

The ability of yeast to ferment sugar molecules

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All cells need to have a constant energy supply. The two processes by which this energy is attained from photosynthetic materials to form ATP are cellular respiration and fermentation. (Hyde, 2012). Fermentation is a way of harvesting chemical energy that does not require oxygen. (Reece et al. 2012). When the body is deprived of oxygen it will then begin to meet its energy needs through the slow process of fermentation. In our lab we investigated alcoholic fermentation by using yeast, which can flourish in an low energyenvironmentin anaerobic conditions.

In this lab our goal was to discover the rate at which yeast will ferment different sized molecules of carbohydrates. In order to perform our experiment we made use of water, glucose, sucrose, and starch. It was hypothesized that glucose, sucrose, then starch would all be used to produce energy during fermentation. Being that glucose is a simple sugar, or monosaccharide, we predicted that glucose would be fermented most quickly. This hypothesis was made based on the idea that glucose is the cell's main source of energy in aerobic cellular respiration. The first step of cellular respiration is glycolysis which breaks down glucose for energy.

We predicted that Sucrose would ferment second to glucose since it is a larger molecule composed of glucose and fructose. Finally, we predicted that starch would ferment extremely slow behind all of the other carbohydrates.

METHODS AND MATERIALS: On October 31, 2012 in the lab of Greenfield Community College my lab partners, Madeline Hawes, Timothy Walsh and I conducted the following experiment in order to test the effectiveness of yeasts' ability to ferment different carbohydrates. We first filled 6 small flasks with 75 ml of water and 5 drops of phenol red to each flask.

Four of these were labeled with the solution that would feed into them and the other two with “ control” and the last with “ increased CO₂. ” The color of phenol red is orangish-pink when there is a neutral pH present. As carbon dioxide is released into this solution from the release of the gas from the yeast filled flasks, the solution turns a light yellow indicating a weak acid. We measured out four weigh boats of 2 grams each of starch and then added 2 grams to each of 4 labeled flasks of 50 ml water, 50 ml Glucose solution, 50 ml Sucrose solution, and 50 ml Starch solution respectively.

All of these had been stored in incubators to maintain an optimal temperature of 35 degrees celsius. We put these flasks into our sink which we made into a water bath. We then drained and added hot plate warmed water from a 1000 ml beaker we kept heated in order to maintain the optimal temperature of 35 degrees celsius around the flasks. We swirled the large flasks to mix the solutions and yeast as they sat in the water bath. The flasks containing the yeasts solutions were then stoppered with glass straws and tubings and their extending tubes placed into the matching labeled smaller flasks adjacent to the sink.

I blew through a straw into the flask labeled “ increased CO₂. ” The phenol red detected the presence of CO₂ turning the solution yellow. The “ control” flask was left as a comparison for the remaining yeast filled tubes feeding into the other flasks of phenol red and water. RESULTS: We recorded our first observations at 10 minutes. Just as we hypothesized, the yeast and water experienced no change. In the glucose solution flask, the glucose molecules were being quickly broken down and forming a frothy head, sending a

bubble of CO₂ through the tube every 2 seconds while turning the phenol red to a light orange.

The sucrose solution was bubbling every three seconds and also had turned light orange. At 10 minutes there was no reaction in the Starch solution. The latter data remained consistent with our hypotheses. The glucose solution at 20 minutes was very frothy and bubbly and had turned the phenol red a very light yellow with a consistent bubble through the tube every second indicating a strong presence of CO₂. The sucrose, too, had turned light yellow and had continuous bubbles every 2 seconds. The starch had a rare bubble with no noticeable change in the phenol red solution.

At the final check in of 40 minutes both the glucose and sucrose had fermented most of the yeast and slowed down on bubbling. The glucose still had the most bubbles occurring. The starch was a lighter pink with little change in the levels of froth in the yeast solution. The water solution still remained completely unchanged. **DISCUSSION:** Our hypotheses were supported through illustrating that all forms of sugar do provide energy and that glucose, being the smallest molecule, was the most efficient. The control tube contained no sugar and therefore produced no energy. A source of sugar is necessary for glycolysis and fermentation to occur.

The strongest presence of carbon dioxide was in glucose, indicated by the bubbles which are a by-product of ethanol fermentation. The rate of fermentation in sucrose was second to glucose and Starch was the least effective at providing a sugar to create energy. The large polysaccharide was difficult for yeast to break down to create the necessary energy that would produce carbon dioxide. Glucose is the most efficient sugar as it is a small

monosaccharide which is already the source of energy for the Glycolysis cycle. The largest possible source of error in our experiment is the time in which each solution began its fermentation process.

We added the yeast into each flask containing the sugar solutions at staggered times. If this experiment were to be repeated it would be more precise to have four people pour in the yeast and swirl at the exact same time and then stopper the solutions. The only minor inconsistency would be the amount of yeast that was spilled or left in the weigh boats. This could create a discrepancy in the final results. Through this lab I understood that in times of oxygen deprivation the body can still function through the process of fermentation.

The yield of 2 ATP molecules is enough to keep muscles contracting for a short period of time when oxygen is scarce. Through the fermentation process NAD^+ is regenerated as pyruvate is broken down to CO_2 and ethanol. This allows the anaerobic production of 2 ATP molecules. (Reece et al. 2012). In essence, keeping cells alive that may otherwise die without the energy to provide for muscle contractions of the heart.

LITERATURE CITED: Reece, Taylor, Simon, Dickey, and Campbell. , Biology: concepts & connections. Pearson Benjamin Cummings, San Francisco, CA. Pgs. 100-101 Hyde, A. October 31, 2012