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Saccharomyces cerevisiae ferments faster with natural sugar glucose than artificial saccharine

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Abstract

Yeast (S. cerevisiae) fermentation is a form of anaerobic respiration in cells, and can be measured by the amount of carbon dioxide (CO_2) produced. Different sugars can be used to become a source of energy for this process, but different sugars have more/less yield. We hypothesized that more "natural sugars" (i.e. glucose and fructose) will evoke a faster rate of fermentation than "artificial sugars", or sweeteners such as saccharine. We found this to be true - our data showed that more CO_2 was produced using glucose, thus meaning that the yeast cells fermented at a higher rate when using glucose instead of saccharine.

Introduction

Fermentation is the anaerobic cellular respiration of yeast cells, which produces ATP and CO_2 (Bauer, 2016). Sugars are the energy source yeast uses. Sugars can range in the amount of energy stored that is available as energy for the yeast. Artificial, man-made sweeteners are advertised as containing little to no calories therefore have less available stored energy useful to any organism's metabolic processes. Glucose is a naturally occuring product of photosynthesis and contains four calories per gram (Deken, 1966). While zero calorie sweeteners may be useful on a human's sugar restricted diet, it is not the best source of energy for yeast fermentation because it does not have as much usable energy as a natural sugar does. Naturally occuring sugars, like glucose, contain usable energy through calories, and its concentration is proven to be a factor in fermentation performance within cells (Damore, 1992). We hypothesize that the yeast would respire the natural sugar at a faster rate than the artificial sugar because it contains more stored and usable energy. Our claim is rejected if saccharine produces more CO_2 or the rates of respiration turn out to be the same, but supported if there are higher concentrations of CO_2 from using glucose rather than saccharine. The use of glucose and a sweetener that resembles a monosaccharide, like glucose, is what makes our experiment unique because many other experiments that compare natural and artificial sugars accidentally compare a disaccharide to a monosaccharide which may unfairly give the disaccharide an advantage in fermentation rate.

Methods

We are creating two mixtures of yeast and an added energy source. The group we know will ferment is the yeast with 10 mL of glucose added. The second group we are measuring is the yeast with 10 mL of saccharine added. We will test each group with three separate trials to gather a more accurate data spread. We will begin by measuring out 10 mL of warm tap water

and pouring it into the respiration chamber sitting on the stir station. Then we will drop in the magnetic stir bar and turn on the station to begin mixing at a moderately high speed. We then will measure out .6 g of dry yeast and add it to the respiration chamber as well. With only the yeast and warm water in the respiration chamber we will allow the solution to mix for three minutes. Then we measure out 10 mL of the glucose and pour it into the mixture. To begin our measurements of CO2 we will stick the tip of a CO_2 measuring probe into the respiration chamber and allow the probe to collect samples for 5 minutes. This procedure will be followed for all trials of the natural and artificial sugar, or glucose and saccharine. This design allows us to compare the rate of fermentation of each group depending on the type of sugar only since we are only manipulating the sugar type and nothing else. Glucose is a monosaccharide so we chose saccharine as the experimental to compare because it is similar to a monosaccharide in its chemical makeup. The rate of fermentation can be measured by its byproduct of carbon dioxide (CO_2). The cellular respiration rate of the two kinds of sugars will be measured using a CO_2 probe. By manipulating the type of sugar used, we will be measuring these CO_2 levels and the rate of fermentation. Using this CO_2 probe and LoggerPro software, we will be able to determine rates of CO_2 production. Table 1 displays the volumes of the different substances used. Our data will be displayed using a box-and-whiskers plot, in order to analyze means, range, and possible outliers between saccharine and glucose.

Results

A carbon dioxide sensor was used to determine the rate of yeast fermentation among two kinds of sweeteners, glucose and saccharine. As observed in Figure 1, the rate of fermentation using glucose provided a larger mean and data range than the trials using saccharine. Our glucose trials had a mean CO_2 ppm of about 600, while the saccharine trials had a mean of about 400 ppm. There was one trial of saccharine in which contained the outlier. This trail was higher, not by much, than the second and third glucose trials.

Table 1: Shows the amount of mL in each solution.

	Yeast Solution	**Glucose**	**Saccharine**	**Total**
Natural Sugar (Glucose)	10 mL	10 mL		20 mL
Artificial Sugar (Saccharine)	10 mL		10 mL	20 mL

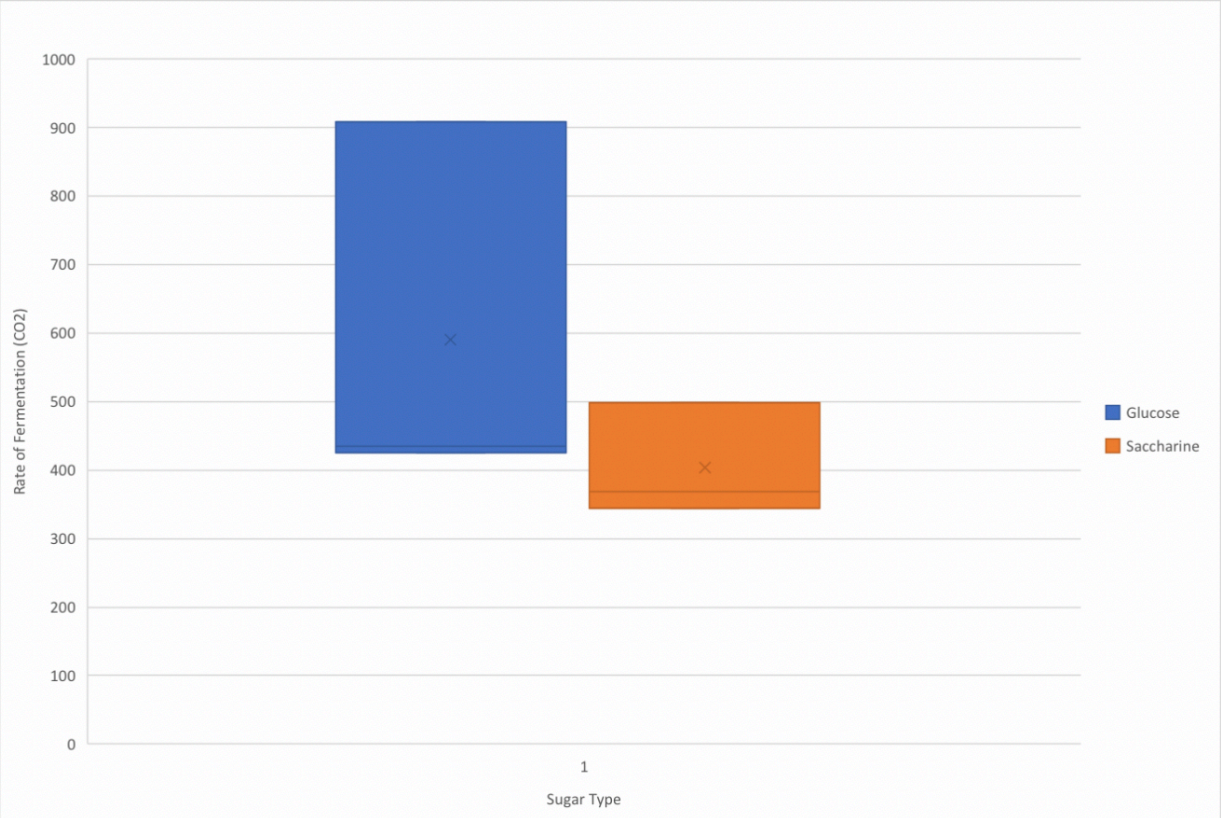

Figure 1: Comparison of fermentation rates of Glucose and Saccharine.

Discussion

Overall, our hypothesis was supported through our results. For the 3 trials in which glucose was used in the fermentation process instead of saccharin, the average slope was much higher. This means that more carbon dioxide was produced within the respiration chamber. Since CO_2 is a product of fermentation, this means that the fermentation rates of trials using glucose were higher. Glucose, a natural sugar, was seen to yield higher rates of yeast fermentation than saccharin, our artificial sugar. A possible explanation to the increased rate using glucose could be that it has a more optimal chemical makeup. However, an alternative explanation for this could be related to the amount of calories within each sugar. Glucose contains more calories than saccharin, thus containing more usable energy (Bauer, 2016). By this theory, our data would reflect a positive correlation between calorie count and rate of respiration. If this experiment were to be performed again, it is possible that a focus on the cell's caloric intake would create different results.

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