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Specific Gravity of Beer and Cider Yeast Solutions

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BIOL 160: General Biology

Abstract

This project set out to research the relative alcohol content created by cider yeast versus ale yeast. We also measured the fermentation rate to correlate with alcohol production. Our hypothesis was that the solution with the higher fermentation rate would have a higher alcohol content, which was supported by the data. The relative alcohol production of various types of yeast is relevant to those who wish to brew their own alcohol.

Introduction

Modern home brewers visiting their local brew store will be greeted with a wealth of yeast strains to choose from. This project looked at two of them - cider yeast and a British ale yeast. We wanted to know how the type of brew yeast affected the alcohol concentration of the fermented product. Ultimately, we reverse-engineered our way into researching attenuation, which is the ability of yeast to convert sugars into ethyl alcohol and CO_2 (Green, 2023).

Our independent variable was yeast strain. Our dependent variables were specific gravity and fermentation rate. The control variables were the volume of solution, sucrose concentration, and temperature. We also monitored qualitative data such as smell, opacity, viscosity, and color. The negative control group for the experiment was yeast in water (0% sucrose).

We hypothesized that the type of yeast with the highest fermentation rate will have the greatest concentration of alcohol. We also hypothesized that, because cider typically has a higher alcohol content than beer, the cider yeast solutions will have higher alcohol content. The research question for this project was, “How does type of brew yeast affect the alcohol concentration and how does fermentation rate correlate?”

Methods

Materials & Location

We used cider yeast, beer yeast, water, and 20% sucrose solution, as well as a graduated cylinder, a pipette, a hydrometer, and a thermometer.

Procedure

We began the experiment with 1L of solution: beer yeast with sucrose solution, beer yeast with water, cider yeast with sucrose solution, and cider yeast with water. First, we poured 500 mL of each solution into a graduated cylinder. Initially, we put 200 mL of each yeast solution (cider/beer yeast and water/sucrose solution) into a graduated cylinder, although after day 8 we began using 500 mL of solution to take our specific gravity readings using a hydrometer. After measuring temperature and specific gravity, we used a pipette to put 20 mL of solution into a fermentation tube. Solutions stayed for 1 week at a time in the incubator between measurements.

Supplies images (hydrometer, flasks with liquids, yeast packets)

Image 1. We used a British style ale yeast and a general cider yeast. Both yeasts were sourced from North Corner Brewing Supply.

Specific Gravity Over Time

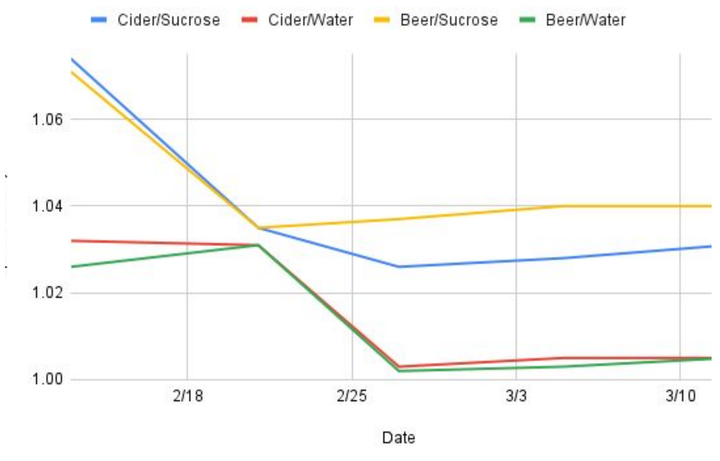

Figure 2. The change in specific gravity of the various solutions over four weeks. The water-based solutions show a similar pattern to one another, as do the sucrose solutions.

Discussion

Over the span of our research, we observed that the cider sucrose solution increased in alcohol content more than the beer sucrose solution, while both of the yeast and water solutions increased in specific gravity the least and did not ferment. This is something that we predicted before starting the experiment, because the yeast requires an input of sugar to ferment. We decided to stop monitoring fermentation rate after the first week because we observed no change at all, most likely because fermentation was happening at such a slow rate that it wasn’t detectable. The cider/sucrose solution ended up with the highest alcohol content and fermentation rate, which supports our original hypothesis.

When brewing beer or cider in a non-laboratory environment, the brewing process takes multiple weeks and requires multiple other steps that help catalyze the fermentation process. This can include “feeding” the solution more sucrose solution. Had we had “fed” our fermenting solutions, we may have seen a greater rate of fermentation and been able to track it more fluently throughout our experiment. Attenuation of yeast is affected by the yeast selection (Green, 2023). To add to this, the production and tolerance to ethanol, organic acids, and CO2 are also important tools to differentiate among species (of yeast) (Maicas, 2020). Our data produced results that showed how beer and cider yeasts differ along with their rate of fermentation rates.

The instructions for the hydrometer indicated that we should use a minimum of 200 mL to take measurements. However, after the second week of measurements, we realized that the hydrometer was touching the bottom of the 200 mL graduated cylinder, leading to inaccurate measurements. We subsequently switched to a 1L graduated cylinder to avoid the hydrometer sinking to the bottom. This is likely the reason that the second week of readings are clustered together - the water solution measurements for this week are probably incorrect. We had the novel experience of being the first experimental group to utilize a hydrometer, so hopefully from our learning process, others in the future can use a hydrometer in a more accurate way, using a larger vessel and larger sample of solution than we did.

Acknowledgements

We would like to acknowledge our instructor Lauren Maniatis and our lab tech Bethany for their guidance, knowledge, and support throughout this process. We would also acknowledge North Corner Brewing Supply as our supplier for the yeast and hydrometer.

References/ Work Cited

Brew Your Own Magazine . (2017, November 6). *Homebrew Yeast Strains Chart*. Brew Your Own. https://byo.com/resource/yeast/?beer-style=english-and-scottish-strong-ale&tax-submit=Submit

Green, D. (2023, February 14). *Attenuation & Finishing Gravity*. Brew Your Own. https://byo.com/article/attenuation-finishing-gravity/

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Raihofer, L., Zarnow, M., Gastl, M., & Hutzler, M. (2022b). A short history of beer brewing. *EMBO Reports*, *23*(12). https://doi.org/10.15252/embr.202256355

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Discussion

The discussion section should be organized as an upright triangle. Thus, start off with a summary of your findings in a statement that clearly describes the support or non-support of your original research hypothesis. Remember that in this section, you should verbally describe your results.

The next paragraph should be an interpretation of the results. You should try to tie in the references you cited in the introduction without simply repeating exactly what was stated in the introduction. Remember, each new statement should help the readers understand the problem/issue at hand and your position on this. If you did not support your hypothesis compared to the other studies you cited, why? What were the shortcomings of your study? What were the differences or similarities between your study and others that could have contributed to the differences in findings? Although you should discuss *some important* reasons as to why you did not find what you hypothesized, you should not dwell on every single reason (just not possible).

Finally the last paragraph should address the implications of your findings: How has your study resolved the original problem/issue? What are some suggestions for future research? Suggestions for future research should be discussed in present tense (as opposed to the rest of your reporting out, which should be in past tense).

Over the span of our research, we observed that the cider sucrose solution increased in alcohol content more than the beer sucrose solution, while both of the yeast and water solutions increased in specific gravity the least and did not ferment. This is something that we predicted before starting the experiment, because the yeast requires an input of sugar to ferment. We decided to stop monitoring fermentation rate after the first week because we observed no change at all, most likely because fermentation was happening at such a slow rate that it wasn't detectable. The cider/sucrose solution ended up with the highest alcohol content and fermentation rate, which supports our original hypothesis.

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Some references - feel free to try to find a place to slide these in

https://byo.com/article/attenuation-finishing-gravity/ (referenced in introduction)

https://www.embopress.org/doi/epdf/10.15252/embr.202256355 (peer-reviewed journal)

https://byo.com/resource/yeast/?beer-style=english-and-scottish-strong-ale&tax-submit=Submit (where i got attenuation rates)

Introduction

Your introduction is a condensed version of the introduction in a research paper. The font should be as large as is necessary to see from 5 feet away. The section title ‘Introduction’ should be centered and bolded.

The first part of this section should introduce the topic at hand followed by a discussion of a few very relevant research references in order to contextualize your research question. Following this rationale, provide a sentence or two briefly describing the variables you studied. The last part of this paragraph should be your research question and hypothesis. Cite references as you would in a paper (Author, 2007).

Summary

Modern home brewers visiting their local brew store will be greeted with a wealth of yeast strains to choose from. This project looked at two of them - cider yeast and a British ale yeast. We wanted to know how the type of brew yeast affected the alcohol concentration of the fermented product. Ultimately, we reverse-engineered our way into researching attenuation, which is the ability of yeast to convert sugars into ethyl alcohol and CO_2 (Green, 2023). Beer yeasts tend to have a lower attenuation rate than cider yeasts, which was borne out by our research.

Our independent variable was yeast strain. Our dependent variables were specific gravity and fermentation rate, although after day 8, we stopped measuring fermentation rate, as it had slowed to the point of immeasurability. The control variables were the volume of solution, sucrose concentration (20% by weight), and temperature, as the flasks of solution were kept in the incubator for the duration of the experiment. We also monitored qualitative data such as smell, opacity, viscosity, and color. The negative control group for the experiment was yeast in water (0% sucrose).

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Some notes - I went into a bit of a yeast wormhole and learned about attenuation, which is the ability of yeast to consume the sugar in its environment. Different yeasts have different attenuation rates, as shown by this website (I think we are allowed to use a website since only 1 resource has to be a journal article?). The specific ale yeast we used does not have a listed attenuation rates, but similar types of yeast are around 70%. Conversely, the cider yeast we used has an attenuation rate of 95-100%. This makes sense considering our data! I’m not sure where to put this information, but it’s relevant!

Works Cited

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