Maltose negative yeast strains in non-alcoholic beer production

Karlovac – With Brewers for Brewers 2024

Introduction

Non-Alcoholic Beer:

- Defined as beer that is <0.05 - 0.5% ABV (dependent on your region)

Low Alcoholic Beer

- Defined as 0.5-1.5% ABV

Non-alcoholic beers can be made in different ways

Two broad Production approaches

PHYSICAL

Alcohol Removal

Thermal

Vacuum rectification

Thin film evaporator

Membrane

Dialysis

Reverse osmosis

BIOLOGICAL

Restricted Ethanol Formation

High temp mashing

Arrested/Limited fermentation

Specialist yeast strain

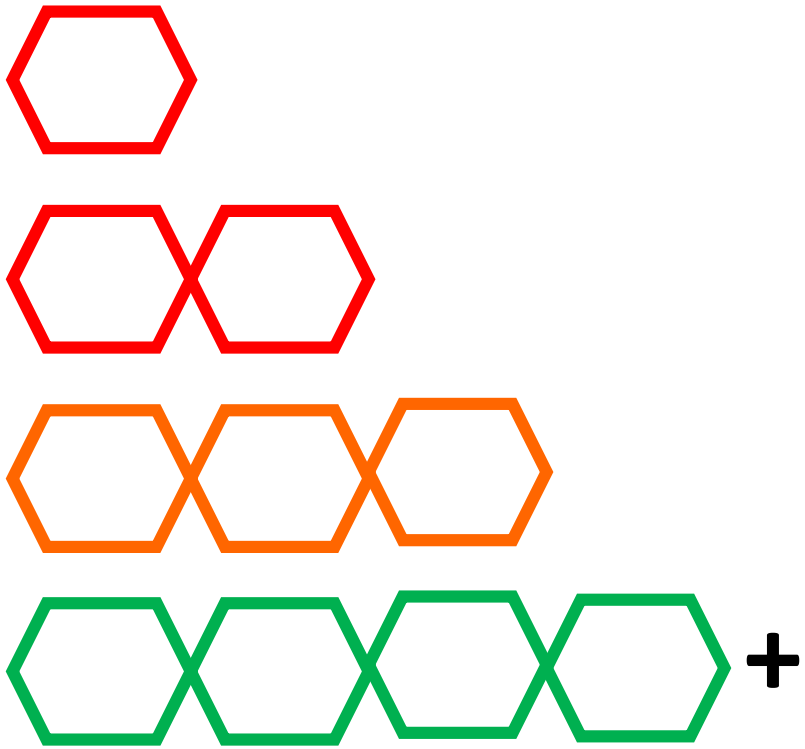
Co-fermentation with bacteria
A combination of the above

Challenges – Physical

- Costly equipment
- Significant process optimization
- Flavor loss by heating
- Energy intensive
- Thermal damage
- Other licensing may be required

In depth justification of high temperature mashing

Understand the importance of wort composition in recipe design



	% of normal wort sugars
Glucose DP1	10-15
Maltose DP2	50-60
Maltotriose DP3	15-20
Dextrin DP4+	20-30

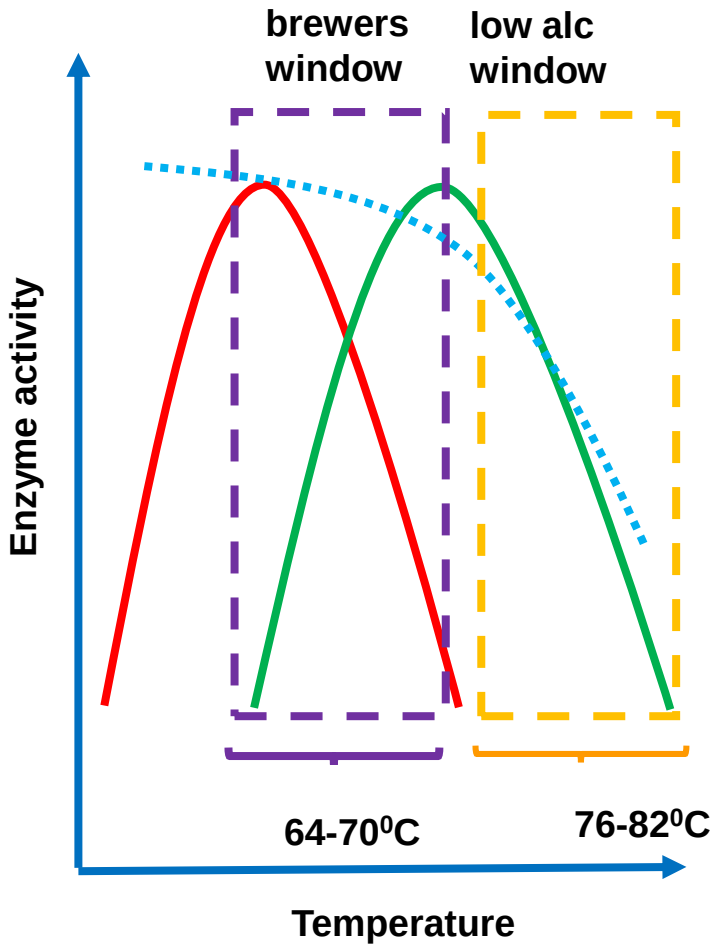
Understand mash enzymes and modify your fermentability

Key

beta amylase

alpha amylase

fermentability



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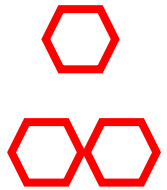
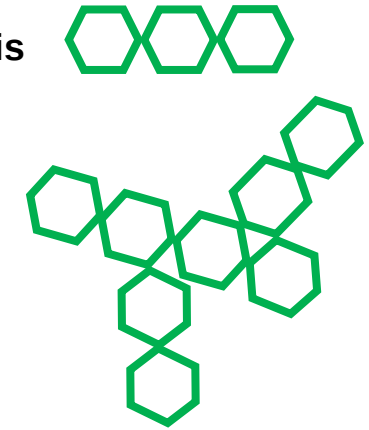


Less of this

CH_3CH_2OH

More of this



Some experimental work with high mashing technique

Mash temperature Trials

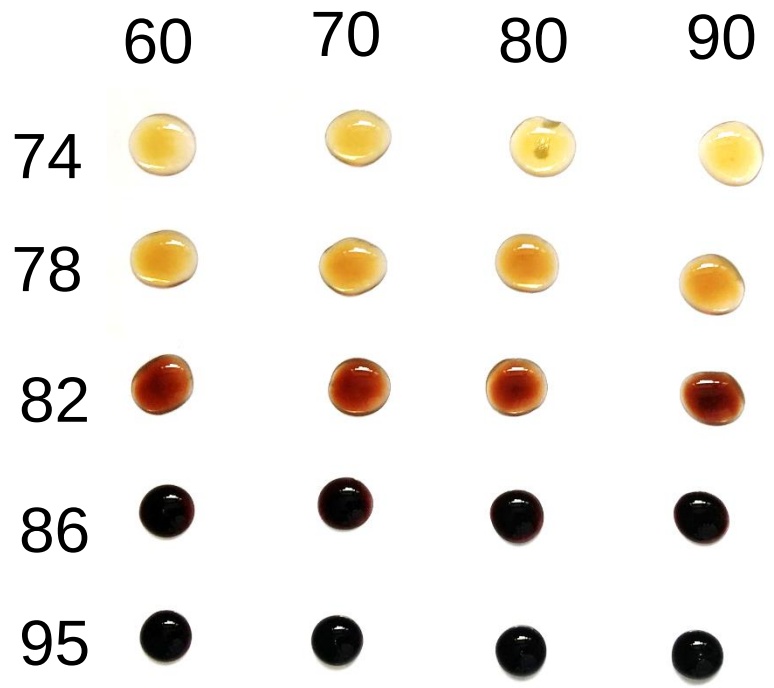
- Idea is to inactivate beta amylase while keeping alpha amylase active
- 5 different single mash temperatures
- Four time periods
- 7.5 Plato wort

AB Vickers Trials (mash bath + iodine)

Initial mashing regime

		Mash Temperature ^{0}C				
		74	78	82	86	95
Mash Time (min)	60	S1	S5	S9	S13	S17
	70	S2	S6	S10	S14	S18
	80	S3	S7	S11	S15	S19
	90	S4	S8	S12	S16	S20

Iodine test



Mascoma analysis (size exclusion chromatography)

g/100ml

	SEC Column			
	HMW	DP3	DP2	DP1
SP-1	0.46	4.947	14.304	2.386
SP-2	0.745	5.111	15.069	2.328
SP-3	0.712	5.263	15.503	2.35
SP-4	0.674	4.959	14.603	1.867
SP-5	5.266	3.764	11.331	1.299
SP-6	4.96	3.603	10.64	1.368
SP-7	4.991	3.683	10.594	1.431
SP-8	3.854	3.739	10.692	1.442
SP-9	9.75	2.944	8.373	1.121
SP-10	11.467	3.181	9.172	1.2
SP-11	11.102	3.35	9.884	1.228
SP-12	10.913	3.245	9.239	1.219
SP-13	16.502	2.029	6.551	1.03
SP-14	16.488	2.206	7.191	1.085
SP-15	15.142	1.981	6.514	0.97
SP-16	17.358	2.169	7.246	1.092
SP-17	15.209	2.762	9.839	1.121
SP-18	15.694	2.681	9.961	1.094
SP-19	15.381	2.513	9.266	1.074
SP-20	14.288	2.709	9.67	1.034

74

78

82

86

95

Too much fermentable sugar

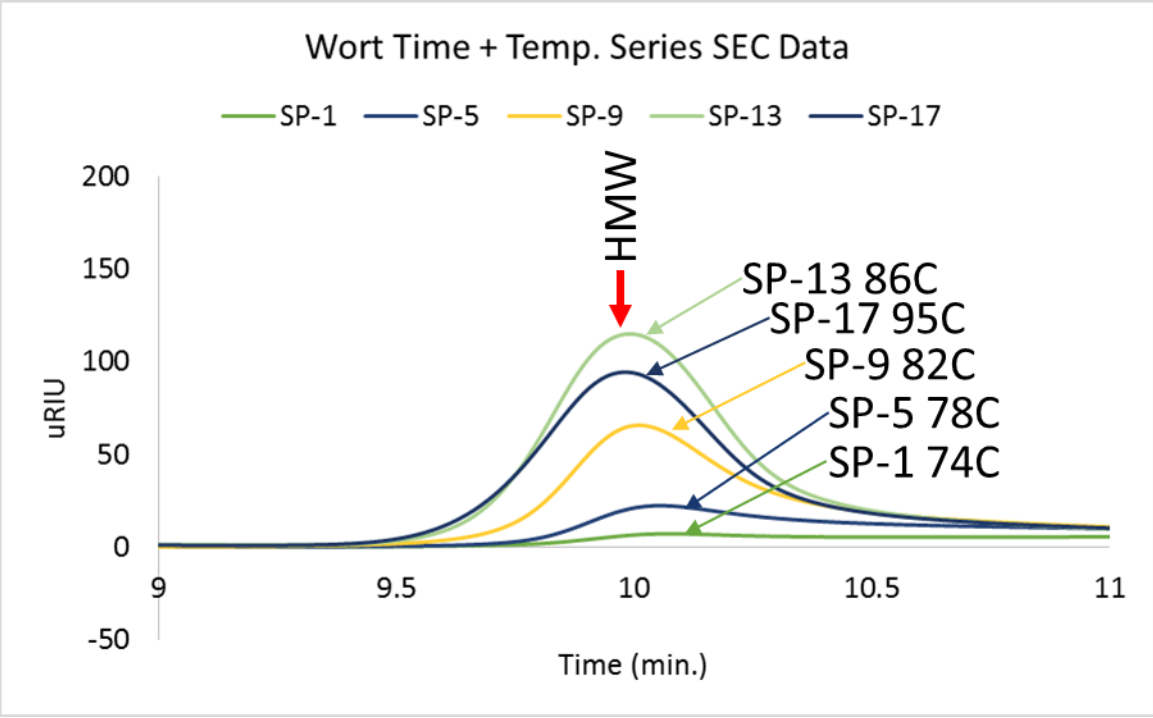
Good potential

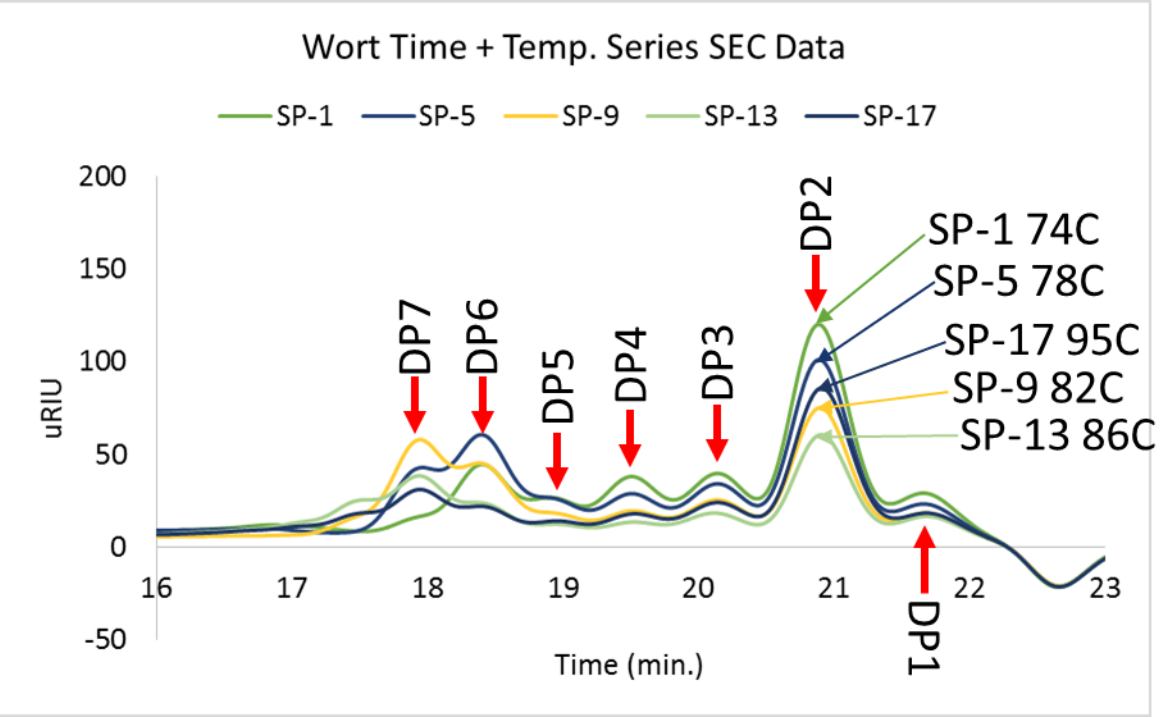
Good potential

Possibly too much starch

Too much starch + some fermentable sugar

Montreal SEC data





Challenges – combined biological approaches

High Temperature Mashing

- Creates tricky worts
- Risk alcohol content will be too high

Arrested Fermentation (including cold contact)

- Requires close monitoring
- Worty flavours
- Risk of over fermentation

Specialist Yeast

Maltose negative

- Most are not saccharomyces
- Almost exclusively wild yeast or food spoilage organisms
- POF+ and sulphur producing
- Poor pH reduction

Maltotriose negative

- Requires high mash temperatures

The Project: making a better nalab strain

Desired Traits:

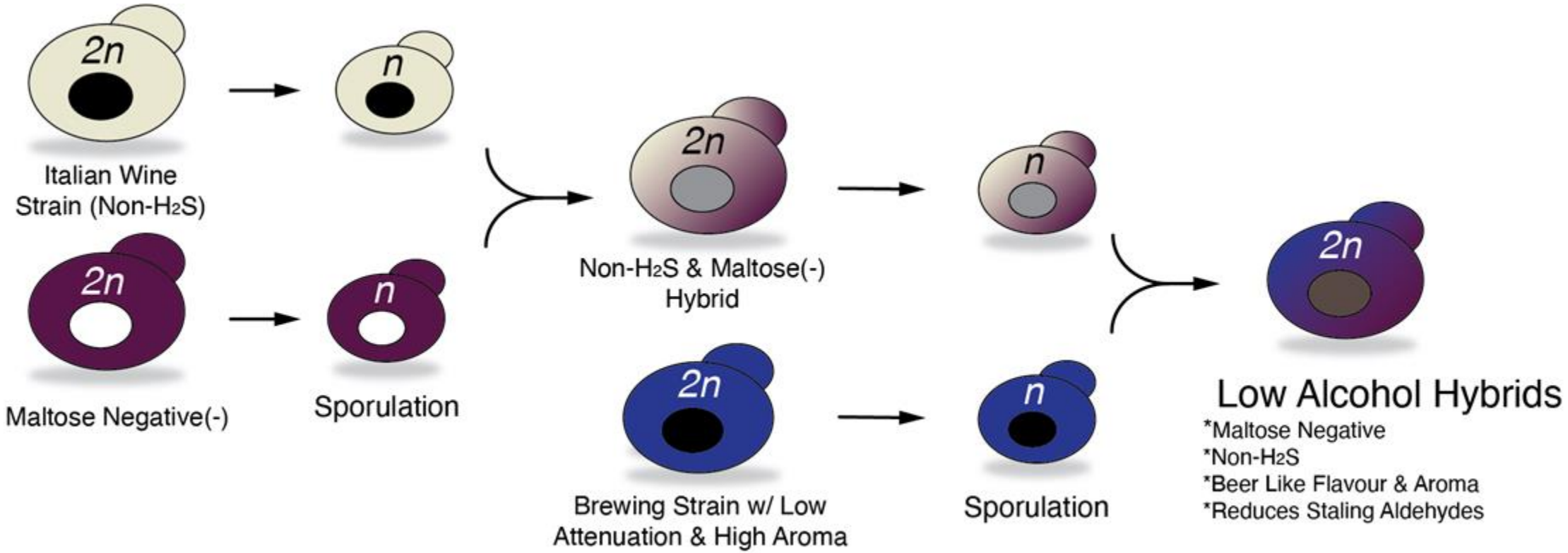
- Fermentation based solution
- Clean flavour profile
- No POF
- Reduced worty flavors
- Low diacetyl prodcucer
- Consistent performance
- Simple process
- Versatility for different styles

Introducing Lalbrew lona

Lalbrew LoNa™ Overview

- non-GMO breeding methods were used to select a strain that does not consume maltose or maltotriose resulting in very low attenuation.
- LoNa™ is the first hybrid *Saccharomyces cerevisiae* strain that does not ferment maltose or maltotriose
- LoNa™ does not produce H2S and uses a large proportion of staling aldehydes resulting in a low or non-alcoholic beer that tastes more like beer

Breeding Schematic



Fermentation characteristics

Based on an 8°P wort

Pitch Rate: 50-100g/hl

Fermentation Temperature: 20-25°C (68-77°F)

Attenuation: 16-20% (lower with high mashing conditions)

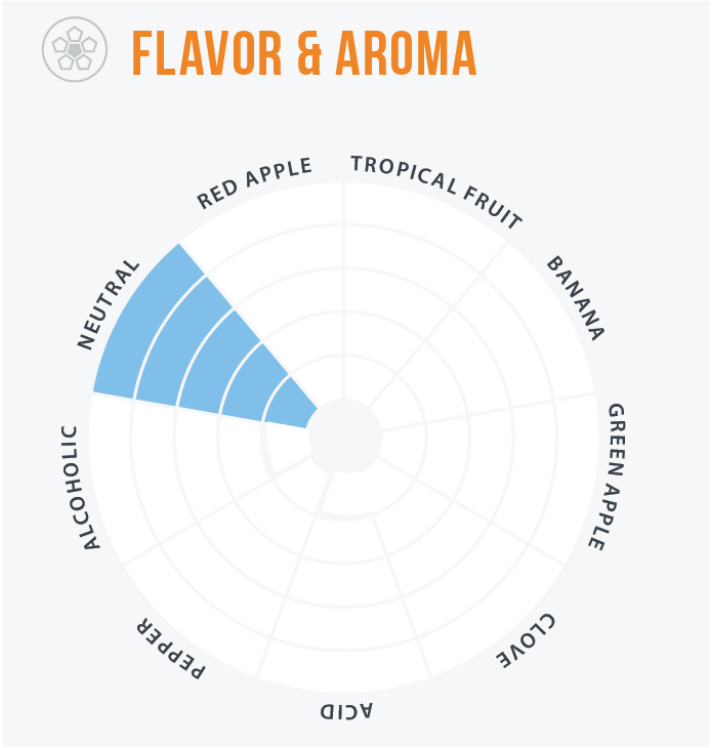
Flocculation: Medium

Fermentation Completed: 2-3 days

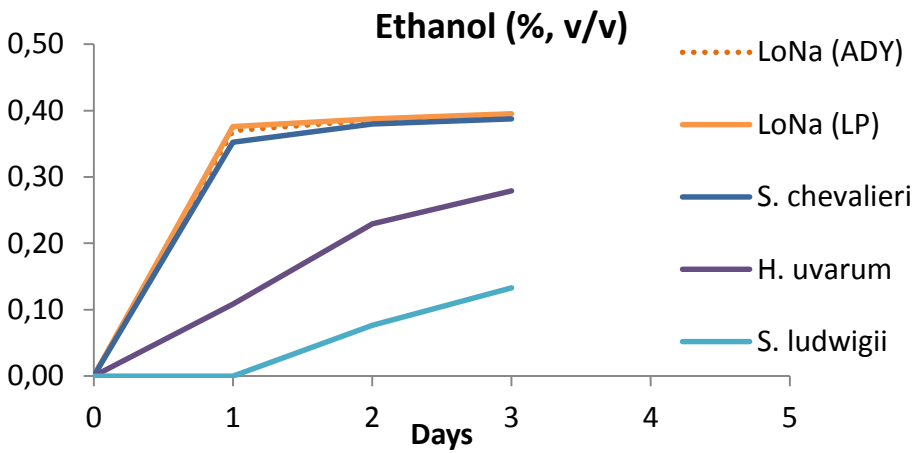
Repitchability: Not repitchable

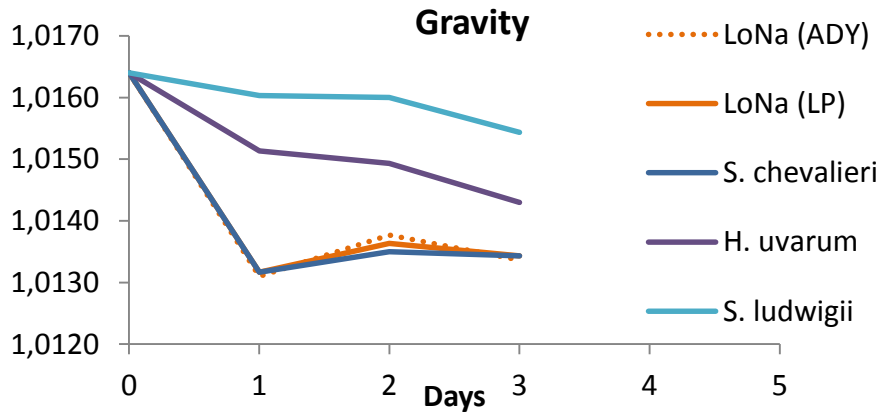
Flavour characteristics

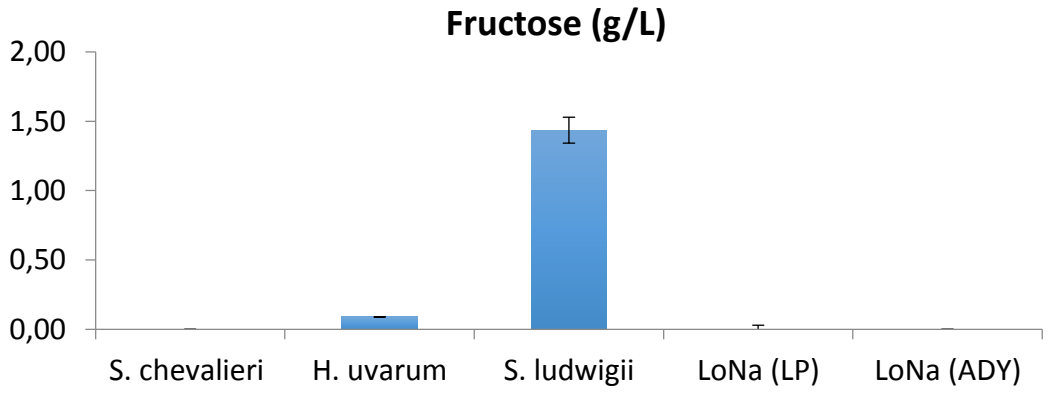
- Has a clean and neutral aroma
- Does not produce H2S and is POF-
- Reduction in aldehydes lends for reduced wort character, similar to a traditional beer fermentation

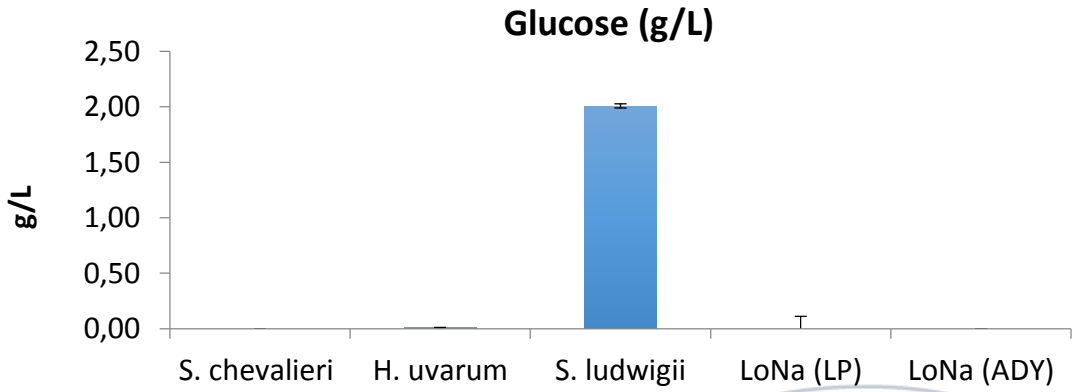


Fermentation Performance and sugar assimilation

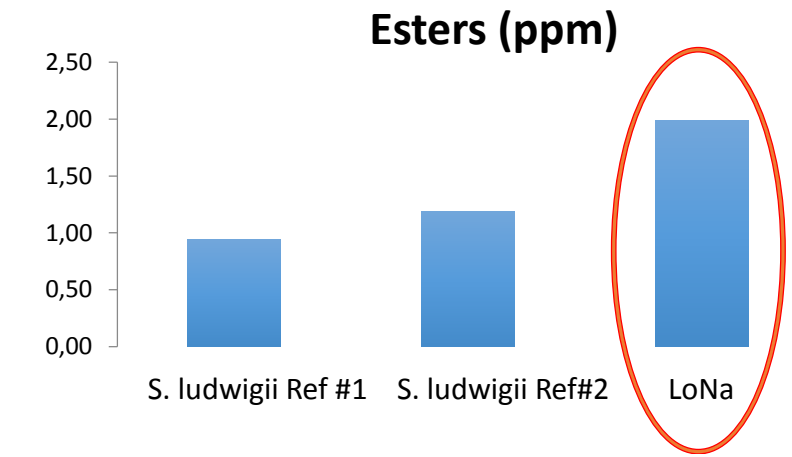


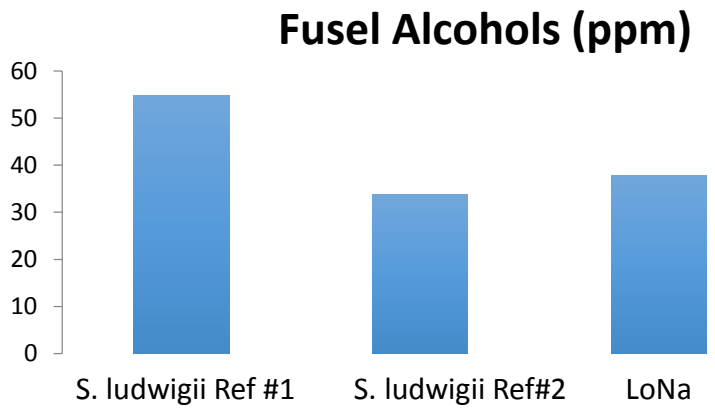


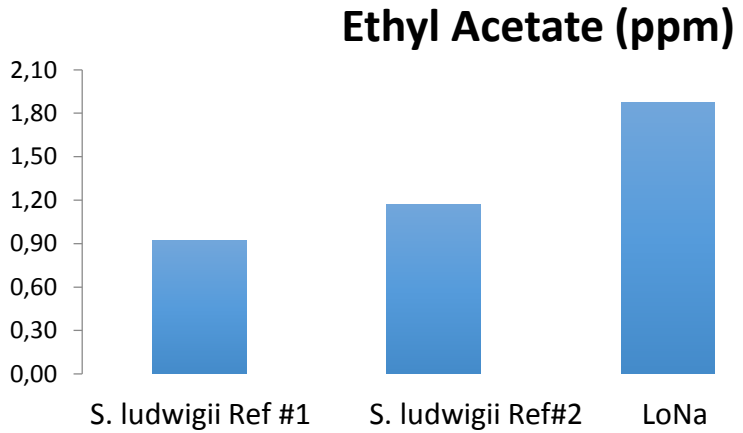


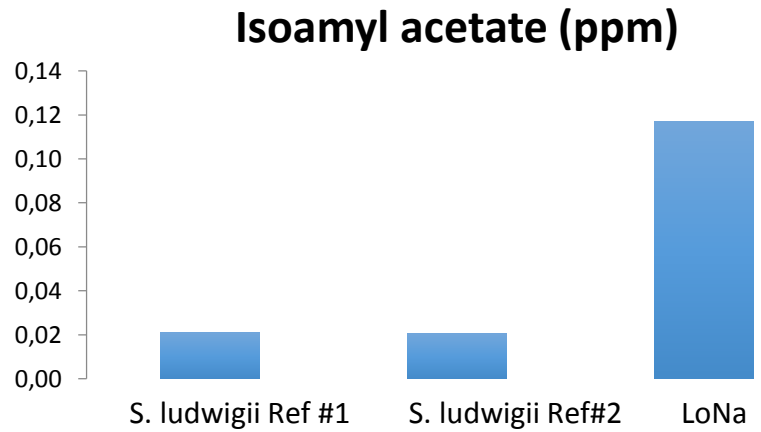


Esters and Fusel Alcohols







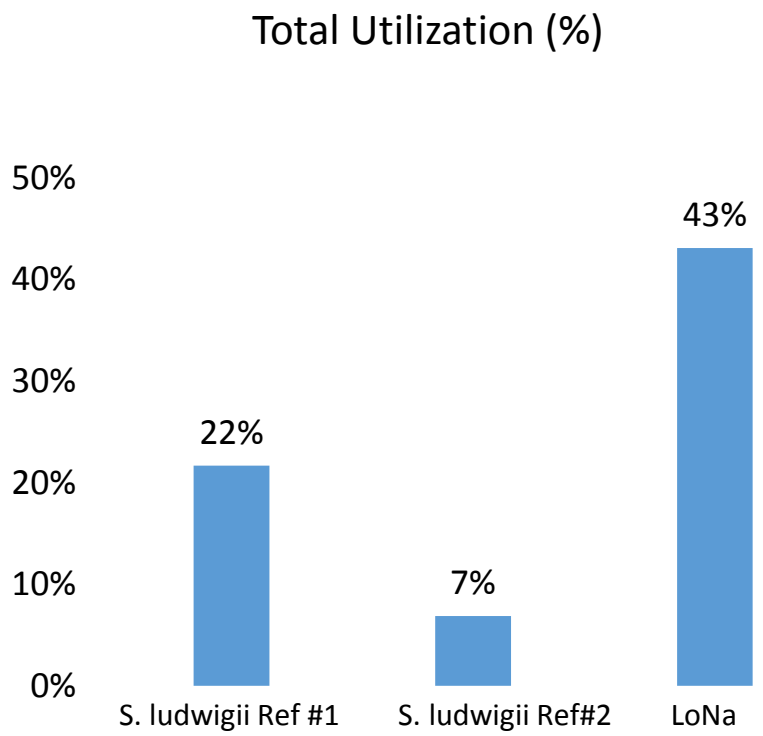


- LoNa™ produces a higher proportion of “beer-like” esters and aromas compared to the reference *Saccharomycodes ludwigii*

Aldehydes

- Low and no alcohol beers suffer from flavor defects often described as sweet or worty.
- These flavors originate from flavor active aldehydes which are created in the mashing and boiling processes. The most abundant are 3-methyl butanal, 2-methylbutanal and methional.
- Ordinarily these aldehydes are reduced to their primary alcohols through the activity of yeast during fermentation, but in a limited or restricted fermentation this reduction may not happen to the same degree.
- LoNa™ exhibits good aldehyde reduction compared to other maltose negative strains

Utilization of Staling Aldehyde



- Low alcohol beers are known to have a high level of staling aldehydes due to the limited nature of fermentation.
- LoNa™ strain utilize a higher proportion of aldehydes when compared to the reference maltose negative S. ludwigii strains.
- Low Alcohol beers fermented with LoNa™ taste fresher and cleaner than other maltose negative strains due to aldehyde reduction.

Stabilisation

Stabilisation is the most commonly overlooked factor in the production of low alcohol beers by craft brewers. If we think about regular beer it is relatively microbiologically stable and pathogens struggle to grow or survive for the following reasons.

High alcohol

Low pH

Hop compounds

Low nutrient

All of these are altered or reduced to a degree in low alcohol beer

Stabilisation (how to)

- Tunnel Pasteurise
- Flash Pasteurise
- Chemical
- Mushroom extracts
- PU low 40-60
- PU no 80-12

Conclusion

No and low alcohol beer can be made by a variety of methods. Modern biological solutions utilising matose negative yeasts offer an easy way of producing low alcohol beer without CAPEX. However, all low and no alcohol beers should be stabilised.