Chemical comparison of a sour beer made with bacteria and genetically modified yeast

2022 ASBC Meeting
BREWING SUMMIT 2022
Providence, Rhode Island | August 14–16

A-12

Neil Fitzgerald, Marist College
3399 North Road, Poughkeepsie, NY 12601
Neil.fitzgerald@marist.edu

ABSTRACT

Sour beers have become increasingly popular over the past couple of years. Sour beer sales increased by 40% in 2019, according to Nielson. Normally sour beers are fermented with a bacteria such as lactobacillus which produces a significant amount of lactic acid providing the beer its characteristic clean, sharp acidity. Recently, genetically modified yeasts have been developed to achieve similar levels of lactic acid. These yeasts allow the brewer to ferment and sour the beer in a single step while reducing cross contamination risks and significantly reducing fermentation times in the production of a sour beer. In this work we compare the chemical characteristics of a fruited sour beer fermented with lactobacillus to the same beer fermented with a genetically modified yeast. Both beers were produced at the same brewery. It was anticipated that both fermentation methods would lead to a similar final product. We compared a number of chemical characteristics including pH, total acidity, lactic acid concentration, %ABV, selected element concentrations, volatile compounds, and diacetyl content. We used a variety of analytical methods including titration, High Performance Liquid Chromatography (HPLC), Headspace Solid Phase Micro Extraction Gas Chromatography Mass Spectrometry (HS-SPME-GCMS), and Inductively Coupled Atomic Emission Spectrometry (ICP-AES). As expected, the beers were found to be similar although the product made with the genetically-modified yeast exhibited lower pH and higher total acidity with a higher lactic acid concentration.

EXPERIMENTAL

Samples: Cross Reference is a fruited kettle sour produced using Lactobaccillus. Raspberry and blackberry versions were obtained for analysis and stored in cans. A version of raspberry cross reference produced using a genetically modified yeast (Sourvisiae®) was obtained from the brewer and stored in a crowler can. All samples were stored in a fridge at 4°C prior to analysis.

The following analytical methods were used:
Acidity: pH (ASBC Method Beer-9), titratable acidity (ASBC Method Beer-8)
Lactic Acid: HPLC DAD with C-18 column and phosphate buffer mobile phase (pH 2.4)
%ABV. FTIR with standard additions calibration
Volatile compounds: Headspace SPME with portable GCMS (Torion-9)
Metals: ICP-AES of diluted samples calibrated with matrix matched standards
Bitterness: ASBC Method Beer-23
Diacetyl: GC-ECD based on ASBC Method Beer-25

RESULTS AND DISCUSSION

	Fe (mg/L)	Mg (mg/L)	Ca (mg/L)	Zn (mg/L
CR Raspberry	1.4 (0.5)	2300 (500)	800 (200)	0.2 (0.1)
Raspberry (yeast)	1.6 (0.4)	2200 (200)	860 (60)	0.69 (0.07)

Figure 1: Metal Concentrations (standard deviation)

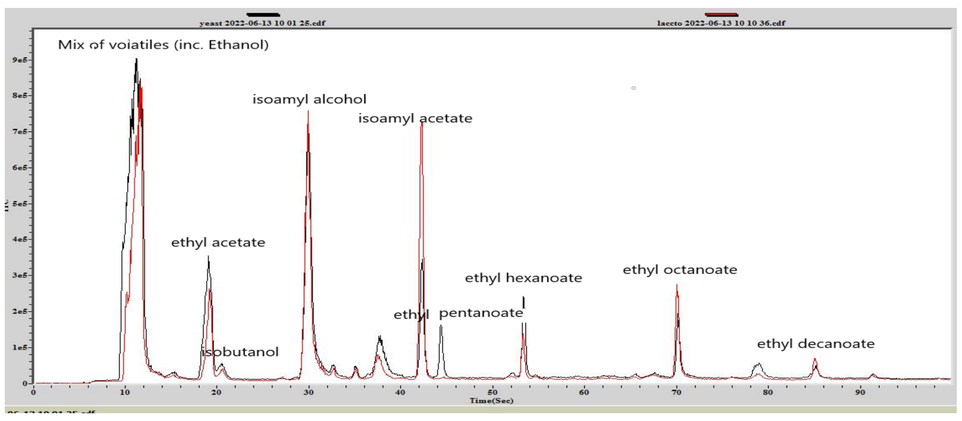
	%ABV (std. dev.)	IBU
CR Raspberry	4.9 (0.3)	5.8
CR Blackberry	4.0 (0.8)	8.1
Raspberry (yeast)	4.3 (0.1)	6.8

Figure 2: General Characteristics

	pH	Total Acidity (M)	Lactic Acid (g/L) *	Lactic Acid (g/L)
CR Raspberry	2.94	0.105	9.45	6.24
CR Blackberry	2.94	0.118	10.62	6.17
Raspberry (yeast)	2.88	0.142	12.78	13.66

* Calculated from total acidity using correction factor as described in Beer-8

Figure 3: Acidity Measurements



Red trace: with lactobacillus
Black trace: with genetically modified yeast

Figure 4: Volatile compounds by headspace GCMS

- The lactic acid concentration of the beer made using the genetically modified yeast was higher leading to a greater total acidity and lower pH
- The volatile compounds (aroma profile) of the two beers were similar although the beer made with the genetically modified yeast exhibited a ethyl pentanoate peak that was absent in the kettle soured beer
- The metals content for the elements studied were similar except zinc which was significantly higher (t-test, 95% confidence) for the beer made with the modified yeast
- Diacetyl concentrations were below the method detection limit

In conclusion, our data indicates that a sour beer can be made with genetically modified yeast with only minor differences in chemistry compared to a similar beer soured using lactobacillus.

Acknowledgements
This project was performed as part of undergraduate coursework. Participating students were Kayla Ali, Alan Bleboo, Noah Cunningham, Halle Owens, and Jack Wrobel.
We wish to acknowledge Jamie Bishop and Mill House Brewery for providing samples and suggesting the project idea.