.02 [a]	0.61	10.83 ± 0.09 [a]	9.50 ± 0.01 [c]

Baking stability of AXs

Formulation



7 AXs

Control

H_2O

Na_2CO_3

$Ca(OH)_2$

Pentopan

H_2O + Pentopan

$Ca(OH)_2$ + Pentopan

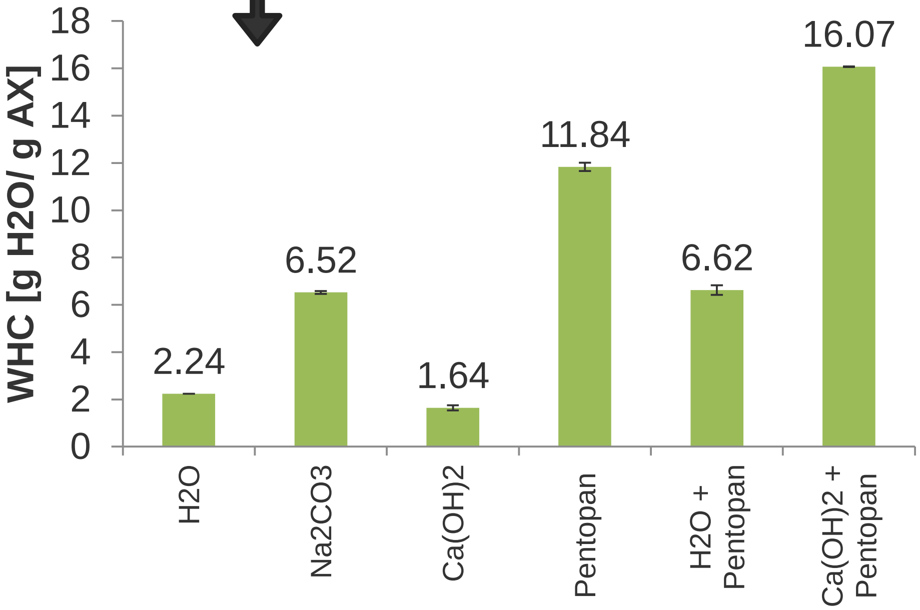
Optimization of AX and POx

3² face centered central composite design

$Ca(OH)_2$ AXs (%)	POx (nkat/g flour)
0	1
0	2
0	0
3	1
3	1
3	1
3	0
3	1
3	2
6	1
6	0
6	2

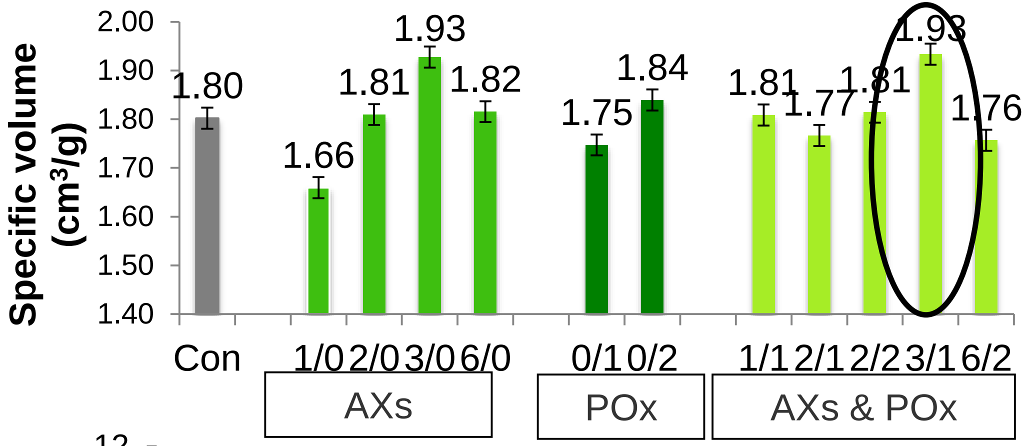
0-6%

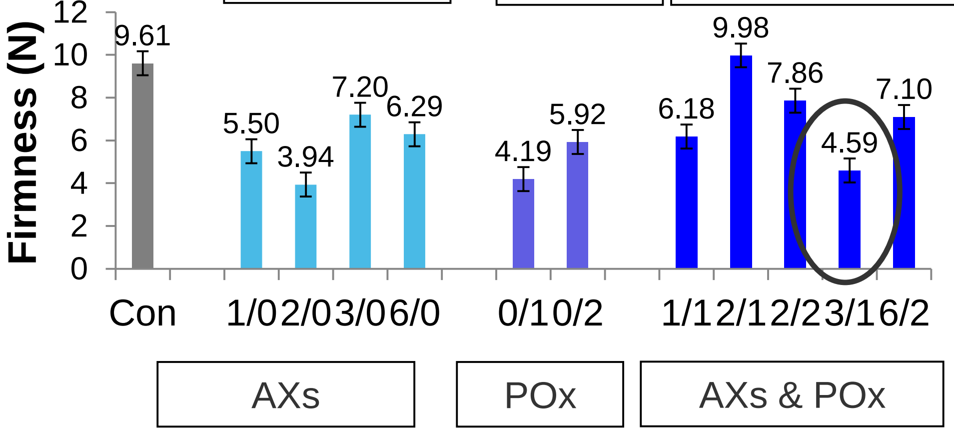
0-2 nkat



POx *pyranose-2-oxidase* [nkat/g flour]
AXs *arabinoxylans* [% of total flour]

Optimization: $Ca(OH)_2$-extracted AX





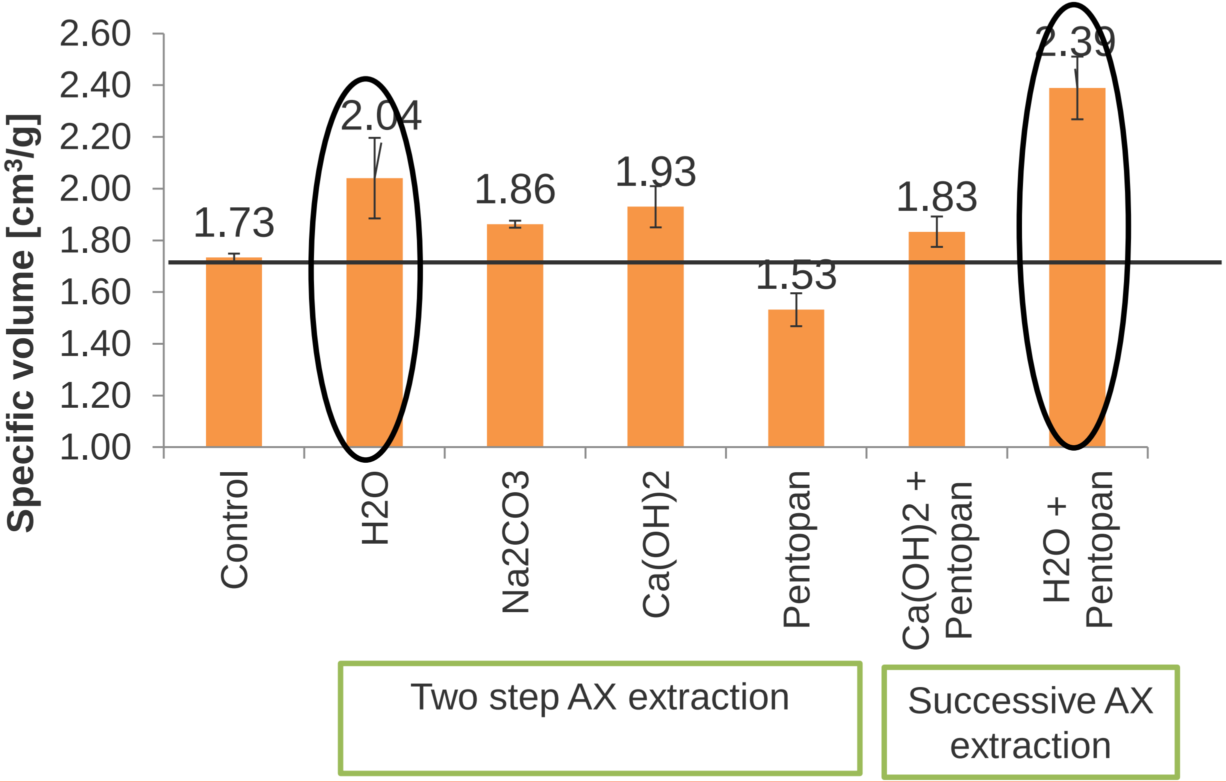
Pore structure

3% AXs /
1 nkat POx/g flour

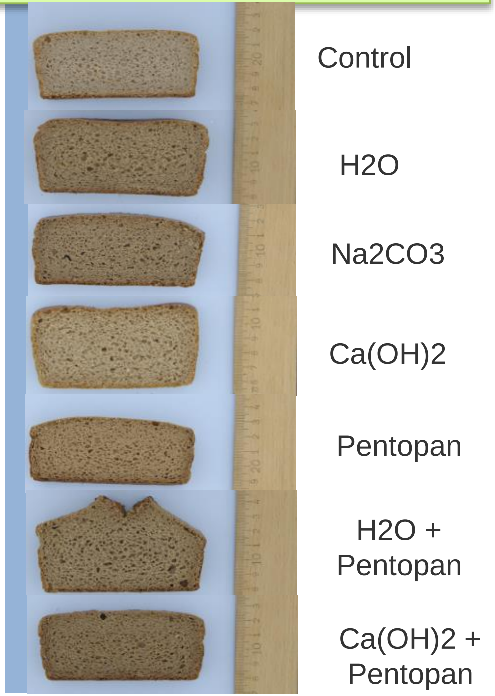
Control

POx *pyranose-2-oxidase* [nkat/g flour]
AXs *arabinoxylans* [% of total flour]

Effect of different rye AXs

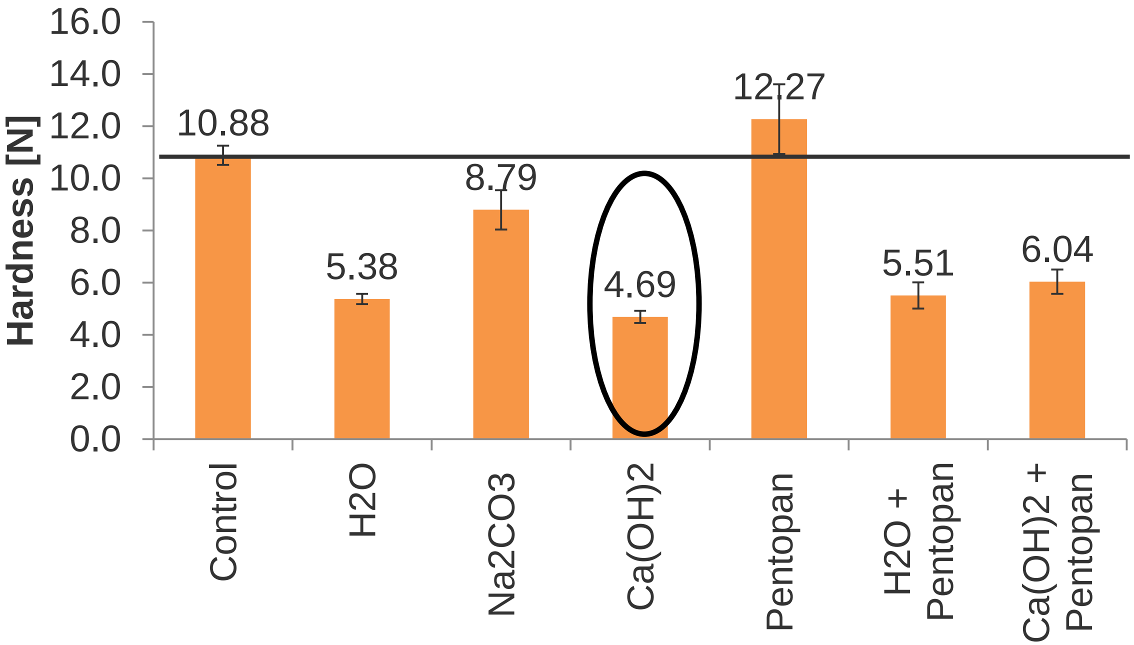


3% AX + 1nkat POx/ g flour



Hardness

3% AX + 1nkat POx/ g flour



Two step AX extraction

Successive AX extraction

Control

H2O

Na2CO3

Ca(OH)2

Pentopan

H2O + Pentopan

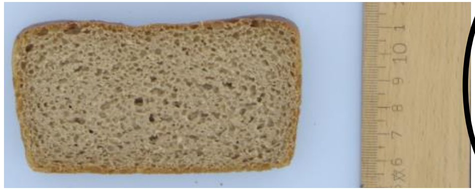
Ca(OH)2 + Pentopan

Crumb properties


Control


Water


Na_2CO_3


$Ca(OH)_2$


Pentopan


Water + Pentopan


$Ca(OH)_2$ + Pentopan

Color differences

	Two step AX extraction				Successive AX extraction	

	Control	H_2O	Na_2CO_3	$Ca(OH)_2$	Pentopan	H_2O + Pentopan	$Ca(OH)_2$ + Pentopan
ΔE crust		7.50 ± 0.57$^{a.b}$	9.40 ± 0.42^{c}	9.10 ± 0.71^{c}	6.60 ± 0.70^{a}	9.60 ± 0.35^{c}	8.50±0.50$^{b.c}$

Conclusions

- AX extraction: Process parameters ←→ AX properties
- Modification of **rheological behavior + baking performance**
- Stability and strength of network formed depend on AX properties
- But also on: GF flour, amount of AX and POx addition
- Overall most AXs could improve bread properties in optimal dosage

Other studies

Arabinoxylan extraction

Bender, D., Schmatz, M., Novalin, S., Nemeth, R., Chrysanthopoulou, F., Tömösközi, S., . . . D'Amico, S. (2017). Chemical and rheological characterization of arabinoxylan isolates from rye bran. *Chemical and Biological Technologies in Agriculture, 4*(1), 14. doi:10.1186/s40538-017-0096-6

Bender, D., Nemeth, R., Wimmer, M., Götschhofer, S., Biolchi, M., Török, K., . . . Schoenlechner, R. (2017). Optimization of Arabinoxylan Isolation from Rye Bran by Adapting Extraction Solvent and Use of Enzymes. *Journal of Food Science, 82*(11), 2562-2568. doi:10.1111/1750-3841.13920

Gelling ability of AXs

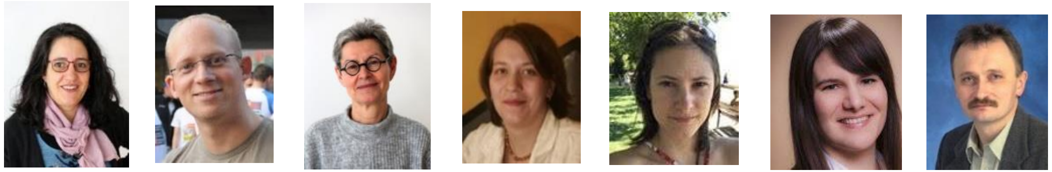
Bender, D., Nemeth, R., Cavazzi, G., Turoczi, F., Schall, E., D'Amico, S., . . . Schoenlechner, R. (2018). Characterization of rheological properties of rye arabinoxylans in buckwheat model systems. *Food Hydrocolloids, 80*, 33-41. doi:https://doi.org/10.1016/j.foodhyd.2018.01.035

Nemeth, R., Bender, D., Jaksics, E., Cazavvi, G., Lango, B., D'Amico, S.,… Tömösközi, S. (2018). Investigation of a hemicellulose network formation in millet flour model systems in order to improve the technological and nutritional value of gluten-free bread. *Food Hydrocolloids.* Submitted.

Sourdough technology

Bender, D., Fraberger, V., Szepasvári, P., D'Amico, S., Tömösközi, S., Cavazzi, G., . . . Schoenlechner, R. (2017b). Effects of selected lactobacilli on the functional properties and stability of gluten-free sourdough bread. *European Food Research and Technology*, 1-10. doi:10.1007/s00217-017-3020-1

Acknowledgements



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Thank you for your attention!

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2. Bender, D., Schmatz, M., Novalin, S., Nemeth, R., Chrysanthopoulou, F., Tömösközi, S., . . . D'Amico, S. (2017a). Chemical and rheological characterization of arabinoxylan isolates from rye bran. *Chemical and Biological Technologies in Agriculture, 4*(1), 14. doi:10.1186/s40538-017-0096-6
3. Bender, D., Fraberger, V., Szepasvári, P., D'Amico, S., Tömösközi, S., Cavazzi, G., . . . Schoenlechner, R. (2017b). Effects of selected lactobacilli on the functional properties and stability of gluten-free sourdough bread. *European Food Research and Technology*, 1-10. doi:10.1007/s00217-017-3020-1
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5. Bender et al (2018a). Potential of isolated arabinoxylans to improve the functional properties of gluten-free bread. In preparation
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