Acceleration of Fermentation in Brewer's Yeast

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Introduction

Saccharomyces cerevisiae is the organism responsible for the generation of the alcohol content of beer. Fermentation is the prohibitive step in the brewing process and acceleration of this would benefit the ability to meet the growing demand for craft beer around the world by reducing total production time. If rate of fermentation is genetically linked then random mutations to the yeast DNA should potentially affect fermentation time. Selection for the fastest strains should be possible by assaying for a product of the reaction. CO2 is a gaseous byproduct that can be captured as it is produced to quantify the rate of ethanol production. Mutations that benefit alcohol production hold the potential to also affect the flavor of the resultant beer. If the genes for flavor and fermentation are linked then selected mutants will yield an altered flavor however if they are not linked then selecting for an accelerated mutant of the same flavor as the original strain should be possible.

Abstract

Domestication of organisms was one of the key strategies that led to the dominance of humans on the planet. *Saccharomyces cerevisiae,* Brewer's yeast, was one of the first organisms to be deliberately cultivated and has been used in the production of alcohol since before written history. *S. cerevisiae* can undergo anaerobic fermentation and alcohol is generated as a byproduct. Currently, various strains of this yeast—with varying fermentation properties—are used in the production of beer as part of a multi-billion dollar beer industry. The goal of this project is to generate a strain of yeast that has an accelerated fermentation rate without compromising the flavor profile of the resulting beer. Using conventional chemical mutagenesis more than 250 independent strains of yeast have been developed and tested. We describe the methodology utilized to generate and characterize three rapid fermentation strains and provide an approach to ultimately reduce production time in the brewing process.

Further Study

Through the use of a CO2 assay we are able to get an idea of which yeast strains are capable of outperforming the control however the design of the assay allows the potential for CO2 to diffuse through the mineral oil layer. To correct this, we plan to continue to assay the yeast with the Ankom Gas Production system. With this system we will be able to determine the fermentation rate of the mutant yeast strains with less error and continuous monitoring of the trial. We will continue to brew with selected mutants to collect more data regarding the linkage between fermentation rate and flavor of the final beer product.

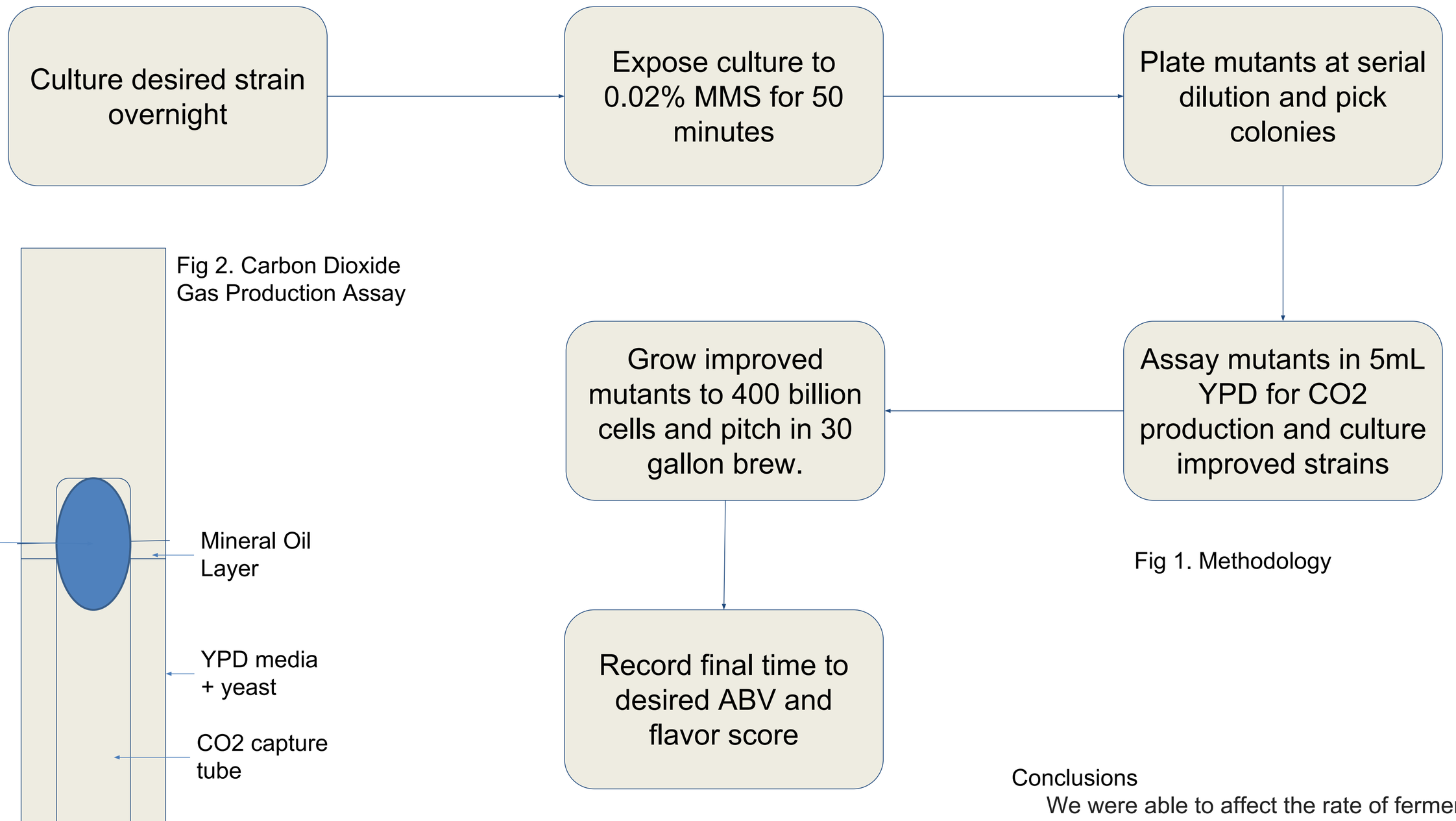


Fig 1. Methodology

Fig 2. Carbon Dioxide Gas Production Assay

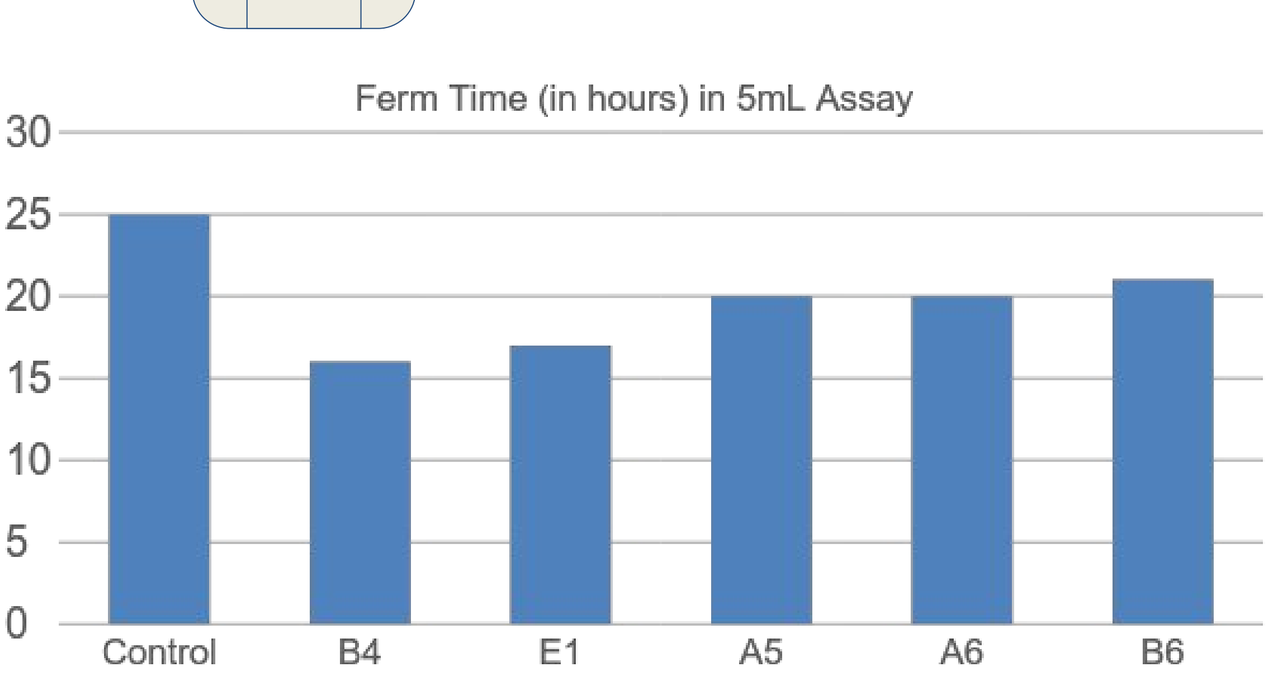
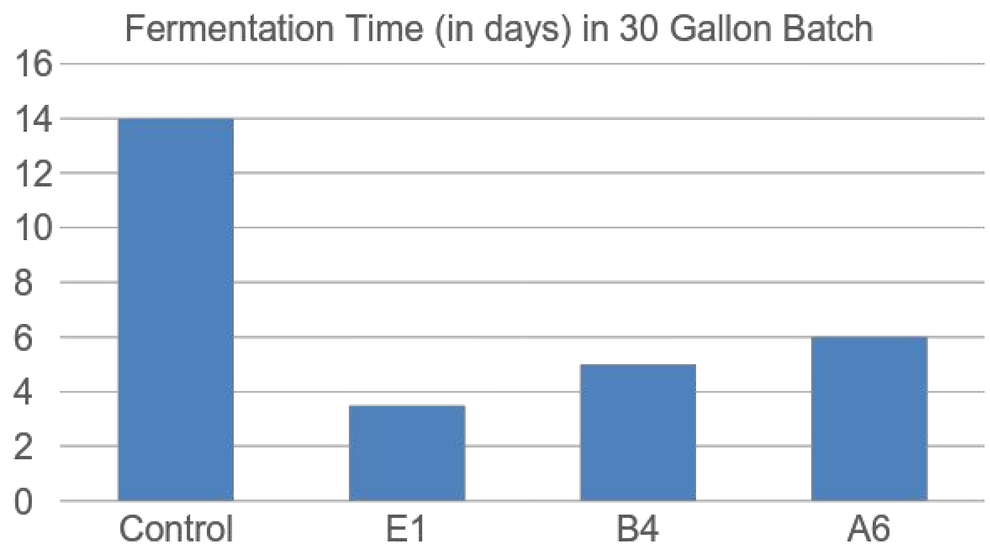


Figure 3.

Of the 180+ mutants assayed, the top 5 fermenters are shown. The strains that perform the best at 5mL are grown up to brew 30 gallon.

Conclusions

We were able to affect the rate of fermentation by causing mutations through chemical mutagenesis. This proves that rate of fermentation is linked to one or more genes in the yeast chromosome. Carbon dioxide assays showed that approximately 1% of the mutants exhibited increased fitness. These mutants were selected and are in the testing stages. Of the mutants already brewed, all have displayed a definite affect on the flavor profile of the final product. Flavor scores of mutant batches thus far are consistently lower than that of the control brew. This indicates that affecting the rate of fermentation will have an affect on the flavor profile of the beer; however, selecting a mutant with a desirable final flavor is a matter of sample size. The possibility also exists that mutant strains may be used in different recipes to accentuate the native flavor notes.



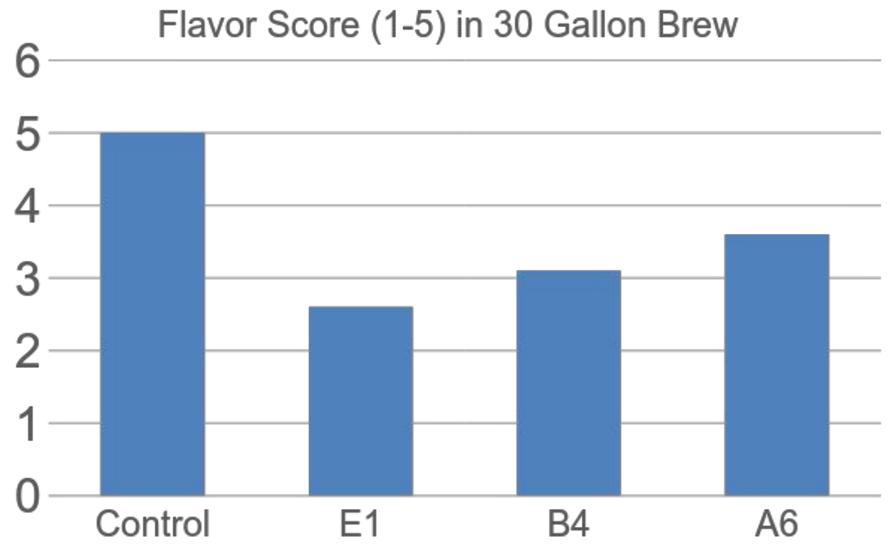


Fig 4 (left) & Fig 5 (right)

Strains that performed well in 5mL assays showed a strong correlation to fermentation rates at full scale. Strains have been developed that ferment in a fraction of the time of the control. The flavor profile of these brews is affected by the mutations present, however some strains yield a better flavor than others.