The influence of fermentation conditions on the exopolysaccharides and β-glucans content of barley sourdough

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BARLEY → poor technological and sensory properties → rarely used

rich in NON-STARCH POLYSACCHARIDES (**β-glucan** (BG) and arabinoxylan), OLIGOSACCHARIDES and PHYTOCHEMICALS → Positive effects on human health

Sourdough fermentation → **Exopolysaccharides** (EPS) produced by lactic acid bacteria (LAB) → prebiotics and substitute for additives

AIM

To investigate acidification and chemical properties of **barley sourdoughs** fermented with ***Lactobacillus reuteri*** (LR) or ***Weisella cibaria*** (WC) with or without presence of *Lactobacillus plantarum* (LP), sucrose (Suc) and bacterial xylanase (Xyl), and to optimise fermentation conditions yielding the high concentrations of **EPS** and **soluble β-glucans**

Experimental design

4 input variables on two levels (16 experiments)

Sourdough fermentation of whole grain barley flour

- With ***L. reuteri*** or ***W. cibaria***
- With/without ***L. plantarum***
- With/without **sucrose (10%)**
- With/without **bacterial xylanase (50 ppm)**

➢ dough yield 250

➢ 30°C (WC) or 37°C (LR) /24h

➢ Monitoring pH value

→ kinetics of acidification (Gompertz equation)

Sourdough analyses

- ✓Total titrable acidity (TTA)
- ✓Total and soluble β-glucan (enzymatically)
- ✓Lactic acid (LA) and acetic acid (AA) → HPLC/ PDA
- ✓Relative molecular weight (Mw) of EPS and soluble β-glucan → HPLC-SEC/RID

Optimisation of sourdough fermentation

- ✓ max. concentration of LA and AA
- ✓ fermentation quotient (FQ=LA/AA (mol/g)) from 2 to 6
- ✓ max. concentration of total BG (BGtot) and soluble BG (BGsol)
- ✓ maximum proportion of total BG and soluble BG compared to sourdough before fermentation (% BGtot and % BGsol, respectively)
- ✓ maximum concentration of EPS

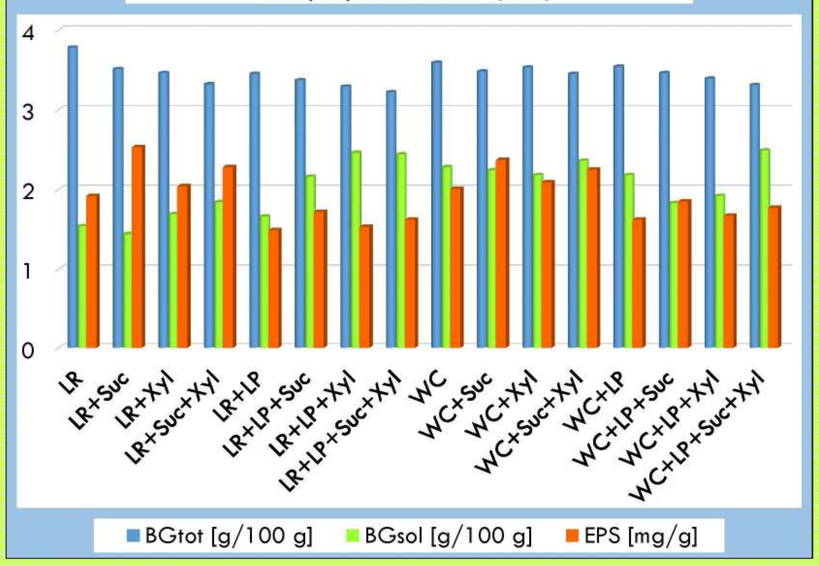
RESULTS

Kinetics of barley sourdough fermentation according to Gompertz model (R^2>0.991)

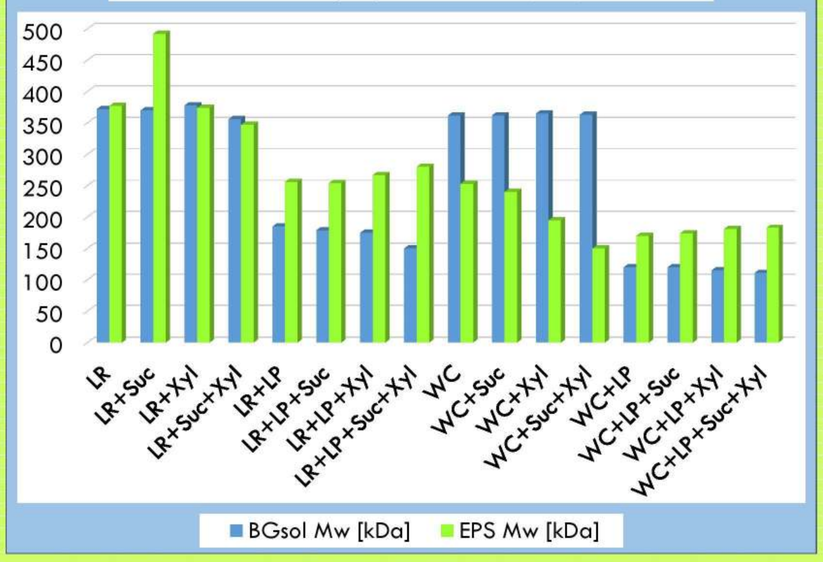
	pH	ΔpH	μ_{max}	t_{max}
LR	3.81	1.74	0.0051	496
LR+Suc	3.75	**2.00**	0.0050	767
LR+Xyl	3.80	1.70	0.0041	787
LR+Suc+Xyl	3.78	1.77	0.0030	865
LR+LP	3.75	1.82	0.0059	726
LR+LP+Suc	3.77	1.76	0.0053	582
LR+LP+Xyl	3.78	1.98	0.0068	774
LR+LP+Suc+Xyl	3.80	2.00	0.0036	842
WC	3.94	**1.56**	0.0049	690
WC+Suc	3.81	1.70	0.0049	757
WC+Xyl	3.82	1.69	0.0049	757
WC+Suc+Xyl	3.78	1.73	0.0052	728
WC+LP	3.79	1.71	0.0040	**898**
WC+LP+Suc	3.79	1.71	0.0065	**366**
WC+LP+Xyl	3.83	1.68	0.0048	572
WC+LP+Suc+Xyl	3.79	1.71	0.0056	528

pH - final pH value
ΔpH - pH change after 24 h of fermentation
μ_{max} - maximum acidification rate (dpH/10 min)
t_{max} - time needed to achieve maximum pH change (min)

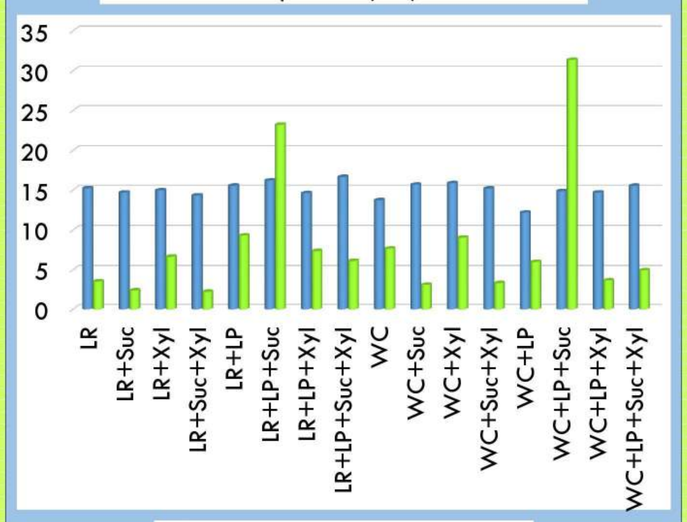
Total and soluble β-glucan (BGtot and BGsol) and exopolysaccharides (EPS)



Relative molecular weight of soluble β-glucan (BGsol) and exopolysaccharides (EPS)



Total titrable acidity (TTA) and fermetation quotient (FQ)



Optimised fermentation combinations

	LR + Suc	LR + Suc + Xyl	WC + Suc	WC + Suc + Xyl
LA [g/g]	0.24	0.23	0.34	0.33
AA [g/g]	0.078	0.060	0.069	0.075
FQ	2.26	2.28	3.16	3.18
BGtot [g/100 g]	3.59	3.34	3.48	3.44
% BGtot [g/100 g]	88.98	86.16	88.03	85.21
BGsol [g/100 g]	1.50	1.76	2.14	2.39
% BGsol [g/100 g]	272.8	272.8	252.4	252.4
EPS [mg/g]	2.44	2.29	2.42	2.28
Desirability	0.47	0.45	0.66	0.48

CONCLUSIONS

- Addition of sucrose positively affected the kinetics of acidification, maximum acidification rate (μ_{max}) and total acidity of sourdough, unless LP was present.
- TTA of LR sourdoughs (14.31-16.63 mL NaOH) was higher than WC (12.16-15.85 mL NaOH).
- The sucrose and xylanase addition positively affected sourdough concentrations of lactic and acetic acid.
- FQ was significantly influenced by sucrose addition, and six sourdoughs (LR, LR+Suc, LR+Suc+Xyl, WC+Suc, Wc+Suc+Xyl, WC+LP+Xyl) had an optimal FQ (2-4).
- Fermentation negatively affected total BG (6-20% decrease), but positively affected soluble BG (110-293% increase) compared to unfermented sample.
- Xylanase (p=0.039) and sucrose (p=0.007) addition positively affected soluble BG while fermentation process increased the Mw of soluble BG (111-378 kDa compared to unfermented sourdough 87 kDa).
- EPS were present in all sourdough samples at 1.5-2.5 g/kg. Sucrose addition (p<0.001) had the most positive impact while LP (p<0.001) had the most negative impact on the EPS concentration. Mw of EPS in sourdough samples fermented with LR (254-492 kDa) was bigger than WC (170-280 kDa).
- For the optimised sourdough fermentation single starter of either *L. reuteri* or *W. cibaria* with sucrose and with or without xylanase should be used.
- **Barley sourdough fermented with *L. reuteri* or *W. cibaria* contains high concentrations of EPS and soluble β-glucans and could be used in making fibre enriched breads.**

References:

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