Reaction Rates of Varying Substrate Concentrations with Catalase

Summary: My group and I observed the reactions of catalase enzyme with varying concentrations of hydrogen peroxide to determine whether the amount of substrate affects the rate of a reaction. We did this by finding the reaction rates of six different concentrations of H_2O_2 (ranging from 0.05% to 3%) with a fixed amount of catalase. Our results showed that the amount of substrate present will change the rate of the reaction, until saturation of the available catalase is reached. This is supported by the knowledge that, when there is a limited amount of certain proteins (such as carrier proteins and enzymes), they can be fully occupied by high concentrations of partner molecules and it is at this point when the rate of a reaction becomes constant (*Raven et al., 2008*).

Methods & Results: My group and I began the experiment by constructing a respirometer out of a 150mL Erlenmeyer flask, a rubber stopper with a hole in it, and a 5mL pipette. For each test, the flask was filled with a sample of 50mL of hydrogen peroxide (H_2O_2) and then placed in a ~22°C water bath to keep it at a relatively constant temperature throughout. Six samples of H_2O_2 were prepared by adding water to make 0.05%, 0.10%, 0.50%, 1.00%, 1.50% and 3.00% concentrations

For each concentration, a ~1mL amount of 0.50% liver homogenate was added to the flask and sealed with the rubber stopper and pipette. Oxygen gas began to form, which increased the pressure in the flask and caused the mixture to rise inside the pipette. We left the reaction to occur for three minutes and recorded the mL reading on the pipette at the end of this time. A rate was determined for each concentration by dividing the total mL of oxygen gas produced by three minutes. This data produced the following graph:



The orange line shows recorded data, which is mostly consistent except for the first value being much higher than the second, when it should be lower. The green line represents a version of the graph that would be more plausible. For our experiment, we found that the maximum velocity value (V_{max}) was 0.83mL/min and that the Michaelis-Menton constant (K_m) was achieved at approximately 0.65% concentration. A Linweaver-Burk graph was attempted, but our data proved to be too erratic to produce a reliable linear regression to determine more accurate V_{max} and K_m values.

Considering some minor inconsistencies, our data shows that the amount of substrate does affect the rate of a reaction up until the point of saturation. When this occurs, all of the catalase is being occupied and a constant reaction rate is achieved.

References:

Raven, P. & Johnson, G. & Losos, J. & Mason, K. & Singer, S., 2008. Biology, 8th ed., McGraw-Hill.