Fermentation Rates with Different Levels of Processed Sugars

Devin King, Amanda Kohler, Isabelle Thompson
Biology 160: General Biology w/ Lab

Abstract

We designed this experiment to determine how different levels of processing in sugar would affect the rate of fermentation of active dry yeast. We hypothesized that less processed sugars will have higher rates of fermentation. We deduced that our hypothesis was correct, based on the results of our experiment. Our Results show us that sugars that undergo high levels of processing will have lower levels of fermentation. These findings are important for the production of alcoholic beverages, showing that for faster production of alcohol it is best to use sugars with lower levels of processing.

Introduction

Yeast uses a specific type of cellular respiration called fermentation to create ATP. During the fermentation process, CO2 is released, which allows us to measure the rate at which yeast digests sugars. Some sugars on the market are more processed than others. Sucacant, Organic cane sugar, table sugar, and lab-grade sucrose solutions all undergo different levels of processing. Each level of processing removes vitamins and minerals from the sugars.

By studying the rate by which yeast ferment these different sugars in a controlled environment, we should be able to identify the impact that sugar processing has on fermentation rate. Our hypothesis is that less processed sugars will have higher fermentation rates, since the vitamins and minerals found in raw sugar can act as an additional food source for the yeast. Yance, D. (2017, July 5).

Methods

Materials & Location

- 5 Test tubes
- 5 Fermentation tubes
- 6 Pipettes
- 5 Stirring rods
- Incubator
- Stopwatch
- 100 mL beaker
- Sucacant solution (sucacant: natural cane sugar, unbleached)
- Organic cane sugar solution
- Table sugar solution
- 20% lab grade sucrose solution
- Red star active dry yeast
- Distilled water

Trials conducted in Kulshan Hall Labs at Whatcom Community College

Procedure

We began by creating a yeast stock solution: 7 grams of Red Star Active Dry Yeast added to 50 milliliters of distilled water. We then combined sugar solutions with 10mL yeast stock solutions in test tubes before transferring them to fermentation tubes. The fermentation tubes were then placed in the incubator, where we left them until fermentation bubbles formed. We then calculated the rate of fermentation based on the volume of CO2 in the fermentation tube divided by the incubation time. Our negative control was a distilled water and yeast solution, and our positive control was a lab-grade sucrose and yeast solution.

Average Fermentation Rate in mL CO_2/minute

Sugar Type	Average	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7
Sucanat	0.43	0.26	0.53	0.65	0.45	0.45	0.29	0.38
Organic Cane Sugar	0.37	0.39	0.54	0.38	0.31	0.36	0.33	0.3
Table Sugar	0.34	0.28	0.37	0.44	0.45	0.32	0.19	0.35
20% lab grade sucrose solution	0.3	0.24	0.49	0.39	0.26	0.24	0.17	0.29
No Sugar: Distilled Water	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01

Table 1. Three sugars with varying degrees of processing were selected for our trials. Additionally, a 20% lab grade sucrose was used as a positive control and distilled water was used as a negative control.

Figure 1. (left) Test tubes containing a yeast solution and fermentation tubes are labeled 1-5. Once the sugar solutions are added to the test tubes, they are transferred to the fermentation tubes and placed in an incubator

Figure 2. (right) Sucanat is less refined than white sugar, containing iron, calcium, vitamin B6, and potassium also found in raw sugar cane

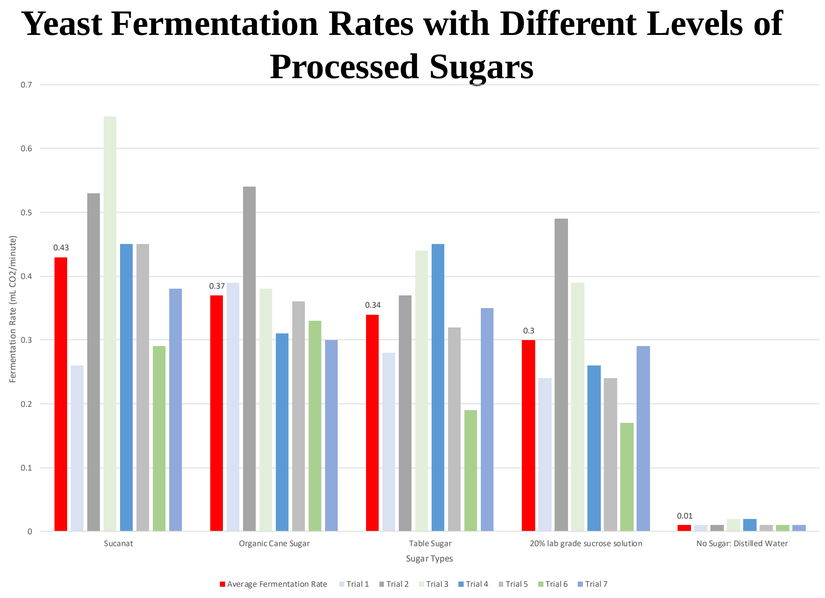

Figure 3. As the level of processing increases in the sugars, the average yeast fermentation rate steadily declines.

Discussion

Our original hypothesis was that less processed sugars would have a higher fermentation rate, because the additional nutrients found in the sugar could act as additional food for the yeast. In our trials, we saw that the sucanat sugar had the highest rate of fermentation, with an average of 0.43 mL CO2/min. Since sucanat is an unrefined, natural cane sugar, our hypothesis was correct.

Drinks like kombucha, beer, and cider use sugar and yeast in their fermentation process. According to TomMacy.com, "Yeast will keep on devouring sugar, and thus producing alcohol, until all the available sugars are consumed, or the alcohol levels reach around 15-17% ABV (alcohol by volume), at which point the yeast can no longer survive and die off." In our research, we saw that the sucanat sugar had the highest rate of fermentation. With a higher fermentation rate, alcohol can be produced faster, which would be beneficial knowledge for alcohol manufacturers to use in their craft. However, the rate of fermentation only differs slightly among the four different sugars we tested; the lowest was the 20% lab grade sucrose solution, with an average rate of 0.3 mL CO2/min, and the highest was the sucrose, with an average rate of 0.43 mL CO2/min. With these small discrepancies, the best application for this data would likely be for alcohol manufacturers who produce in large quantities, as this is where we would see the difference.

In our project, we used active dry yeast to test the rate of fermentation. We originally considered how this would affect baking, but since most baked goods do not use sugar and yeast together, this would more apply to beverage production. In the future research, it might be advised to use a yeast specifically for beer, cider or kombucha to see how the results would differ.

Acknowledgements

We would like to thank the Whatcom Community College biology department for their dedication to student learning. Our Instructor Lauran Maniatis has shown a great commitment to our success through her continued communication and extensive knowledge. We would also like to thank our lab technician, Bethany Tegt, for gathering materials, mixing our sugar solutions, and assisting with additional support during our trials in the lab. The success of this experiment would not be possible without the scientists of WCC.

References/ Work Cited

Hamilton, A. (2012, February 28). *Turbinado Sugar & Sucanat | Better than Sugar? 5 Natural Sweeteners Demystified*. Time.

Homrok, C., Woltjen, J., Weaver, H., Bhupathiraju, V., & Felder, M. (2019). Monosaccharides Yield Higher Fermentation Rates than Disaccharides in Saccharomyces cerevisiae. *JUBLI, 2*, 1.

Mengesha, Y., Tebeje, A., & Tilahun, B. (2022). A Review on Factors Influencing the Fermentation Process of Teff (Eragrostis teff) and Other Cereal-Based Ethiopian Injera. *International Journal of Food Science, 2022*(PMC8970856), 1–10.

Yance, D. (2017, July 5). *The Health Benefits of Unrefined Raw Sugar : The Mederi Blog : Mederi Foundation 501(c)(3)*. Medericenter.org.