Cell Growth and Ethanol Production of High and Low Flocculating Yeast

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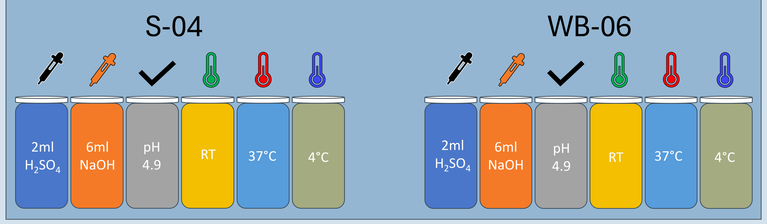
Introduction

pH and percent alcohol content depend on sugar content and fermentation of wort. Too high of a fermentation temperature is associated with expedited yeast cell death and an accumulation of large amounts of ethanol in a short time. Lower fermentation temperatures allow the persistence of yeast cells for longer periods [1]. Fermenting at a pH of 5.0 or higher could allow for the introduction of microbial contamination, while lower pH levels can inhibit cell growth and fermentation capabilities [2]. This study aimed to provide a concise guideline of the optimal conditions for yeast growth and ethanol production for brewers through a series of manipulations of temperature and pH levels on yeast strains *Saccharomyces cerevisiae* (S-04 English Ale) and *Saccharomyces cerevisiae var* (WB-06 German Wheat Ale). Species S-04 has a high flocculation rate [3]; yeast cells aggregate early in the fermentation process leaving unfermented sugars behind and may require resuspension to complete fermentation [4]. Species WB-06 has a low flocculating rate [5]; the yeast stays in suspension after fermentation, producing a hazy beer product with higher alcohol content [4]. Fermentation temperature plays a principal role in flocculation; too much heat will kill the yeast quickly while too little inhibits it [6].

Methods

A malt solution was made with 12L of water, 2kg of dried Malt extract, and 6.05g of Northern Brewer Cascade hops. Specific gravity was collected with a refractometer then the malt solution was distributed into 12 sterile jars.



Results

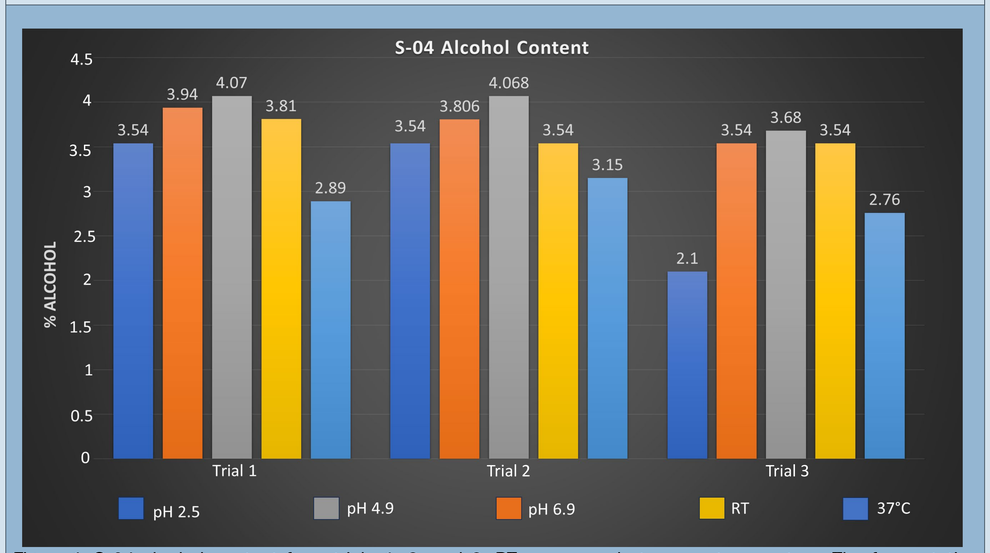


Figure 1: S-04 alcohol content from trials 1, 2, and 3. RT corresponds to room temperature. The fermentation temperature of 4°C is omitted due to lack of data. The pH of 4.9 in trial 3 is 5.5.

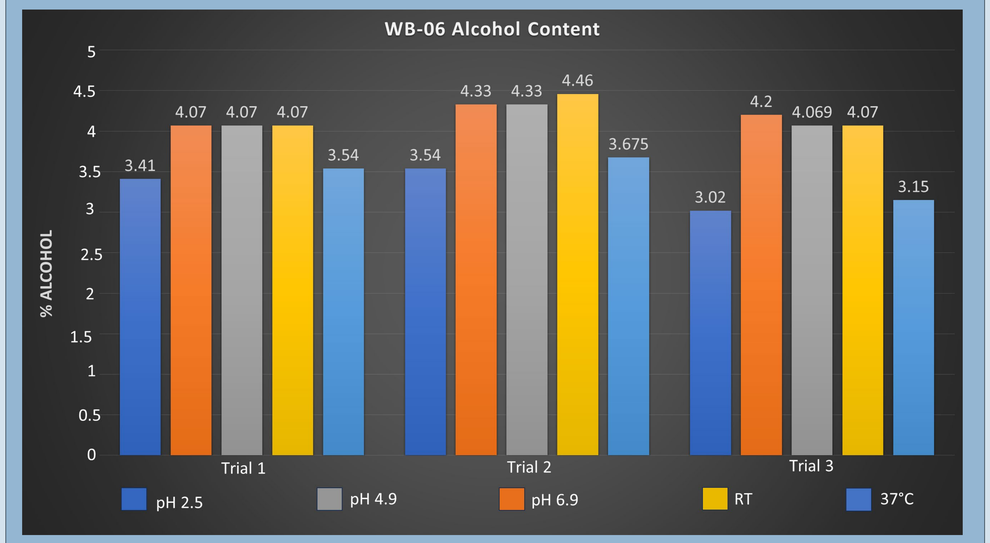
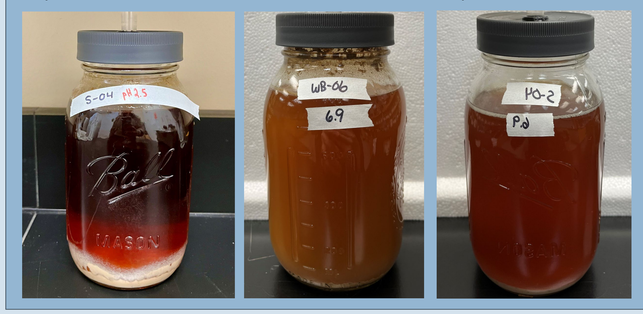


Figure 2: WB-06 alcohol content from trials 1, 2, and 3. RT corresponds to room temperature. The fermentation temperature of 4°C is omitted due to lack of data. The pH of 4.9 in trial 3 is 5.5.



Strain	Yeast Cake (g)
S-04 pH 2.5	6.96
S-04 pH4.9	5.48
S-04 pH 6.9	6.15
S-04 4°C	4.44
S-04 RT	5.02
S-04 37°C	2.73
WB-06 pH 2.5	6.45
WB-06 pH 4.9	5.02
WB-06 pH 6.9	6.99
WB-06 4°C	7.65
WB-06 RT	7.4
WB-06 37°C	8.32

Table 1: Yeast Accumulation

Discussion

Fermenting at 4°C had no significant negative effect on yeast cell growth for WB-06 as evident in *Table 1*. However, S-04 showed less yeast cell accumulation inferring inhibited cell growth. Alcohol production was found to be suppressed for both strains at 4°C. A fermentation temperature of 37°C accelerated yeast cell growth [7], peaking earlier than normal and producing lower amounts of alcohol. When allowed to ferment at room temperature, both yeast strains produced higher percent alcohol content. This finding coincides with the suggested optimal brewing temperatures for each species [3][5]. A pH level of 2.5 limited fermenting capabilities resulting in comparatively lower alcohol concentrations [2]. Given a pH of 5.5, S-04 produced a smaller percent alcohol content compared to a pH of 4.9. WB-06 yielded comparatively similar results with a pH of 5.5 and 4.9. Fermenting with a pH of 6.9 produced an analogously high alcohol content when compared to a pH of 4.9 for WB-06; this can be attributed to the tolerant nature of the species [5], whereas, S-04 resulted in a slightly lower concentration of alcohol at pH 6.9 compared to 4.9.

Conclusion

The most economically useful conditions for brewing variant S-04 are indicated by the data to be at room temperature (20-25° C) with a pH of 4.9. This is analogous to the suggested optimal conditions from the manufacturer [3]. The comparatively lower alcohol content of S-04 to WB-06 reflects the high and low flocculation characteristics respectively [6]. For WB-06, room -temperature fermentation and a pH of either 4.9 or 6.9 was shown to be the most beneficial, this aligns with the diverse nature of the strain [5]. Yeast accumulation was inconclusive, filtration methods need to be reevaluated.

References

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