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Biology 157
20 July 2017

The Effect of pH on the Production of Carbon Dioxide During the Fermentation of Yeast

Materials and Methods

5 Fermentation Tubes	10% Sucrose Solution
5 40 mL Beakers	Dry Yeast (*Saccaromyces cerevisiae*)
Millimeter Ruler	NaOH Solution
37℃ Water Bath	HCl Solution
pH Paper	Scale

Steps of the Experiment:

1. Measure 0.2 grams of the yeast for each fermentation tube, and 20 milliliters of the Sucrose solution for each beaker.
2. Using the NaOH (alkaline solution) and HCl (acidic solution) to change the pH of the five Sucrose beakers. Keep one beaker at a neutral pH, which will be your control group. Then create a wide range of pH's that you prefer, which is your experimental group. In this particular experiment, the pH was two, four, nine, and eleven.
3. Mix the, now varied pH, sucrose in the reservoir of the fermentation tubes containing the yeast.
4. Tilt the fermentation tube backwards until the new sucrose and yeast solution fill the upright portion of the tube.
5. Place all of the fermentation tubes in the 37℃ water bath.
6. Record the amount of carbon dioxide from the starting point to the solution level produced at five minute intervals for a thirty minute duration. If using the millimeter ruler, measure the displacement in millimeters. If there is units on the fermentation tube, measure in milliliters. (Sidenote: Millimeters are equal to milliliters)
7. Create a graph to record the data.
8. Repeat steps one through seven to test the experiment for three trials.

Results

Figure 1:The Effect of pH on the Production of Carbon Dioxide during the Fermentation of Yeast

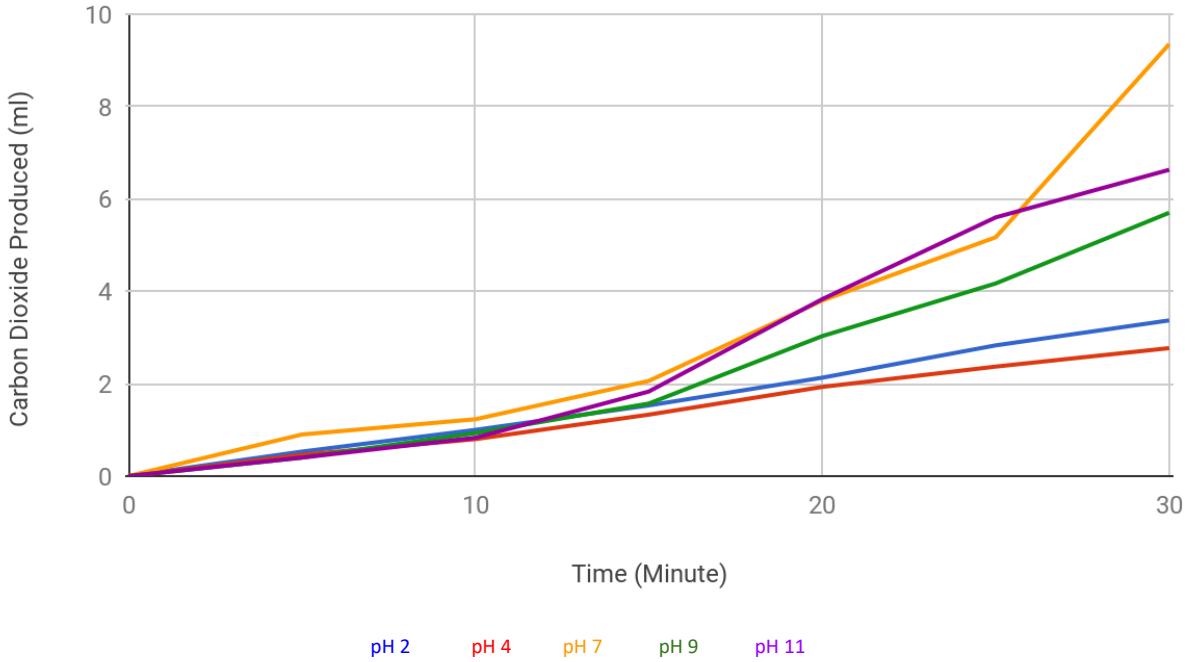
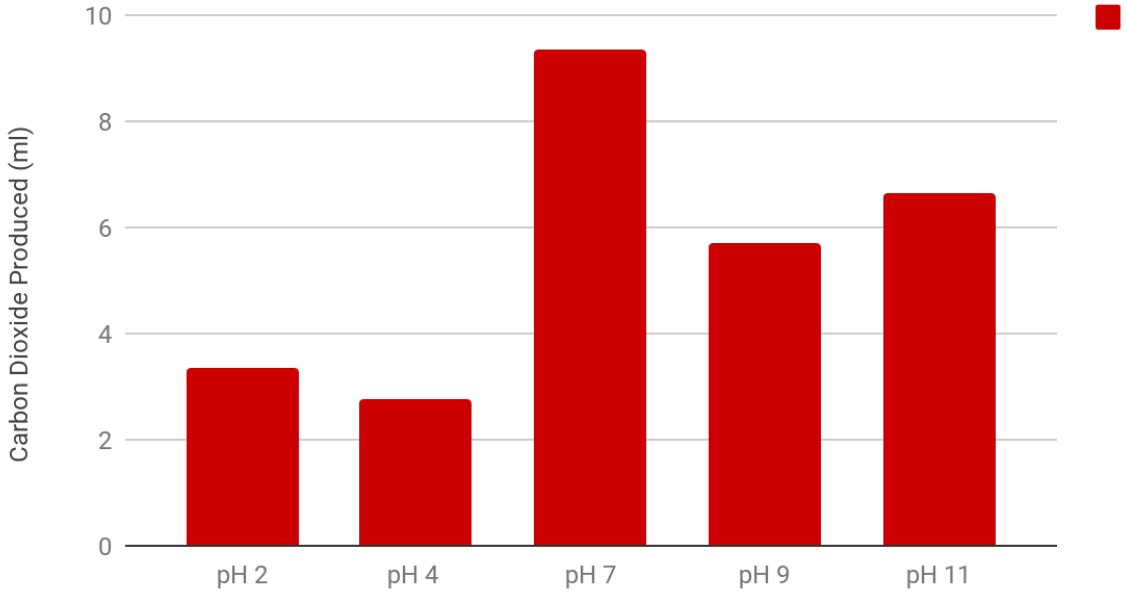


Figure 2: The Effect of pH on the Production of Carbon Dioxide During the Fermentation of Yeast after a Thirty Minute Duration



In the experiment, the goal was to see the effects of pH on the fermentation of yeast. To accomplish this, we varied pH levels and measured the production of carbon dioxide. The ending results proved that a neutral pH was the ideal level for fermentation with a more alkaline level close behind. It was found that the more acidic the solution, the amount of activity during fermentation slowed. There was three trials conducted to verify the results. The averages of those three trials are represented in the graphs above. Figure one shows the gradual production, while figure two shows the ending results.

As the data shows in table one and figure one, the pH level of two had a linear growth with a final volume of 3.37 mL. The pH level of four was slightly lower in the final volume with 2.77 mL, but had a consistent linear growth as well. The alkaline pH's seemed to follow this linear pattern as well, at least until halfway through the time. After fifteen minutes, both the pH of nine and eleven spiked in production. The final volume of the pH of nine was 5.7 mL, and pH of eleven was 6.63 mL. The neutral pH of seven usually had a high production than the others at all times, yet the most drastic increase was in the last five minutes. The data follows a curve with a final volume of 9.35 mL. The carbon dioxide production measured includes the bubbles. In addition, the experiment smells like baking bread.

Table 1:The Averages of the Effect of pH on the Production of Carbon Dioxide During the Fermentation of Yeast

Time (mL)	pH 2	pH 4	pH 7	pH 9	pH 11
5	0.53 ml	0.46 ml	0.9 ml	0.4 ml	0.4 ml
10	1 ml	0.8 ml	1.23 ml	0.93 ml	0.83 ml
15	1.53 ml	1.33 ml	2.06 ml	1.57 ml	1.83 ml
25	2.83 ml	2.37 ml	5.17 ml	4.17 ml	5.6 ml
30	3.37 ml	2.77 ml	9.35 ml	5.7 ml	6.63 ml

Discussion

Our hypothesis was that the yeast will produce more carbon dioxide at a more alkaline reading. This was based on previous research that showed fermentation behaves heterofermentative at a high alkaline level. A heterofermentative state produces carbon dioxide, while more lactic acid is produced at an acidic level. The results do not completely refute our hypothesis, but it does prove it wrong. In table one, the data of the production from the test with the pH of seven is the highest with 9.35 ml. The highest alkaline level, pH of 11, was not far behind with a volume of 6.63 ml, but with a difference of 2.72 ml.

On the other note, I believe the fermentation of yeast has two ideal spots of production supported by the data in table one. These spots are the neutral stage and highly alkaline stage. Considering how fast the production was with just the pH of 11, I would like to try a pH of 14 to see of it is equal to the pH of 7. If further research was conducted, then our hypothesis may even be proved right.