Candidate 1 evidence

The effect of substrate concentration on enzymes

Aim

To investigate the effect of increasing the substrate concentration on enzyme activity.

Underlying biology

The presence or absence of certain enzymes as well as regulation of rate of reaction controls metabolic pathways. Some metabolic reactions are reversible, and the presence of high substrate concentrations can push a sequence of reactions in a certain direction.

The active site of an enzyme has a high affinity for the substrate meaning there is a high chemical attraction and when they come into contact, the substrate fits into the active site. This is because the enzyme is specific to its substrate and complimentary to the enzymes active site.

Inhibitors are molecules which bind to enzymes to decrease their activity as the substrate has less chance of binding at the active site. They have different effects on enzymes and come in the form competitive and non-competitive. Competitive inhibitors are the same shape as the substrate, so therefore compete to bind at the active site, reducing rates of enzyme reactions. This can be reversed when the substrate concentration is increased giving the substrate a greater chance of binding than the inhibitor and increases rate of reactions. Non-competitive inhibitors do not bind to the active site but bind away from the active site changing the shape of the active site which stops the substrate from binding. This, however, cannot be reversed by increasing the substrate concentration, stopping any enzyme reaction taking place.

Experimental Method

In each of the 5 different measuring cylinders there were different concentrations of hydrogen peroxide (substrate) solution, set volumes of fairy liquid and catalase (enzyme), measured using syringes were then added to the first test tube. The timer was started and after the given time, the volume of foam produced was measured and noted. This was repeated 3 times for each concentration.

Experimental data

- Raw data

Test 1
0% = 0 cm^3
20% = 15 cm^3
40% = 20 cm^3
60% = 46 cm^3
80% = 53 cm^3
100% = 73 cm^3

Test 2
0% = 0 cm^3
20% = 13 cm^3
40% = 21 cm^3
60% = 46 cm^3
80% = 54 cm^3
100% = 70 cm^3

Test 3
0% = 0
20% = 12 cm^3
40% = 23 cm^3
60% = 44 cm^3
80% = 54 cm^3
100% = 69 cm^3

- Raw data continued

	Volume of Foam produced (cm^3)		
Concentration	Test 1	Test 2	Test 3
0%	0	0	0
20%	15	13	12
40%	20	21	23
60%	46	46	44
80%	53	54	54
100%	73	70	69

- Results table

	Volume of foam produced (cm^3)				
Concentration	Test 1	Test 2	Test 3	Average	Rate of reaction (cm^3/s)
0%	0	0	0	0	0
20%	15	13	12	13.3	0.11
40%	20	21	23	21.3	0.18
60%	46	46	44	45.3	0.38
80%	53	54	54	53.7	0.45
100%	73	70	69	70.7	0.59

(seconds)

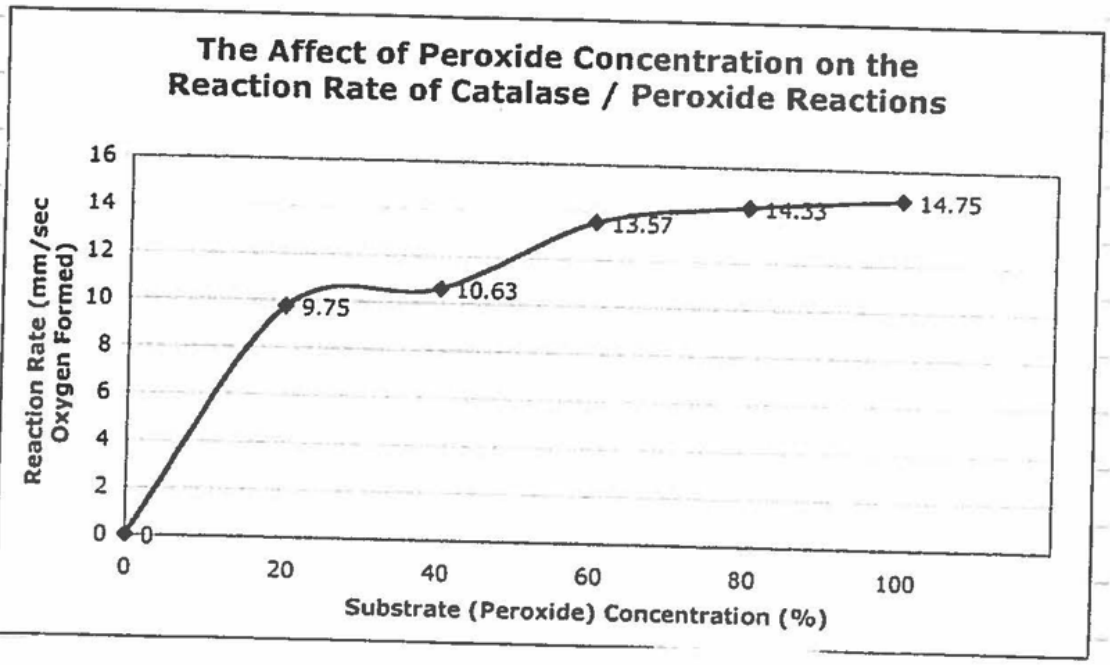
Rate of reaction = Average ÷ time left
= 13.3 ÷ 120
= 0.1108.
= 0.11

Experimental Graph

Experimental source

(1)

Substrate Concentration (%)	0	20	40	60	80	100
Average Reaction Rate (mm/sec)	0	9.75	10.63	13.57	14.33	14.75
Standard Deviation	0	2.03	1.28	0.56	0.46	0.57



Analysis

From the results I have gathered it is clear that the substrate concentration effects the volume of foam produced and therefore the rate of reaction. I calculated the percentage increase from the lowest concentration to the highest.

$$\% \text{ Increase} = \frac{\text{difference}}{\text{original}} \times 100$$

$$= \frac{0.59 - 0.11}{0.11} \times 100$$

$$= \frac{0.48}{0.11} \times 100$$

$$= 4.36 \times 100$$

$$= 436\%$$

This shows that the reaction rate increased by 436% as the hydrogen peroxide concentration increased from 20% to 100%.

The results of the experiment from the internet source showed similar effects to increasing concentrations of the substrate as my experiment. This reveals that it is the increased substrate concentration which impacts enzyme activity.

Conclusion

As the substrate hydrogen peroxide concentration is increased the enzyme activity also increases. This is shown by the volume of foam production increasing, as the percentage of hydrogen peroxide was increased. The more foam produced, the greater the enzyme activity.

Evaluation

I believe that the results from my experiment were fairly reliable. I know this because I completed the experiment 3 times which provides more reliable results than just completing it once. An average was also taken. As my results were similar within each testing, this suggests there were no mistakes. This can further be supported by the internet source which has similar results to my experiment.

The results I took were also accurate as I completed previous testing's to find an appropriate time scale to leave the substrates for, before measuring the foam production. This ensured the substrates had time to act on the enzymes and show the effect they had on enzyme activity.

My experiment was further reliable as I used syringes to measure the volumes which allowed me to produce accurate measurements of each substance. To make my results more reliable I could complete the experiment using water baths for the measuring cylinders so the temperature could be controlled. This would benefit my results as enzyme activity is effected by temperature, providing a constant heat would rule out temperature varying the enzyme activity and ultimately my results.

References

http://science.halleyhosting.com/Sci/ibbio/inquiry/example/enz/substrate/dpp.htm

- date accessed: Feb 2019