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Differentiating beer aroma, flavor and alcohol content through the use of *Torulaspora delbrueckii*

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Introduction

In the last decades, the rapid growth of craft brewing gave rise to the experimental use of non-Saccharomyces yeasts which were previously only reported as spoilage microorganisms in brewing.

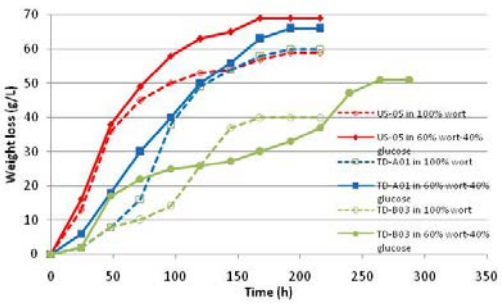
Saccharomyces strains provide better fermentation control and reproducibility. Non-Saccharomyces yeasts generally have slower fermentation rates, lower alcohol resistance & yield and different flocculation properties. These however are not necessarily limiting factors for the small craft breweries that experiment with unfiltered beers and provide to the consumer seasonal specialty products, with novel and more extravagant taste.

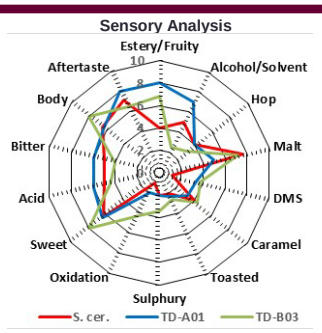
This study explores the brewing characteristics and effects of two *non-Saccharomyces* strains of *T. delbrueckii* on the fermentation parameters as well as on the flavour profile of the Pale Ale beer produced either with 100% malt wort or 60 % malt wort and 40 glucose, in comparison with a well known *S. cerevisiae* brewing strain.

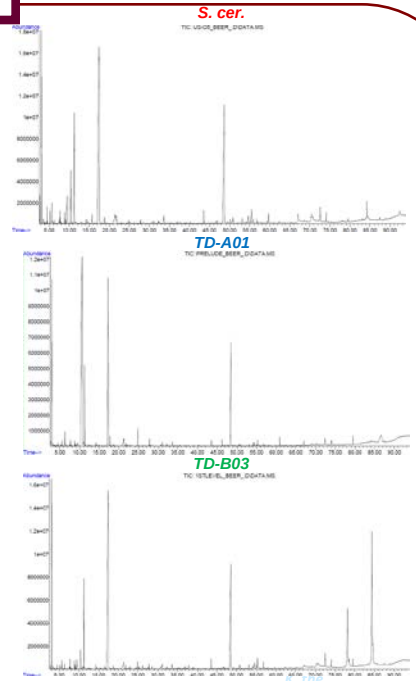
Materials and Methods

Pale Ale wort was produced in a 100L pilot brewery with specific gravity 1,049, pH 5.3 and 237 mg/L FAN. Hop use were kept at a minimum to avoid a masking effect of the strains influence. Fermentations were carried out at 20ºC and the beer was bottle conditioned. Semi quantitative GC-MS analysis was performed after addition of 3-octanol as an internal standard and liquid extraction (dichloromethane), with Hewlett-Packard 6890 Agilent Technologies 5975C VL MSD with Triple-Axis Detector. HP-1 (Hewlett-Packard) silica capillary column, cross-linked, 100% methyl siloxane 30m x 0.32mm x 0.25µm. The temperature program was as follows: 40ºC for 5 min, then raised at 3ºC/min up to 230ºC. Carrier gas was He at 1 mL/min. Injection: 1 µl in split mode. Split flow was 70.6 ml/min. Data analysis was carried out by HP Chemstation rev.A.06.03. HPLC analysis was performed with an ELITE LaChrom HPLC system comprised of a VWR HITATCH L-2130 pump, a VWR HITATCH L-2200 autosampler fitted with a 20 µL sample loop, a VWR HITATCH L-2455 DAD (organic acids) and an RI detector (sugars, glycerol, ethanol). Peaks data were collected with Agilent EZChrom Elite Client/Server Enterprise Data System. The column was an Aminex HPX-87H from Biorad, the mobile phase was H_2SO_4 0,005M at 0,4 mL/min, with a column temperature of 40 ºC Other analyses were performed according to EBC methods. Sensory analysis was performed by a group of 12 trained assessors. *T. delbrueckii* strains originated from wine and *US-05 S. cerevisiae (Fermentis)* was used for comparison.

Results & Discussion







	various volatile compounds (mg/L)		
	S.cer.	*TD-A01*	*TD-B03*
Isobutyric acid	10,2	0	17,9
Ethyl lactate	6,2	3,1	2,6
Isoamyl acetate	1,6	15,6	3,1
2-phenylethyl acetate	3,3	29,1	11,2
2-phenylethanol	★	★★	★★
Σ esters	★	★★	★★
Σ higher alcohols	★	★★	★★

	In beers from 100% wort		
	S.cer.	*TD-A01*	*TD-B03*
Alcohol (%vol)	5,12	4,2	2,34
Apparent Attenuation (%)	79	63	36
pH	4,69	4,43	4,85
Acidity (g/L)	1	1,3	1,1
Volatile acidity (g/L)	0,21	0,14	0,17
Succinic acid (g/L)	0,079	0,487	0,236
Glycerol (g/L)	2,54	2,6	2,1
FAN (mg/L)	184	161	129
Color (EBC)	12	12	12
Haze (EBC)	4,9	9,7	11

All strains fermented faster and better in the wort supplemented with glucose, with TD-B03 showing a diauxic growth curve. One of the *T. delbrueckii* strains exhibited slightly lower but similar fermentation ability with the *S. cerevisiae* with the exception of greater lag phase. They were also more nitrogen demanding. However it produced lower volatile acidity and the organic acids profile was different from that of *S. cerevisiae* strains. It also showed higher production of esters, higher alcohols & other volatile compounds and lower production of undesirable compounds and greater sensory complexity with floral and fruity characters. The other *T. Delbrueckii strain* TD-B03 had longer lag phase and was able to ferment only about 60% of the initial sugars, resulting in a beer with only 2,3% ABV, but presented an equally pleasant, although slightly less intense flavour profile.

Conclusions

Although, *Torulaspora delbrueckii yeast* strains exhibit variability in maltose and maltotriose consumption, through fermentation in a laboratory and pilot scale, we have observed that the overall effect of selected *T. delbrueckii* strains is positive, leading to beers with more distinct & intense floral/fruity aromas. Even maltose negative strains can be used, either for wort high in glucose, or low % ABV beers, or in co-inoculation with *S. cerevisiae* for enhanced flavor.

In conclusion, the results obtained showed that some *T. delbrueckii* strains, either in malt wort or in glucose supplemented wort have merits that could be exploited in brewing, pure culture or possible co-inoculated with *S. cerevisiae*.