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#ElevateBeer

Addition of Xylanase and β-glucanase Under Optimal Conditions Improves Filtration Efficiency in Rye Malt Brewing

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Agenda

1. Background
2. Study objective
3. Results and discussion

<Brewing process>

(1) Enzyme addition at mashing-in

<Malting process>

(2) Modification of malt

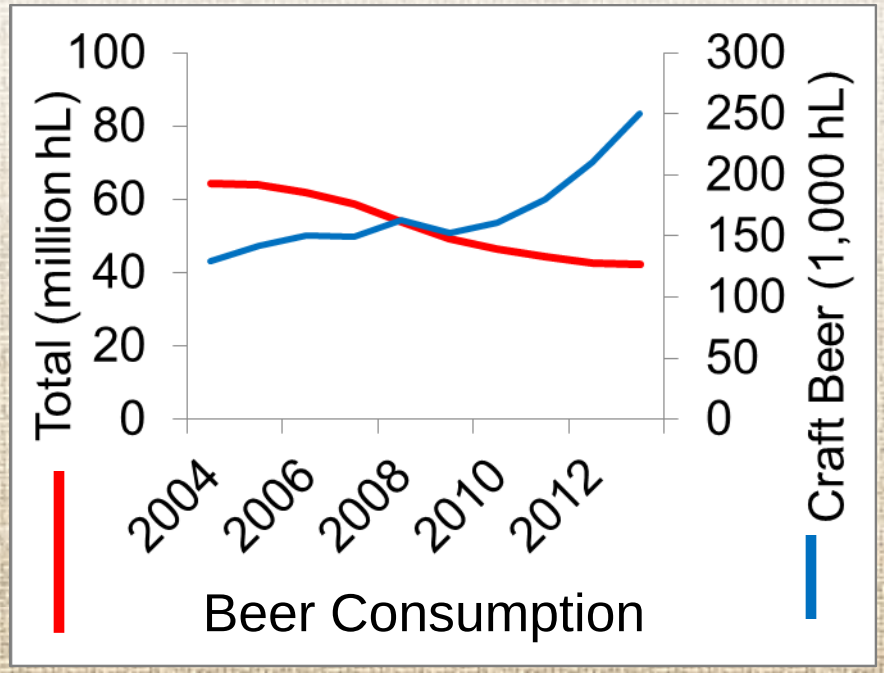
(3) Enzyme addition during germination

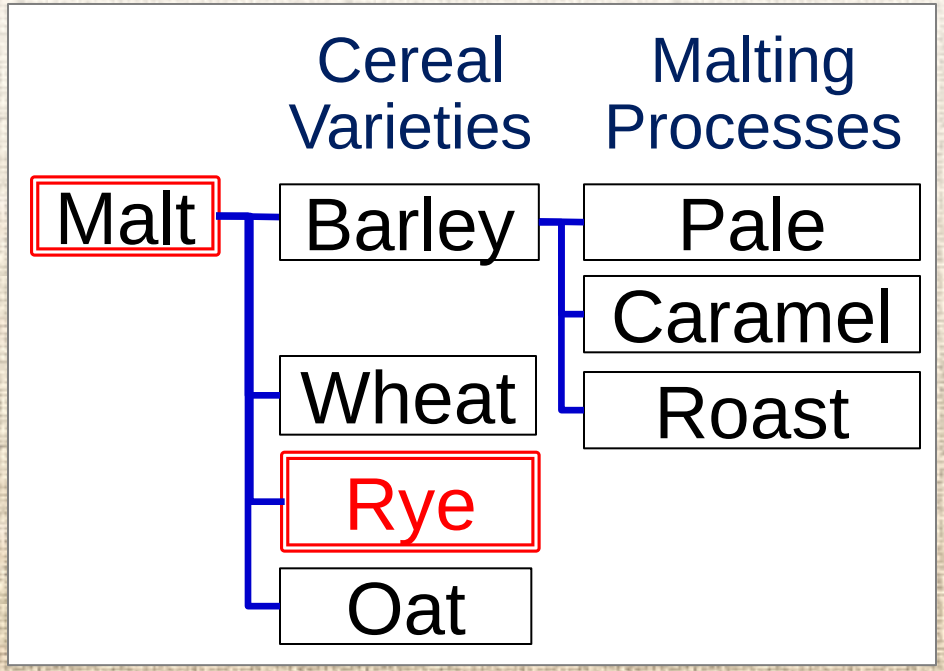
4. Conclusions

1. Background

Beer market trend in Japan

- Market share of craft beer is growing in Japan
- Cereal varieties and malting processes largely contribute to taste and flavor





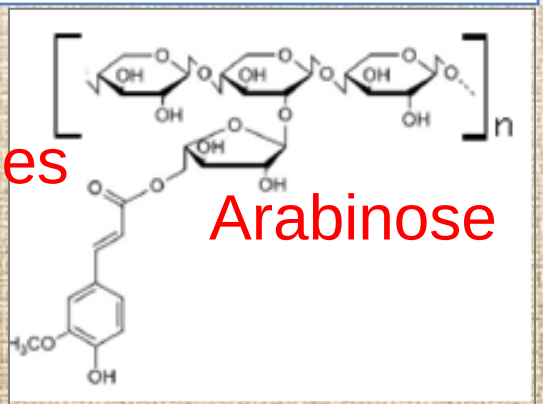
(Reference : Tax Agency of Japan)

Characteristics of rye malt

- Rye malt imparts spicy taste
- High arabinoxylan content, which decreases lautering and beer filtration efficiency

Content rate (%)	Barley	Wheat	Rye
β-glucan	2.9	0.7	0.7
Water-soluble Arabinoxylan	0.2	1.2	2.6

(Reference: Professor Methner, TU- Berlin)

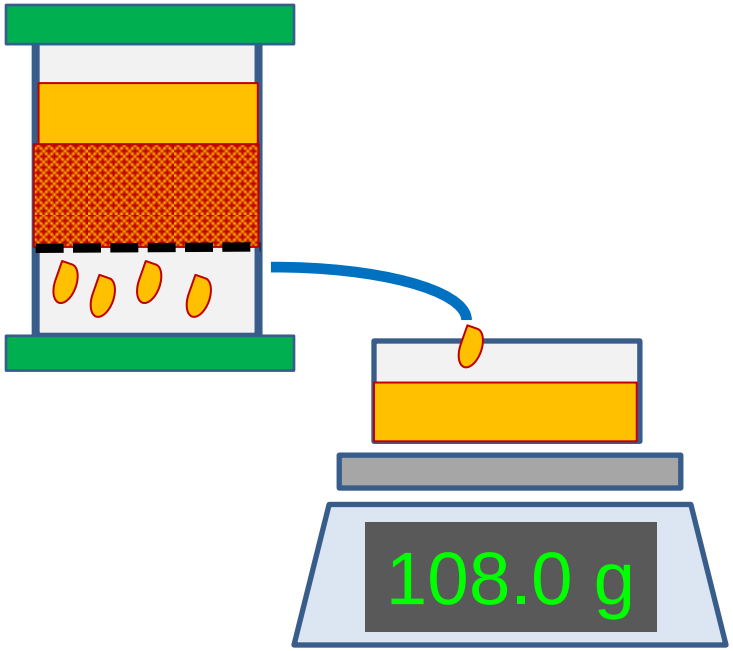


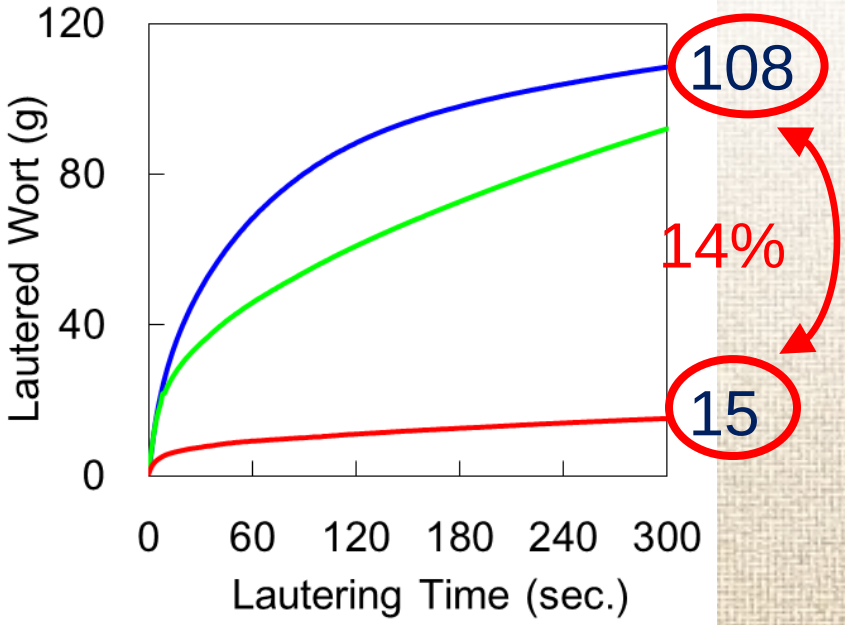
Lautering of rye malt

- Rye malt decreased lautering efficiency

Lautering test

Monitoring the weight of lautered wort after 300 sec.





: Barley malt
: Wheat malt (50%)
: Rye malt (50%)

2. Objective

Study objective

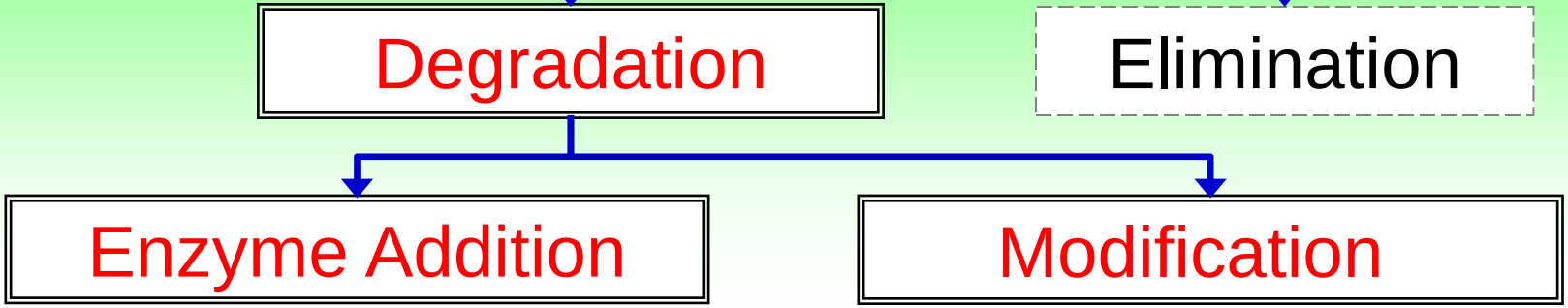
- Determine the reasons for the slow lautering rate of rye malt

Goals

i) Understand the correlation between arabinoxylan levels and lautering rate

ii) Find countermeasures to improve lautering rate

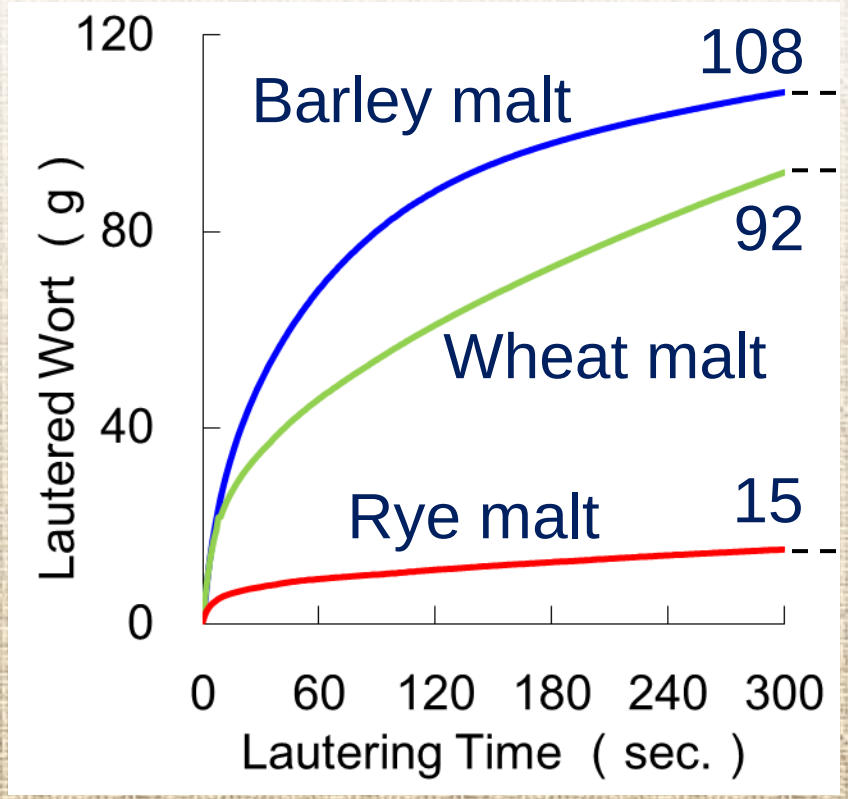
Method

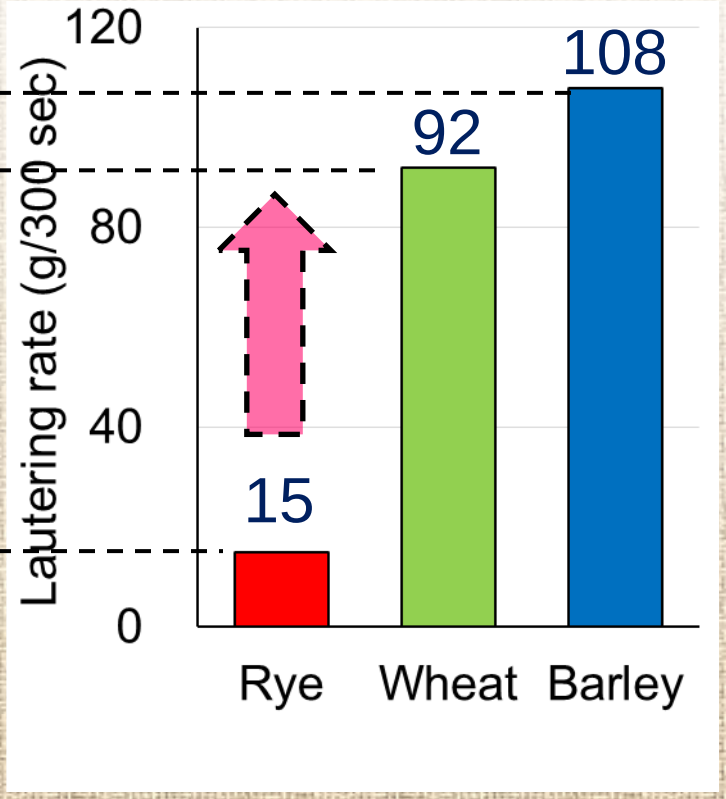


3. Results and discussions

Definition of lautering rate

- Lautering rate was defined as the weight of wort (g) lautered in 300 sec





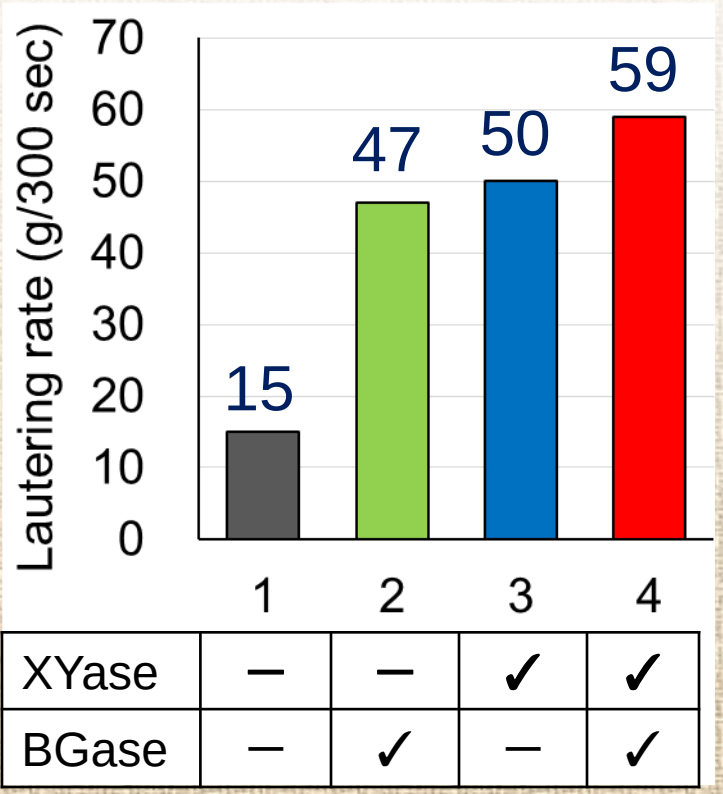
(1) Enzyme addition at mashing-in

- Both arabinoxylan and β-glucans affect the lautering rate of rye malt

【Commercial enzyme addition】

- Barley malt : rye malt = 50 : 50
- Enzymes added at mashing-in

	Product Name (Novozymes)	Activity (U/g)	
		XYase	BGase
1	No addition	—	—
2	Ultraflo L	—	45
3	Shearzyme 500L	550	—
4	Ultraflo MAX	250	700



XYase : Xylanase BGase : β-glucanase

(2) Modification of malt

➢ Hypothesis

By progress of modification, arabinoxylan and β-glucan can be degraded to improve lautering rate

➢ Trial

- Rye was malted at a pilot scale (800 g)
- Effects of malting conditions on lautering rate were evaluated

→ Steeping duration
→ Malting temperature

Outline of malting test

	T1	T2	T3	T4	T5	T6	T7	T8
Steep Duration(hr.)	25	45	48	48	48	48	48	48
Steep/Germ. Temp. (℃)	15	15	15	20	20	20	20	20
Addition Substance	No Addition				GA		XYase	
Process					Germination			
Timing (hr.)					0	24	0	24

GA : Gibberellic acid (0.2 mg/g-malt)

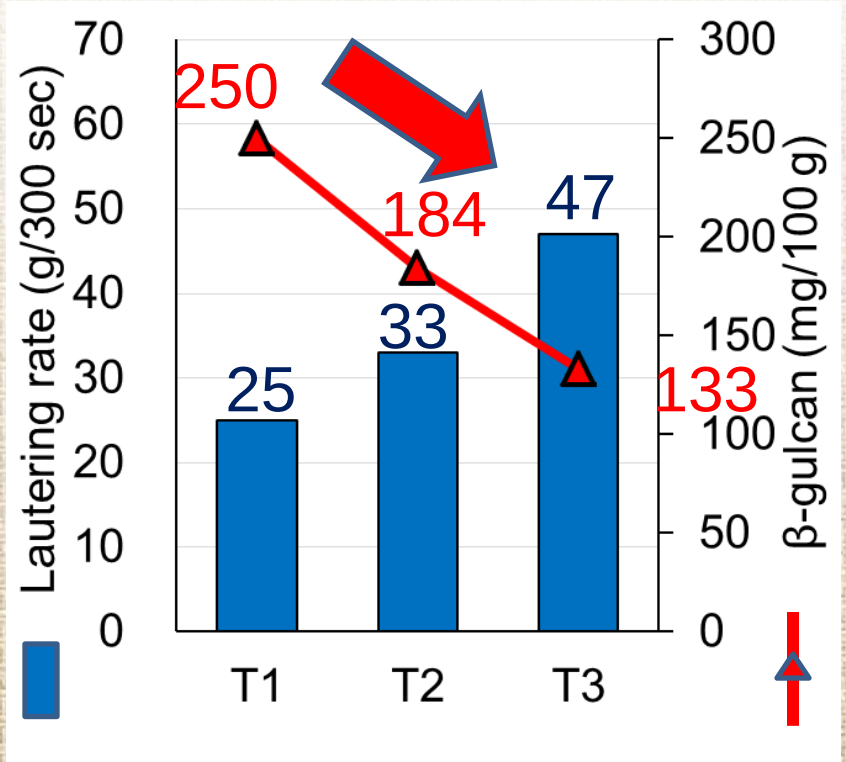
XYase : Xylanase (Shearzyme 500L, 1.0 mg/g-malt)

Effects of steeping duration

- As steeping duration increased, β-glucans decreased and lautering rate increased

【Steeping conditions】

(Hours)		T1	T2	T3
Duration		25	45	48
Cycle	Water	–	1	4
	Air		19	
	Water		4	
	Air		19	
	Water		2	



- Germination duration ⇒ 3 days
- Malting temperature ⇒ 15℃

Effects of malting temperature

- As malting temperature reached 20℃, β-glucan decreased sufficiently but lautering rate didn't so increase.

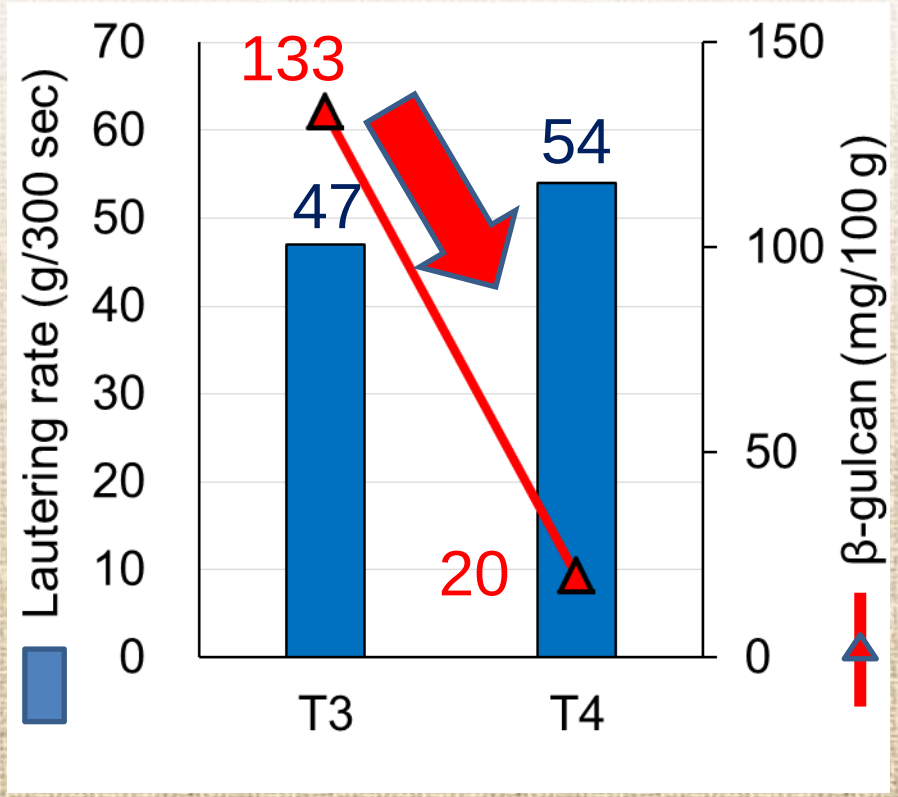
【Temperature conditions】

	T3	T4
Steeping/ Germination	15℃	20℃

- Steeping cycle (hours)

4	19	4	19	2

- Germination Duration
  ⇒ 3 days



Short summary

- Increasing steeping duration and malting temp. increased lautering rate by decreasing β-glucans

Malting condition	Total steeping duration	Malting temperature
	25⇒48 h	15⇒20℃
Lautering rate	Higher	Higher
β-glucan amount	Lower	Lower

- At 20℃ steeping/germination conditions:

⇒ β-glucan amount was markedly reduced

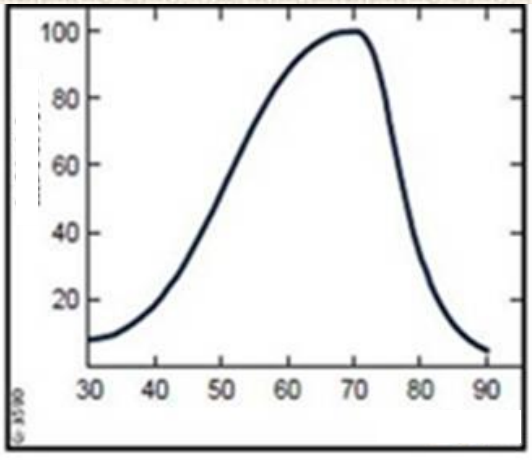
⇒ Lautering rate was still 40% of that of barley malt

(3) Enzyme addition during germination

- Hypothesis

① Endogenous xylanase activity is low during the malting process

② Adding commercial xylanase during germination would improve lautering rate



	Germination	Mashing
Optimal temperature	Lower than optimal temp.	Closer to optimal temp.
Reaction time	Longer (several days)	Shorter (< 1 hour)

Optimal temperature of xylanase (Novozymes, 'Shearzyme 500L')

Effect of addition during germination

➢ Trial

Gibberellic acid or xylanase was sprayed directly on kernels { ① 0 hours ② 24 hours } after germination start

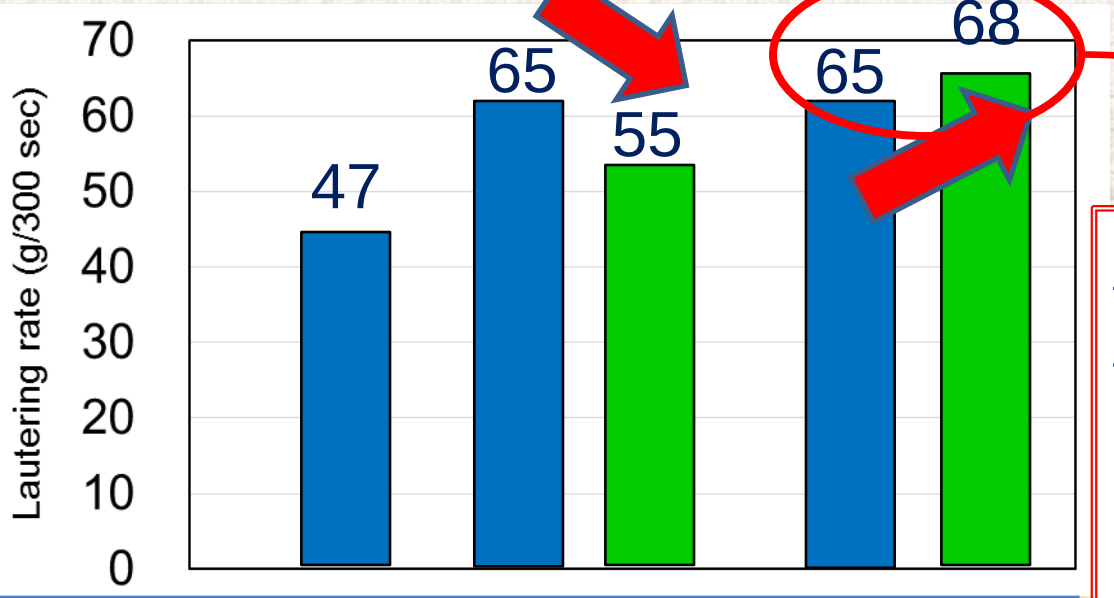
	T4	T5	T6	T7	T8
Addition	–	GA		XYase	
Timing (hr. after germ. start)		0	24	0	24

GA : Gibberellic acid (0.2 mg/g-malt)

XYase : Xylanase (Shearzyme 500L, 1.0 mg/g-malt)

Effect of addition during germination and addition timing

- Xylanase addition during germination improved lautering rate
- Gibberellic acid addition was also effective



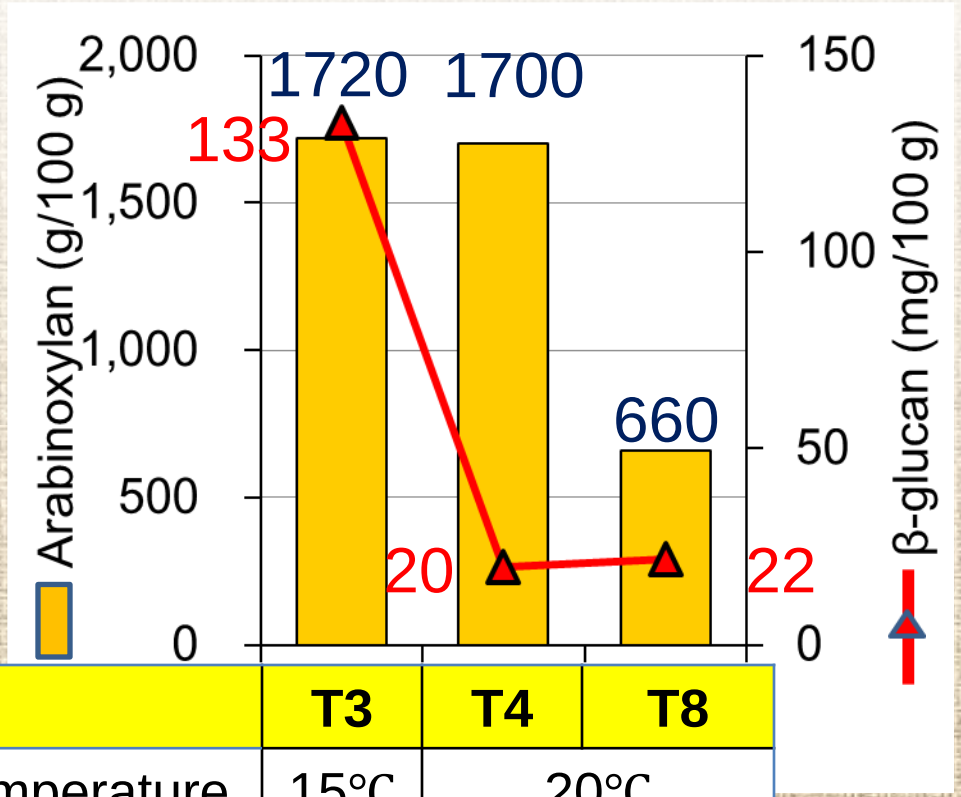
	T4	T5	T6	T7	T8
Addition	None	GA		XYase	
Timing (hr.)		0	24	0	24

Xylanase addition during germination

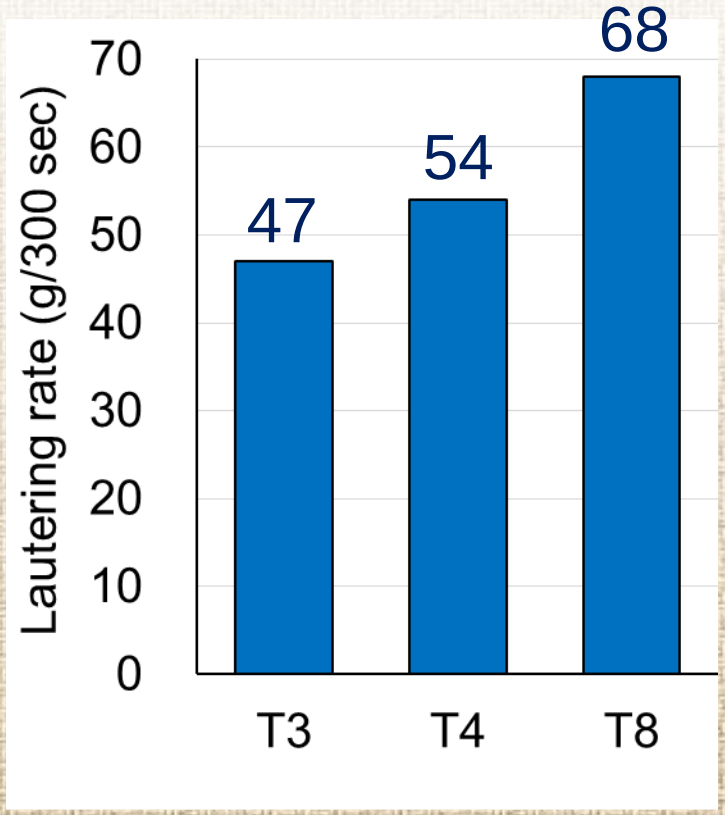
- Increased lautering rate
- Later addition was more effective

Arabinoxylan degradation

- Xylanase degraded arabinoxylan, resulting in increased lautering rate



	T3	T4	T8
Temperature	15℃	20℃	
Addition	None		XYase



Short summary

- Exogenous xylanase degraded arabinoxylan, resulting in increased lautering rate
- Rising malting temperature was no effect to degrade arabinoxylan

⇒ Rye malt has low endogenous xylanase activity

- Later addition of xylanase was more effective for increasing lautering rate

⇒ At later stages of germination, cell wall components are degraded and xylanase can more easily enter grains

Enzyme addition during germination vs. at mashing-in

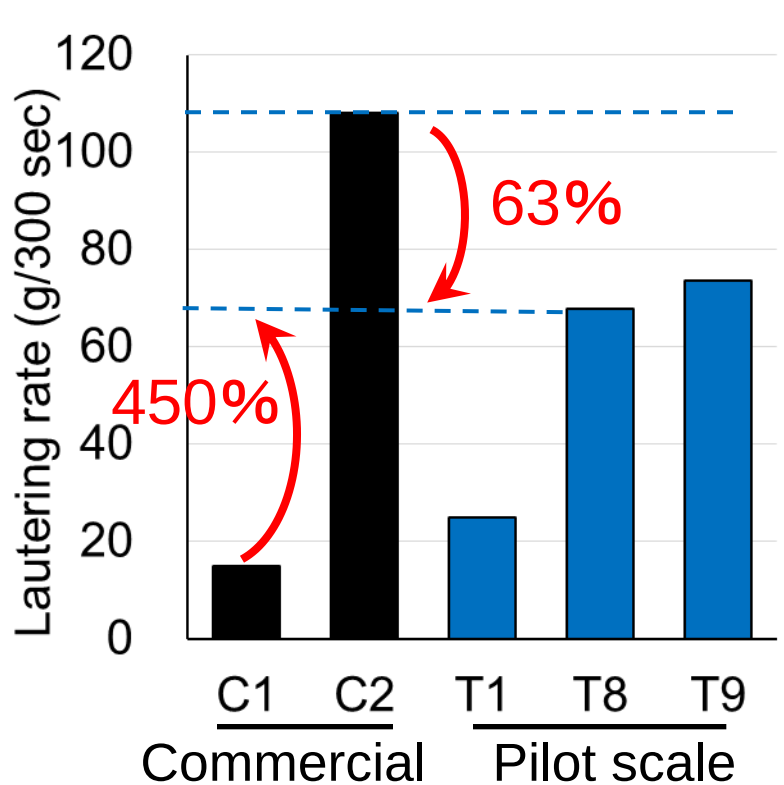
- Xylanase addition during mashing-in resulted in a similar lautering rate as addition during germination

【Commercial malt】

	C1	C2
Variety	Rye	Barley

【Malted in pilot scale】

	T1	T8	T9
Temp.	15℃	20℃	
Addition	None	Xylanase	
Timing	—	Germi-nation	Mashing-in



4. Conclusions

Conclusions

Problem

- Rye malt is associated with slow lautering rate

Mechanism

- Endogenous xylanase activity of rye malt is too low to degrade arabinoxylan and results in poor lautering efficiency

Countermeasure

- Adjusting malting conditions and adding xylanase during germination improve lautering rate

Thank you for your kind attention

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