

Title

Effect of Temperature on the activity of enzyme catalase

Commented [HG1]: The Title of my experiment was later amended to make it sound good

Aim

To find out how different temperatures will affect the chemical reaction of the enzyme catalase in hydrogen peroxide.

Commented [HG2]: These words were later edited so that the context makes more sense and it makes easier for the reader to read.

Hypothesis

The higher the temperature, the enzyme catalase will become more effective whereas when the temperature gets above 37°C, it starts getting less effective because enzymes become denatured at high temperatures (usually body temperature which is 37°C). Therefore, at higher or lower temperatures, the activity of enzymes is lower.

Commented [HG3]: This was later added to the hypothesis to make it sound better.

Equipment

1 potato, ruler, 6 beakers, 6 test tubes, 1 hot plate, 1 packet of ice, 1 bottle of hydrogen peroxide, 1 stop watch, 1 thermometer, Marker pen, safety glasses, knife, chopping board, potato Peeler, test tube rack and tongs

Commented [HG4]: This was later written as dot points and in a more readable manner.

Variables (how will these be recorded and controlled)

- **Dependent variable** – Height of the bubbles.
- **Independent variable** – Temperature of hydrogen peroxide
- **Controlled variables** – The amount of hydrogen peroxide used, amount of potato used

Commented [HG5]: The dependent variable was changed from the reaction time to the height of the bubbles.

Commented [HG6]: The independent variable was changed after the teacher's consultation and the temperature of the potato was removed from the list.

These dependent variable was recorded using a ruler.

Commented [HG7]: A stopwatch was written here before, but while editing it was realised that the ruler recorded the results; not the stopwatch.

These were controlled by the following ways:-

- The same stopwatch was used when the experiment was repeated.
- Hydrogen peroxide was taken from the same bottle when the experiment was repeated.
- The same type of test tube and beaker was used
- The variables were controlled as the same size of potatoes were taken and the same area was used and this made it control.

Commented [HG8]: The area wasn't taken, the volume as taken and this was later edited.

Commented [HG9]: These were added later to the report.

Risk assessment

Commented [HG10]: The risk assessment was written in future tense before, but it was later edited and fixed.

RISK	PRECAUTION	IF ACCIDENT OCCURS
Hydrogen peroxide can drop/spill on the floor while handling it	Be careful when handling hydrogen peroxide and try not to drop/spill it	Rinse the floor with a plenty of water and wipe out small amounts with a damp cloth and rinse it well
Hydrogen peroxide can drop/spill on your clothes while handling it and cause an injury	Always keep hydrogen peroxide away from your body and also be careful while handling it. Also don't play around with this chemical as it can harm you.	Flood the area with a plenty of water. Also remove contaminated clothes and soak it. If a large area is affected, or blistering occurs, see a doctor.

Commented [HG11]: This risk was added later as there are different precautions if the hydrogen peroxide drops of the floor and if it drops on your clothes.

Commented [HG12]: This was added later as this is also a precaution to this risk.

Commented [HG13]: This is really important and was added while editing, as if a large area is affected, you should see a doctor.

Glassware can break and cause injury	Handle the glassware carefully and never carry more than 1 glassware at once as you can drop them. Also, do not overcrowd the table.	Clean the area immediately using a dustpan. Also make sure that all the glass has been wiped off.
Constant exposure to hydrogen peroxide can cause irritation in eyes and constant inhalation can cause serious issues	Wear safety glasses. Do not smell hydrogen peroxide	Wash the eyes with cold water for 5-10 minutes. Move to fresh air.
Playing around with knife can cause serious injury	Never play around with the knife and always keep the knife away from yourself and other people.	If it a minor cut, put it under cold water for 5-10 minutes and put a bandage on it. If it a serious injury, visit the doctor.

Commented [HG14]: This part was later edited as this is also important.

Commented [HG15]: This was edited later after some research being done.

Commented [HG16]: This risk was later added, as this risk was realised after doing the actual experiment.

Method

- The safety glasses were put on and the area was safe with full ventilation.
- The potato was peeled using peeler before being cut into 6 cubes with the side of 5mm using a knife and chopping board.
- 6 beakers were taken and marked 1 to 6 using a marker pen.
- The 6 beakers were filled with water up to 10cm high and this was measured using a ruler. By adding some ice to the water, the temperature of beaker 1 was brought to 10°C and beaker 2 to 20°C. Using the hot plate, the temperatures of the water in beakers 3 to 6 were brought to 30°C, 40°C, 50°C and 60°C. The temperature was measured using a thermometer.
- 6 test tubes were then taken and marked 1 to 6 using a marker pen.
- The test tubes were then marked with a line 2cm from the bottom of the tube. The hydrogen peroxide solution was poured into the 6 test tubes up to the level of the line.
- Each test tubes were placed in a different beaker for 5 minutes, to enable the hydrogen peroxide to stabilize at the same temperature.
- The potato that was cut into small pieces was placed into test tube 1 using tongs. As soon as the potato was placed into the test tube, the stopwatch was started.
- The stopwatch was stopped after 5 minutes and the height of the bubbles was recorded using a ruler.
- Steps 8, 9 and 10 were repeated with different test tubes.
- The experiment was repeated 5 times and the average of was taken.

Commented [HG17]: The method was first written in first person perspective with pronouns being used but later it was edited as third person and it was made sure that no pronouns were used. The method was put into systematically order later so that the reader can easily read the information.

Commented [HG18]: This is the first thing you should always do before an experiment like this. This was later added in.

Commented [HG19]: This was later added in to be more specific.

Commented [HG20]: This was edited later to make sure that everything is clear and specific.

Commented [HG21]: This was added later to tell why the test tubes were placed for 5 minutes.

Commented [HG22]: This was later edited to make sure that everything is specific and nothing is confusing.

Research

Enzymes are proteins that help a certain chemical process to take place. Enzymes are very large and complex organic molecules that are synthesised by the cell to perform very specific functions. Catalyst is an enzyme that is found in foods such as potatoes. Catalyst speeds up the decomposition of hydrogen peroxide into water and oxygen gas. These biological catalysts are important because they speed up the rate of the reaction they

Commented [HG23]: The research part was really long but it was later edited. Now, the research is about a page and it was made sure that everything necessary was covered within a page.

catalyse that would otherwise be too slow to support life. In the presence of enzymes, the amount of energy required for a chemical process to take place is reduced. The reduction in the energy level helps to make the process happen faster.

Commented [HG24]: This was edited later to make sure that the reader understands the theory behind it.

Catalysts are also critical in almost every industrial chemical process, including the production of fertilisers, plastics and petrol. Every day you encounter many products that are made in catalytic reactions. Catalysts are widely used in industry because they speed up reactions and reduce the amount of energy needed for reactions to occur. This means energy savings to the manufacturer. Catalytic converters in cars reduce the amount of pollutants released. The metals that act as catalysts are platinum, palladium and rhodium.

Commented [HG25]: This was added later as this is important as well. Although it doesn't directly relate to my experiment, but this was something interesting which was found during researching.

Catalase is an enzyme present in the cells of plants, animals and aerobic bacteria. It promotes the conversion of hydrogen peroxide, a powerful and potentially harmful oxidising agent, to water and molecular oxygen. Hydrogen peroxide (H_2O_2) is a harmful substance that kills cells. Nonetheless, our body generates hydrogen peroxide within each cell as a regular cellular function. So, in order to get rid of the toxic compound, our body has developed catalase to break down peroxide into water and oxygen.

All biochemical reactions are catalysed by enzymes. Since enzymes are proteins, they can be denatured in a variety of ways, so they are most active under mild conditions. Most enzymes have optimum activity at a neutral at body temperature.

Commented [HG26]: This sentence was later added as this states when the enzyme have their optimum activity.

All reactions are faster at a higher temperature. However, enzyme-catalysed reactions become slower or stop if the temperature becomes too high, because enzymes become denatured at high temperatures. A $10^\circ C$ rise in temperature will increase the activity of most enzymes by 50-100%, whereas if the temperature is only changed by 1 or $2^\circ C$, the activity of most enzymes increases by 10-20%.

Commented [HG27]: This was edited later as this goes into more depth and provides important information related to my topic.

As the temperature increases, the rate of reaction increases as well. But very high temperatures denature enzymes.

Terminology

Denature – It means to destroy the characteristic properties of a protein (in this case; enzymes). This is usually done by heat, acidity, or other effects which disrupts its molecular conformation (in this case; by heat).

Commented [HG28]: The meaning of denature was added while researching. This word is used in my research and my experiment so it was important to explain its meaning.

Enzymes – Enzymes are biological molecules that increase the rates of chemical reactions.

Catalase – Catalase is an enzyme which is found in blood and in most living cells that causes the decomposition of hydrogen peroxide into water and oxygen.

Reliability

- The experiment was repeated with different temperatures to get reliable results.

- Experiment was repeated 5 times to get the average results and thus, making the experiment reliable.
- One factor that was not reliable was that the results were different each time, this is probably because of human errors in recording or whilst undertaking the actual experiment.
- The stopwatch was used, instead of estimate, to get the accurate results.
- Hydrogen peroxide was poured into the same type of test tube to be accurate and reliable. The size was also the same.
- The same person was measuring and recording the substances to get reliable results.

Commented [HG29]: This was edited later and this made my experiment unreliable and I wanted to tell the teacher about it.

Commented [HG30]: More points relating reliability were added and some of the existing ones were edited to make it sound more professional and sophisticated.

Validity

- All the variables were kept constant except the temperature
- The same samples of potatoes were used for each experiment.
- The experiment was performed at the same temperature.

Commented [HG31]: More points related to validity were added and it was concluded that the my experiment was valid.

There are a lot of factors that make my experiment reliable and valid and they are listed above. Although, there are also some factors that are not reliable, but most of them are reliable and that makes my experiment reliable and valid.

Results

Experiment Done First Time

Test Tube Number	Beaker Number	Temperature (°C)	Height of Bubbles (mm)
1	1	10	15
2	2	20	38
3	3	30	60
4	4	40	75
5	5	50	42
6	6	60	31

Experiment Done Second Time

Test Tube Number	Beaker Number	Temperature (°C)	Height of Bubbles (mm)
1	1	10	18
2	2	20	34
3	3	30	62
4	4	40	72
5	5	50	45
6	6	60	38

Experiment Done Third Time

Test Tube Number	Beaker Number	Temperature (°C)	Height of Bubbles (mm)
1	1	10	11
2	2	20	33
3	3	30	62
4	4	40	74
5	5	50	49

6	6	60	34
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The Average of The Results

Test Tube Number	Beaker Number	Temperature (°C)	Height of Bubbles (mm)
1	1	10	16
2	2	20	36.8
3	3	30	61.2
4	4	40	74
5	5	50	45.8
6	6	60	33.2

Commented [HG32]: The experiment was done another two times before taking the average of the results. The experiment was repeated to make the experiment more reliable.

Analysis & Conclusion/Discussion

• Graphs of quantitative data

By looking at the graph, we see that different temperatures were used but the same amount of potato and hydrogen peroxide was used. This indicates that the higher the temperature, the higher the height of bubbles, whereas when the temperature was above 40°C, the height of the bubbles decreased. Thus, the enzyme activity gradually increases with temperature up to around 40°C. Then, as the temperature continues to rise, the rate of reaction falls rapidly as heat energy denatures the enzyme. Therefore, this proves that enzyme catalase gets its optimum result at the normal body temperature.

Commented [HG33]: This was edited later as this concludes the summary of my graph analysis.

• Link between results and hypothesis

I have proven that as stated in my hypothesis that the enzyme catalase will become more effective when the temperature gets higher, whereas when the temperature gets above 37°C, the enzyme catalase starts getting less effective because enzymes become denatured at high temperatures. Therefore, it is proven that at higher or lower temperatures, the activity of enzymes is lower and they get an optimum activity at the normal body temperature. Hence, my hypothesis is supported.

Commented [HG34]: This was edited later as this concluded the summary of the link between the results and the hypothesis.

• Problems encountered in the experiment

There were some problems that I encountered during doing this experiment and some of them were:-

- ❖ Data was collected over several days. Although the solution was preserved in a refrigerator, time still influences enzyme activity. Enzymes can sometimes become less effective as time passes so data collected during the later days may not be as accurate as the first day. Hence, data may be slightly inconsistent.
- ❖ It was really hard to cut the potato into exactly the same size; probably could have tried boiling the potatoes before cutting it or mashing the potatoes and measuring it and taking the same amount.
- **Improvements to be made**
- ❖ All the data collection should have been experimented on the same day and even better if conducted in same environmental conditions. In this way, the experiment will be more consistent and controlled and accurate results will be obtained.

Commented [HG35]: This problem was edited at a later date, as I later realised that this could have had an impact on my results.

- ❖ After the experiment, I should have repeated the experiment with temperature of 30-45°C (with the increment of 1 degree) to see the perfect optimum result of enzymes.
- ❖ Instead of test tubes, I could have used measuring cylinders (which have measurements and thus correct height of froth would have been measured).
- ❖ Should have repeated experiment with another source of catalase (starch or liver)
- ❖ Instead of volume of potato, I would have used 'how much weight of potato should be in each test tube).

Commented [HG36]: These improvements were added later and these were also some things that I could have done to make my experiment better and reliable.

Conclusion linking to the aim

The purpose of my experiment was to find out how different temperatures will affect the chemical reaction of the enzyme Catalase in hydrogen peroxide. It was found that as the temperature gets higher, the enzyme catalase becomes more effective, whereas it will start getting less effective at temperatures above 37°C.

Commented [HG37]: The conclusion was edited a bit after taking consultation from my teacher.

Besides playing an important role in the life of living organisms, the catalase enzyme also has some commercial uses. In the food industry, it is used to make the milk free from hydrogen peroxide so that the milk can be used to make cheese. In the textile industry, it is used to remove hydrogen peroxide from clothes. Catalysts are also important in many industrial chemical process also, including the production of fertilisers, plastics and petrol because they speed up the reactions and reduce the amount of energy needed for reactions to occur. This means energy savings to the manufacturer.

Commented [HG38]: The broader issues in the community were edited later after some research being done.

References/Bibliography

Points how the sites were reliable.

- ❖ The sites used are reliable as these are organisational and educational websites whose information is tested before published.
- ❖ More than one website was referred, to ensure the information gather is reliable
- ❖ The information on the website was recently updated, which ensures the data is fresh, new and reliable
- ❖ Wikipedia or any unreliable sources were not used as anyone can post data on it.

Commented [HG39]: These points were added later stating how the websites I used were reliable.

Bibliography using HARVARD referencing

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Commented [HG40]: More references were added after some more research being done.