Optimal Temperature in Cider Yeast Fermentation

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Abstract

An experimental design was created and data collected to see how different temperatures affect the fermentation rate in ciders yeast.We started by looking at data collected from previous biology students with a similar experiment and used their data to come up with possible temperatures that would result in a more optimal and precise temperature for faster fermentation. Our hypothesis that the optimal temperature for fermentation would be between 65-70 degrees celcius was refuted by our data, which showed temperatures beyond 70 degrees celsius provided faster rates. Although it was refuted by our data, we're now a step closer to finding the optimal temperature for faster fermentation rates which can lead to cost reductions in brewing companies where yeast is a vital component.

Introduction

In our research project we wanted to test the temperature that facilitated the fastest fermentation rate in Cider yeast. Studying this question could help businesses with cost reduction in terms of energy use for fermentation of alcohol products.

We hypothesized that the optimal temperature for the fastest fermentation rate would be between 65 to 70 degrees Celsius. Some research suggests that the optimal fermentation temperature was between 24-30 degrees celsius (Bleoanca, 2013). However we found that even at our highest temperature the fermentation rate was still increasing. In our research we kept the sucrose concentration the same with each trial and used cider yeast in each trial. Our control variable was the trial at room temperature. We increased the temperature by 5 degrees each trial to test the rate of fermentation.

Methods

Materials & Location

For each replication: 12 clean test tubes, 12 clean fermentation tubes, 4 packets of cider yeast, 4 beakers, 4 stir sticks, 4 graduated cylinders, 4 pipettes, 4 different temperature conditions (3 water baths held at 3 different temperatures, 1 room temperature condition), 4 beakers with 20% sucrose solution at select temperature, 4 beakers with water at select temperature: 22° C, 55° C, 60° C, 65° C, 70° C, 75° C

Procedure

1. Create stock cider yeast suspension by adding 50 mL of appropriate temperature water via graduated cylinder to the beaker, adding the cider yeast packet, and stirring with the stir stick until combined.
2. With a pipette, measure 10 mL of yeast solution and place into each of three test tubes, followed by 10 mL of temperature-appropriate sucrose solution.
3. Pour each test tube into a separate fermentation tube, tipping the fermentation tubes back between pours to ensure no air bubbles at the top of the vertical column. Place all fermentation tubes in the select temperature water bath and record time of placement.
4. Check fermentation tubes every five minutes and pull out when CO2 has reached the halfway point of vertical column. Record time and CO2 volume.

Cider Yeast Fermentation Rate

Temperature (Celsius)	Fermentation Rate (mL CO2/min)
22	0
55	0.61
60	0.88
65	0.93
70	0.87
75	0.99

Table 1. Fermentation rate (mL CO2/ min) of cider yeast at different temperatures (celsius).

Cider Yeast Fermentation Rate

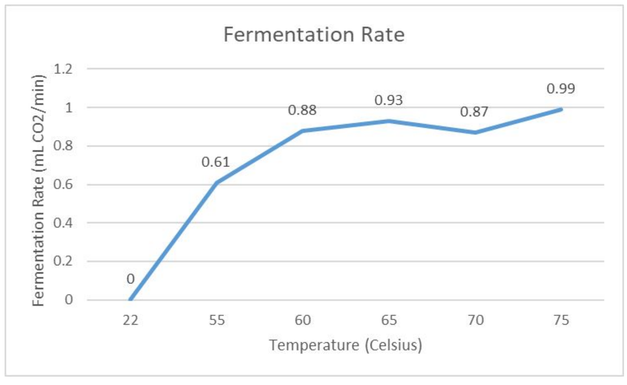

Figure 2. Fermentation rate (mL/CO2/min) of Cider yeast at different temperatures (celsius) to determine what temperature ferments cider yeast at the fastest rate.

Discussion

The fermentation rates generally increased as the environmental temperature increased. From room temperature to the next highest environmental temperature (55° C), the fermentation rate increased most dramatically, showing no carbon dioxide output (0 mL CO2/min.) to an average of .61 mL CO2/min, respectively. The second highest increase was demonstrated between 55° C and 60° C when the average rate increased by .17 mL CO2/min. Average fermentation rates continued to increase as temperature rose. However, the 70° C condition presented a lower average fermentation rate than the 60 and 65° C conditions. Interestingly, the 75° C condition's average fermentation rate continued to increase and held the highest rate of our experiment. Our data did not support our hypothesis for optimal fermentation rates between 65-70° C . Instead, the highest rates were found at the 65° C, (.93 mL CO2/min.) and 75° C (.99 mL CO2/min.).

This research underlines the importance of heating cider yeast (Bleonca, 2013) to speed up the fermentation process. Room temperature does not suffice for optimal fermentation rates. Our study showed that a minimum of 60° C is necessary to increase rates, and up to 75° C is better. Because we adjusted the temperature conditions during each replication and added fermentation tubes as we gained comfortability, we had few trials all together for each condition, and our results may be therefore statistically insignificant. Likewise, different people set up each condition, water bath temperatures slightly varied from day to day and were affected by amount of time the lid was removed, the air conditions may have varied each day, and the separate cider yeast packets for each condition may have varied as well.

Further research should add more trials to the temperature conditions we attempted, as more statistical significance would be supported. Given that we found the highest fermentation rate to be at the highest temperature, future trials could increase the environmental temperatures to at least 80° C. Repeats of the 60° C, 65° C, 70° C, and 75° C conditions are warranted to investigate and replicate whether a drop at the 70° C condition would occur again.

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References/ Work Cited

Bleoanca, Iula. *Overview on Brewing Yeast Stress Factors*, 5 Nov. 2013, www.researchgate.net/profile/Iula-Bleoanca

Slaa, J., Gnode, M., & Else, H. (2009). Yeast and fermentation: the optimal temperature. *Journal of Organic Chemistry Chem. Dut. Aspects* (134)

Magalhães, F., Krogerus, K., Vidgren, V., Sandell, M., & Gibson, B. (2017b, August). *Improved cider fermentation performance and quality with newly generated saccharomyces cerevisiae × saccharomyces eubayanus hybrids*. Journal of industrial microbiology & biotechnology. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5511608/