



Fermentation Characterization and Sensory Panel Preference of Combined vs. Staggered Pitch Sour Beers

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BACKGROUND

- Expectations of consistency, control, and access can complicate spontaneous fermentation. Many brewers purposefully inoculate their sour beers with particular microorganisms to facilitate controlled sour beer production and flavor profiles^[1].
- The organoleptic impacts of specific species and strain level organisms have been more extensively researched than the implications of their interactions with each other^[2]. The interactions between the organisms during fermentation are complex, but there are certain parameters that can be altered to modulate outcomes of the beer. One of these parameters is staggered vs combined pitching.

OBJECTIVES

- H₀: There will be no statistically significant difference between consumer panel preference of staggered vs. combined pitch sour beer fermentations.
- Beer must ultimately be a saleable product. As such, sensory evaluation and consumer preference provide some of the most critical brewer metrics to achieve this goal.
- The **first aim** of this research was to determine consumer preference across the different pitching schemes.
- The **second aim** of this research was to provide Gilded Goat Brewing with a synthesis of the collected analytical data and trends which can be referred to and applied appropriately to achieve certain organoleptic results in future sour beer production.

METHODS

- On 9/15/18 brewed a traditional lambic wort of 50% pilsner malt and 50% un-malted wheat to ensure presence of fermentable extract for all pitched microorganisms.
- The wort was distributed evenly into three separate five gallon fermenters: labeled A, B, C, denoting the respective pitching schemes detailed in Table 1.
- All microorganisms were pitched at a rate of 1 million cells/1° plato/1 mL according to the pitching scheme detailed in Table 1.
- Two 50ml samples were collected from each fermenter weekly, for a duration of six weeks.
- One tube from each sample was spun down in a centrifuge. Testing was implemented under a rotation schedule between students. Tests and methods are outlined in Table 2: Analytical Tests.

Table 1: Test Key

	Pitch 1 (9/15/18)	Pitch 2 (9/18/18)
Sample A/Control	<i>Saccharomyces cerevisiae</i> <i>Brettanomyces bruxellensis</i> <i>Lactobacillus plantarum</i> (co-pitch)	N/A
Sample B	<i>Saccharomyces cerevisiae</i> <i>Brettanomyces bruxellensis</i>	<i>Lactobacillus plantarum</i>
Sample C	<i>Lactobacillus plantarum</i>	<i>Saccharomyces cerevisiae</i> <i>Brettanomyces bruxellensis</i>

METHODS CONTINUED

Table 2: Analytical Tests

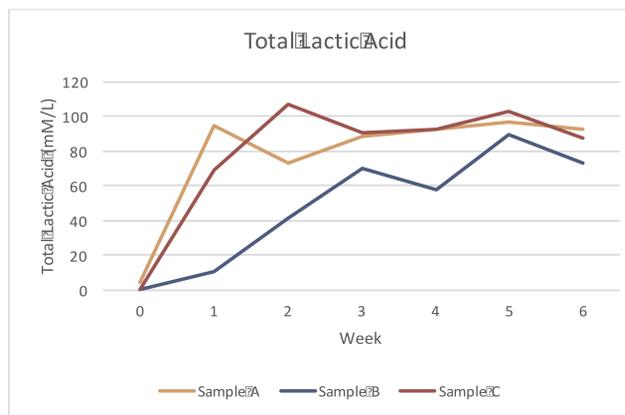
Test	Method
Alcolyzer	ASBC Beer-46
Color	ASBC Beer-10
Polyphenol	ASBC Beer-35
Titrateable Acidity	ASBC Beer-8
Protein	ASBC Beer-11
Turbidity	ASBC Beer-26
pH	ASBC Beer-9
Lactic Acid*	Megazyme D-/L- Lactic Acid
Maltose/Sucrose D-Glucose*	Megazyme Assay Kit
Cell Count**	Hemocytometer

*Performed by Kelley Freeman of Beyers Analytical Brewing Sciences **Performed by Charlie Hoxmeier of Gilded Goat Brewing Co.

- On 10/29/19, all three sour beers were force carbonated and kegged.
- On 11/1/18, a blind consumer sensory preference test with a hedonic ranking scale was performed at Gilded Goat's Tap Room on thirty-one consumers.
- Panelists were presented with the samples in random order, labeled with a three digit code in small clear glassware.

RESULTS

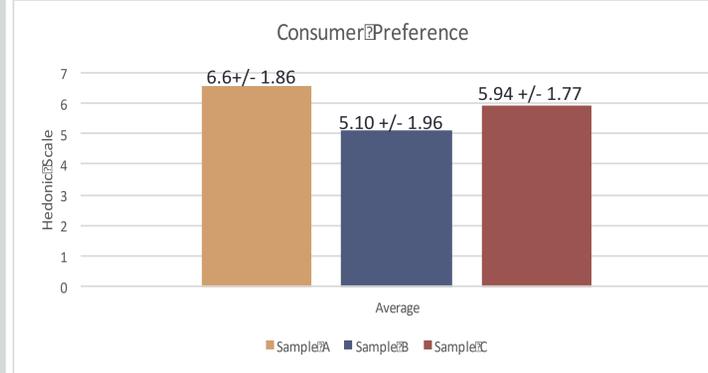
Graph 1: Total Lactic Acid (mM/L)



Graph 1: Sample B consistently had the lowest concentration of lactic acid. Sample A contained a higher concentration of Lactic Acid in week 1 than Sample C, however they finished within of 5 mM/L of each other

RESULTS CONTINUED

Graph 2: Consumer Preference



Graph 2: (n=31) Performing a two tailed T-test resulted in a p-value of 0.0035 for preference of Sample A compared to Sample B.

Table 3: Final Beer Sensory Data

Week 6	Sample A	Sample B	Sample C
Alcohol (% v/v)	3.53	3.77	3.53
pH	2.94	2.99	2.92
Proteins (%w/w)	0.24	0.17	0.30
Polyphenols (mg/L)	6.15	9.02	2.46
Turbidity (FTU)	21.30	53.00	8.72
Color (SRM)	5.56	10.33	4.15
Titrateable Acidity (mM [H+]/L)	96	84	90
Total Lactic Acid (mM/L)	92.14	73.27	87.81
Total Sugar (g/L)	43.48	44.56	40.63

CONCLUSION

- There was a statistically significant difference in preference for Sample A (co-pitch) compared to Sample B (1° *Saccharomyces cerevisiae* and *Brettanomyces bruxellensis*, 2° *Lactobacillus plantarum*).
- Sourness was perceived as more pronounced in Sample A (co-pitch) compared to Sample C (1° *Lactobacillus plantarum*, 2° *Saccharomyces cerevisiae* and *Brettanomyces bruxellensis*) despite having higher total lactic acid (mM/L) and titrateable acidity (mM [H+]/L). Sample A had higher amounts of total sugar (g/L) than Sample C at the time of sensory evaluation, which could have contributed to perception of Sample A as a more 'balanced' beer.
- Each pitching method produced a distinct fermentation and sensory fingerprint. The collected data provides key metrics for industry partner, Gilded Goat. This data can be used to tailor future sour beer production through manipulation of the pitching scheme which produces certain organoleptic outcomes that are preferred by the Gilded Goat customer base.

FUTURE DIRECTIONS

Recommended follow-up experiments include investigations into longer duration staggered-pitch vs combined-pitch fermentation and maturation, more frequent analytical data collection during early fermentation, and more comprehensive analysis of respective pitching schemes' volatile aroma and acid compounds using SPME GC-MS and HPLC.

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