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

Introduction:

To understand the upcoming information, there are a few terms that are key to know. For instance fermentation, which is an anaerobic energy generating process. Anaerobic respiration, unlike aerobic respiration, does not need oxygen to function. Even though it doesn't need that key element in life, fermentation uses the pyruvate that is produced after glycolysis, and glycolysis takes place after glucose is produced by photosynthesis (Starr, 2009). The process of fermentation occurs in animals, fungi, and bacteria. In animals, it is called lactate fermentation. In this, your muscle cells oxidize NADH to NAD+ 1, while pyruvate is reduced to lactate (Starr, 2009). The resulting lactate help your muscles in strenuous exercise when your oxygen count is low. On the other hand, alcoholic fermentation takes place in bacteria and fungi, specifically yeast. The process starts with the conversion of pyruvate to carbon dioxide and ethanol, while oxidizing NADH to NAD+ (Starr, 2009). Alcohol fermentation is used to make wines and cook bread.

The upcoming experiment that we will conduct will be focused on the alcohol fermentation with yeast. A study by Rhee and Pack was done on environmental pH on fermentation in Lactobacillus bulgaricus, which will be used to take an educated guess on the outcome of our experiment. This bacteria is often found in yogurt and is different than the yeast that will be used in ours, but the processes are similar. Rhee and Pack changed the pH of the medium, which was a complex combination of elements and compounds (1980). Then they

searched for the reasoning behind the homofermentative behavior, solely one product of fermentation (lactic acid), and heterofermentative behavior, multiple products of fermentation (volatile acids and carbon dioxide) (Rhee, 1980). It was believed that the bacteria was heterofermentative as an alkaline because of the phosphoroclastic split in the pyruvate conversion and a decrease in lactate dehydrogenase biosynthesis. Lactate dehydrogenase is the catalase in the conversion from pyruvate to lactic acid (Rhee, 1980). Meanwhile, the acidic medium produced homofermentative behavior due to the high lactate dehydrogenase synthesis (Rhee, 1980).

This reasoning explains the results that Rhee and Pack had found. In table one, the lactate produced high levels the more acidic the medium was, and there was high levels of ethanol produced with the higher alkaline medium (Rhee, 1980).

Hypothesis:

The information generated by Rhee's and Pack's experiment has influenced our hypothesis. The the yeast will produce more carbon dioxide at a more alkaline reading because the fermentation will behave heterofermentative.

To further explain our hypothesis I will refer back to the information above. In the heterofermentative state the process produces carbon dioxide and little lactic acid. Since we are observing an alcoholic fermentation the lactic acid is irrelevant, but the carbon dioxide is the independent variable in our experiment to come. In addition, the production of carbon dioxide is little with the acidic medium. Based on Rhee's and Pack's results, I believe our hypothesis will prove to be accurate.

Prediction:

From the information above, it will be easy to make a prediction for our upcoming experiment. To start with the hypothesis standpoint, if the pH is set to eleven then the production of carbon dioxide will be the highest because the heterofermentative activity will also be the highest. The production may reach up to eight or nine milliliters. On the other hand, if the pH is set to one or two then the carbon dioxide production will be little to nothing because of the homofermentative reaction will be the highest. The production may be as low as two or three milliliters. However, if the pH is neutral then the carbon dioxide production will be roughly the same than the previous experiment in lab five because there is no changes to that instruction.

Literature Cited

Rhee, S. K., Pack, M. Y. (1980). Effect of Environmental pH on Fermentation Balance of Lactobacillus bulgaricus. *Journal of Bacteriology, Volume 144, Number 1.* Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC294626/pdf/jbacter00571-0231.pdf

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