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The Effects of Artificial and Natural Sugars on Carbon Dioxide Production in a Yeast Solution.

Chanh Dang, Fawaaz Hameed, Justus Harris, Abigail Matthews, Rodet Rodriguez*

[1] University of Oklahoma, Department of Biology, 730 Van Vleet Oval, Room 314 Norman, OK 73019

Yeast fermentation occurs at different rates depending on what is added to it. In this investigation, we observed the different effects that natural sugar and artificial sweetener had on the CO2 release rate. We used sucrose as our natural disaccharide and sucralose as the artificial disaccharide. We added 5mL of .15 M of one sugar to a solution with 10mL of water and .6g of yeast and 5mL of .15M of the second sugar to an additional solution with 10mL of water and .6g of yeast. We also had a negative control solution that had no added sugar but still contained the 10mL of water and .6g of yeast. Through this experiment, we were able to observe and record which type of sugar would yield the most CO2 and which would yield the least. We found that natural sweeteners helped the yeast respire at a faster rate.

Introduction

In recent studies, it has been found that a product with a high caloric sugar content metabolizes at a faster rate than a sugar with little or no caloric content (Bauer, 2016). Fermentation is a type of metabolism that respires molecules anaerobically and in doing so, gives off ethanol and CO2. Sugars cause the gluconeogenesis process to start, as well as trigger, unexpected hormone like responses causing a faster metabolism, which in return, increases carbon dioxide levels (Verstrepen, 2004). This is why both CO2 and ethanol can be used to measure the rate of respiration for yeast. Many countries that produce a high amount of sugar cane take advantage of this and often infuse the yeast with sugar to increase the fermentation rates and produce more ethanol for their economy (Rolz et al., 2010). In this experiment, we will test and further prove that sugars with higher caloric contents will improve fermentation rates. The question we will be testing in this experiment is why different types of sugars cause changes in the respiration rate of cells. We will be preforming four trials on three separate solutions comparing two different types of sugars and their carbon dioxide production rates. We hypothesized, if combined with yeast in a sealed environment, refined sucrose will yield carbon dioxide at a faster rate than a yeast solution with sucralose because natural sugars have a higher caloric content. We predict that our refined sucrose solution will produce carbon dioxide at a much faster rate when compared to sucralose.

Methods

In order to test our hypothesis, we produced three separate solutions; one containing only 0.6g of yeast powder and 10mL of water; one containing 0.6g of yeast powder, 10mL of water, and 5mL of

* Research Mentor

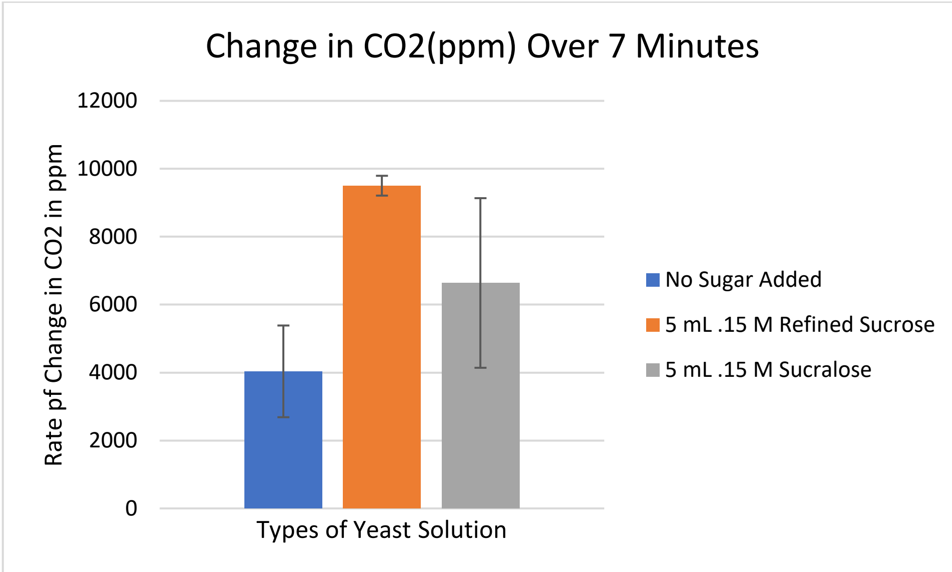

Figure 1: This graph illustrates the change in CO_2 within the chamber over a period of 7 minutes for four trials. The error bars are representative of standard deviation.

.15 M refined sucrose; and one containing 0.6g of yeast powder, 10mL of water, and 5mL of .15 M sucralose. Each solution was placed in a 250mL beaker with a stir bar placed inside the solution. The beaker was then placed on a Carolina magnetic stir station and set on a level just high enough for the solvent and solute to combine for a total of five minutes. After the initial five minutes, a CO_2 probe was then inserted inside the beaker, to measure the rate of respiration, and the solution continued to mix for an additional seven minutes with the CO_2 production being recorded. We calculated and compared the amount of CO_2 production in each solution over a span of seven minutes, using logger pro software. After all four trials were completed, results were calculated and placed on an excel graph to be compared and observed.

Results

We found that the yeast solution with 5 mL of .15 M of refined sucrose added to it had the greatest change in CO_2 and therefore the greatest CO_2 yield. It is important to keep in mind that the CO_2 probe that was used in the experiment had a maximum value of 10,000 ppm, therefore the Sucrose could have potentially yielded even more CO_2 if it had not reached the probe's limit. Along with that, the yeast solution with no sugar added had the least amount of change of CO_2 and therefore respired the least CO_2 out of all three solutions. It is also worth noting that the solution with 5 mL of .15 M sucralose had the greatest amount of variation in that it had the largest standard deviation out of the three other tests conducted for figure 1.

Discussion

At the beginning of our lab, we hypothesized that refined sucrose would yield CO_2 at a faster rate than sucralose. Our data proved our claim correct in that on average sucrose yielded 2,864.25 ppm more than the average CO_2 yielded by sucralose. We believe these results are because of the increased calorie content found in natural sugars, such as sucrose. This increased energy allows the yeast solution to metabolize at a faster rate, thus releasing more CO_2 into its surroundings. This explains why raw sugar, which contains the most calories, had the greatest yield and why the control solution that contained no sugar/sweetener, and therefore no additional calories, had the smallest CO_2 yield. In a similar study to this, researchers also tested if a natural sugar would produce more CO_2 than an artificial sweetener in a yeast solution. In their experiment however, they found that in some of their trials the solutions with sucralose in them led to the maximum amount of yeast respiration and yielded the largest amount of

CO_2 (Fawole et al., 2015). In another similar experiment, their results were much more similar to ours, as they found sucrose to allow yeast to respire the quickest and yielded the most CO_2 (Cherif et al., 2017). In an additional experiment, researchers tested the rates of yeast respiration and they also found that more sucrose in a yeast solution led to faster rates of yeast respiration, therefore supporting our findings (Beritez et al., 1983). However, instead of measuring respiration through CO_2 yield, they measured it through ethanol yield. It is important to keep in mind that throughout our experiment sources of error did occur. One includes that our CO_2 probe had a max limit of 10,000 ppm, causing some of our results to be incomplete. For example, in two trials of sucrose, the limit of 10,000 was reached at the six-minute mark, meaning it was still producing more CO_2, but the probe couldn't read it. Another source of error that occurred is that half way through our data collection our CO_2 probe unfortunately died. We quickly replaced the probe, but this implicates that the data our faulty probe collected may not be entirely reliable. Interesting areas for additional research would be testing if there is a difference between raw sucrose and refined sucrose, as well as testing for differences between monosaccharides and disaccharides.

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