Relationship between enzyme concentration and reaction rate

The scientific concept of this lab is to test the relationship between rate of reaction and the concentration of enzymes and the substrates, as well as the effects of pH, temperature, and salinity. This lab consists of an introduction which lays out the background for this lab, our hypothesis of an optimal environment to ignite a reaction, and the factors that contribute to the reactions in an enzyme. The method section lays out the procedures for part A and C. The results display a graph for each environment measure and an analysis for each graph is presented. Finally, the discussion talks about the validity of our hypothesis and the conclusion sums up what we have learned from the lab.

Objectives –

Part A: To see the relationship between different enzyme (yeast) concentrations to the rate of reactions.

Salinity: To see the relationship between different salinity concentrations to the rate of reactions.

Hypothesis –

Part A: The rate of reactions will be faster as the concentration of enzymes increases.

Salinity: The rate of reactions will be slower as the concentration of salt increases.

Introduction –

Enzymes catalyze chemical reactions and are necessary for life because it produces energy for the cells. Each and every enzyme is “ specific” meaning

that it recognizes only one substrate and converts it into a specific product. In this lab, we are trying to discover and find out the relationship between the concentration of enzymes, substrates and the rate of reaction it results. So, if there is a faster rate of reaction then there is a higher concentration of either enzymes or substrates. Our hypothesis was: If there is higher enzyme concentration with a constant level of substrate (1% H_2O_2), then enzyme activity/rate will be faster because they won't be easily denatured. Several experiments in this lab test the effect of temperature, salinity, and pH on the rate at which an enzyme works.

Materials –

- Potato extract
- 1000 ml flask with distilled/deionized/dechlorinated water
- 1-250 ml beaker for potato extract
- 200 ml 1% H_2O_2 solution for the first part of experiment
- 3 % H_2O_2 solution to dilute for second part of the experiment
- 100 ml graduated cylinder
- Forceps
- Paper towels
- 60 % catalase
- 8-100 ml beakers
- 40 filter paper disks
- Stop watch if available
- calculator

Methods –

Finding Optimal Catalase & Substrate Concentration Level

Get/ prepare yeast solution that was prepared by the teacher, as well as other materials listed above.

Create five different enzyme solutions with different extract concentrations following the table guidance (see below) to create each solution (20%, 40%, 60%, 80%, 100%).

Prepare 30mL of the 1% H202 into a clean beaker to work as the reaction beaker.

Using forceps dip the paper disks into the solution starting with the 20% extract concentration for 5 seconds, then place it on a piece of paper towel to partially drain the liquid out then place the disk into the bottom of the reaction beaker.

Start timing from the moment the disk was placed on the bottom of the beaker until it rises to the surface of the reaction beaker.

Repeat steps 5 and 6 three times per each solution and record data.

Calculate Averages of the data for each set of trials.

Finding Optimal Temperature for Enzyme Reaction

For the second part of the lab, first prepare 200ml of 3% H202.

27 mLLooking at the table below make 6 different substrate concentration solutions (2%, 1. 5%, 1%, 0. 8%, 0. 6%, 0. 3%) by mixing H2O2 with water.

Create a 60% enzyme concentration solution by combining 24mL of yeast (enzymes) and 16mL of water.

Using forceps dip the paper disk into the extract concentration for five seconds and then drain it on the paper towel for another five, then place it on the bottom of the reaction beaker of the 2% H2O2.

Start timing when the paper disk is placed on the bottom of the reaction beaker until it floats to the surface.

Repeat steps 12 and 13 three times per each substrate solutions and record data.

Calculate the averages of the data for each set of trials.

Results –

Effect of Enzyme Concentration on Rate of Reaction (Part A)

The graph above clearly shows that the concentration of enzymes increases as the rate of reaction increases. This idea is proved by the fact that both the team average and class average show a positive correlation. However, the trends differed between the team and class average. For the team average, the optimal concentrations of enzymes seem to be when the percentages are at 80-100% while for the class average, the rate of reaction seemed to be consistent and static, having an almost straight line.

Effect of Salinity on the Rate of Reaction

The graph above shoes the effect of salinity on the rate of reaction. This time, the graph shows a negative correlation, which suggests that as the concentration of substrate decreases, the rate of reaction decreases also. Looking at the sudden change between the salinity concentrations of 6% to 10 %, it shows that the rate of reaction can drastically change if the salinity concentration differs in great amounts. Unlike the previous graph, the salinity seems to have no limit in its optimal concentration.

Effect of Temperature on the Rate of Reaction

The graph above shows the relationship between temperature and the rate of reaction. This time, the optimal temperature is clear. It is between temperatures 20 degrees Celsius to 60 degrees Celsius. However it would be more of the optimal temperature if it were to have lower temperature because any temperature too high will be exempted due to denaturalization.

Part B

The graph above shows a negative correlation between the effect of substrate and the rate of reaction. The line is almost straight as a regression of 1, showing a reliable data. According to the data, I can say that as the substrate concentration increases, the rate of reaction decreases. If I were to choose the optimal concentration of substrate I would say there is a slight change between 1% to 0. 60 %.

pH Level vs. Height of Bubbles

The graph above shows the correlation between pH level and the height of bubble. There seems to be no particular trend in this relationship. In this

case, if the height of bubbles is high, then it means that the reaction is happening at a fast rate. In the acid states, the height of bubbles seems to decrease dramatically, while in the basic states, the height of bubbles seems to increase dramatically.

Discussion –

The data I received from the lab proves that my hypothesis is at least somewhat right. It showed how the higher the concentration level of the substrate or the enzyme has; the faster reaction speed would be there for the enzyme activity with the substrates. This could be easily seen by just simply looking at the data or the graphs. When the concentrations of substrates were constant, and the concentration of enzymes increased, it showed an improvement in reaction speed. Because as the concentration of enzyme increases there are more enzymes for the paper disk to react with, the reactions speed up, causing catalase to break down H2O2 and rise to the surface. And also at the second graph and table, you can see that when the concentrations of enzymes were constant and the number of substrates decreased, the graph went down with it. As concentration of salinity in the yeast is increased, the amount of enzymes available for reaction decreases. In other words, the reaction occurs at a slower rate. However the part about my hypothesis where I stated that after reaching its peak, the enzyme activity would remain at that reaction speed could not be proven through this experiment. This was because for the experiments, the number of substrates and the enzymes for one of them each were always constant. For example, that part of my hypothesis could be proven true or false if the

concentration of the substrates could be raised a lot when the enzyme level was at 100%.

The trend of the lines for both my group and for the class was very similar as the enzyme or the substrate concentration increased the reaction time for the paper disk to float to the top got faster. In the graph, the rate or reaction is measured in inverse seconds to show how the time for the disk to float became less and less. Even though we ran two separate experiments to test the number of enzymes and substrates as the independent variables, the results we received were similar for the similar reasons. Even though our graphs are pointed in different directions (one has a positive slope and the other has a negative slope) the results, if organized all the data can be interpreted to one result: the higher the number of enzymes or substrates there are, the faster the rate of reaction is. So this time, the enzymes around the substrate would try to work as fast as possible but since only so many enzymes can work on a limited number of substrates, the reaction speed along as predicted gets lower along with the amount of the concentration of the substrates creating a downwards or a negative slope of the graph. This two experiments within this lab proved that the higher the number of substrates or enzymes there are, until it reaches it maximum potential to react as fast as possible, the more of each there is, the faster the reaction would occur.

I realize that my group and I could make a few errors. First, the time keeping with the stopwatch could not always be constant. Sometimes it was pressed seconds early and sometimes it was pressed seconds too late, providing inaccurate data that often were clearly way off and wrong. Also we didn’t

always stir the yeast solution before we dabbed the disk in it, which could have created different results. Especially, I had to miss one class to work on the experiment; another person replaced me to do the job of timing. The results might have been more accurate if I had cleaned out the H2O2 and yeast after doing one trial to start independently for the next trial.

Conclusion/Analysis –

In conclusion, the main point of the labs was quite simple: the higher concentration of substrates or enzymes put together would result a higher enzyme activity. This lab successfully demonstrated in fact, multiple times by using different concentrations of yeast and H2O2 to prove that point. In addition to grasping the main objective of the lab, another interesting concept I learned was that the pH level usually has its optimal point in its base state. Although my hypothesis was found to be valid, next time, I want to reduce errors in order to make the results more accurate.