IB INTERNAL ASSESSMENT SAMPLE

WRITING METIER

TITLE

HOW DOES TEMPERATURE IMPACT THE RESPIRATION RATES IN YEAS?

Research Question: How does temperature impact the Respiration Rates in Yeas?

Introduction:

An essential biological function that is crucial to the creation of energy in living things is respiration. It includes the enzymatic breakdown of organic molecules like glucose to produce adenosine triphosphate (ATP), which fuels different cellular processes. Due to their simplicity and ease of manipulation, yeasts, which are unicellular fungi that are frequently employed as model organisms for investigating metabolic pathways, are particularly susceptible to this phenomenon. Nevertheless, a wide range of variables, including temperature, have an impact on how well respiration occurs.

An essential concept in biological research is how temperature affects metabolic activities. Enzymes, the biological catalysts that speed up chemical processes in cells, are extremely sensitive to temperature variations. Changes in temperature can cause differences in enzyme activity, which in turn can impact how quickly metabolic processes occur overall. Temperature is anticipated to have a significant influence on the rate of energy generation through the breakdown of glucose in the context of yeast respiration.

This study aims to investigate the effect of temperature on yeast respiration rates. "How does temperature affect the respiration rates in yeast?" is the main research issue that underlies this investigation. We want to elucidate the link between temperature and yeast respiration by systematically altering temperatures while maintaining constant yeast and substrate concentrations. Through this investigation, we learn more about the basic biological reactions of yeast to temperature changes and advance our knowledge of how organisms adjust to changing environmental conditions.

Beyond the realm of theoretical biology, understanding the temperature-respiration connection in yeast is important. Yeasts are used in a variety of sectors, such as baking, brewing, and the manufacturing of biofuels, where ideal metabolic rates are crucial for the quality and output of the final product. Additionally, this examination supports inquiry-based learning and critical thinking in the context of current scientific research, two major tenets of the International Baccalaureate (IB) Biology programme.

We will describe the technique used to look into how temperature affects yeast respiration rates, present and analyse the data we gathered, and talk about the consequences of our results in the parts that follow. Through this research, we want to learn more about the dynamic interaction between temperature and cellular functions, adding to the corpus of knowledge.

Hypotheses and Objectives:

Up to an ideal temperature, yeast will begin to respire more quickly as the temperature rises. Beyond this ideal temperature, the respiration rate will slow down as the respiration-related enzymes denaturate and become inactive. This is because changes in temperature affect molecules' kinetic energies, which in turn affect the speed of enzyme-catalyzed processes.

Objectives:

- To investigate the effect of different temperatures on the respiration rates of yeast.
- To determine the optimal temperature range at which yeast exhibits the highest respiration rate.
- To explore the relationship between temperature and enzyme activity in yeast respiration.

Variables:

Independent Variable: Temperature

Levels: 20°C, 30°C, 40°C, 60°C, 80°C

In order to study the influence of temperature on yeast respiration rate, temperature is intentionally changed. The variety of circumstances that yeast could experience in diverse habitats is represented by the selection of several temperature levels.

dependent variable: Yeast respiration rate

The result is monitored in reaction to changes in the independent variable, which is the yeast's respiration rate. It displays how quickly yeast cells are conducting cellular respiration at various temperatures.

Controlled variables:

pH Level: Under all temperature ranges, the experimental solution's pH level remains constant. This is crucial because pH can have an impact on the activity of enzymes, which in turn affects respiration. The possible impact of pH on the outcomes is reduced by maintaining a constant pH.

The yeast samples are exposed to each temperature level for the same amount of time throughout the incubation period in the water bath. By ensuring that the impact of time on respiration rate is managed, valid comparisons between temperature situations are made possible.

Level of Yeast Concentration: The levels of yeast in the test samples are kept constant. This is crucial because different yeast concentrations could affect the respiration rate as a whole..

Equipment:

- 25 g Baker's yeast
- Water bath
- x5 Boiling tubes
- Thermometer
- Stopwatch
- Measuring glass pipette
- x5 Delivery tubes
- 1 Beaker
- Distilled water
- x2 Spatula

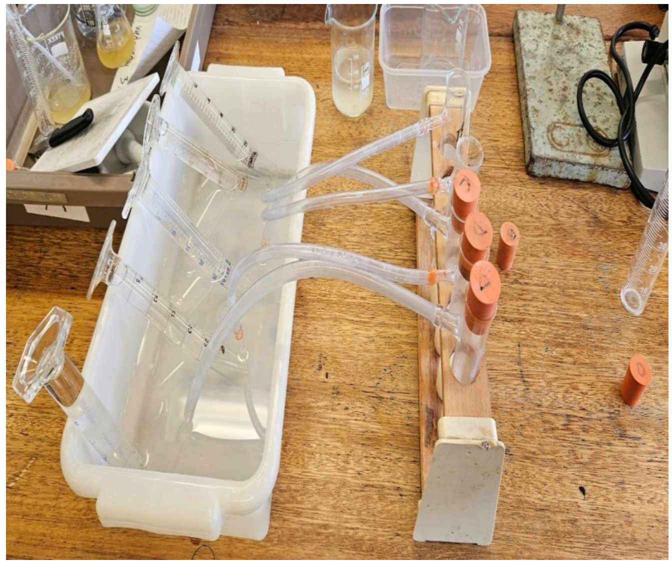
100ml of water
5g of yeast

1 gram of sugar

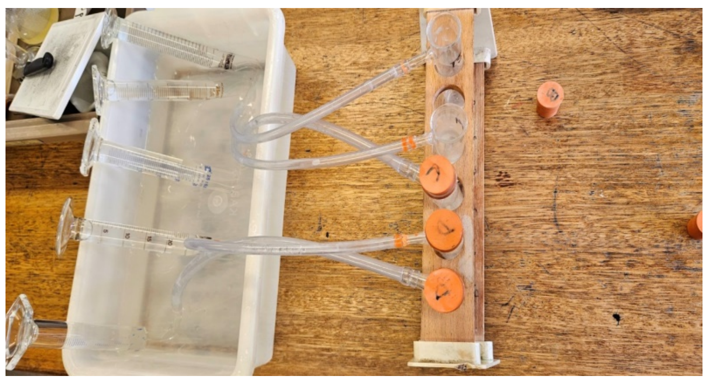
Methodology:

- Step 1: Prepare water bath at temperatures of 0C, 20C, 40C, 60C, and 80C.

- Step 2: label the test tubes T1, T2, T3, T4, and T5 with the corresponding temperatures.



- Step 3: For the sugar-water solution
- 1.) In a clean beaker, add 1g of sugar and a 100ml of water. Stir until sugar is dissolved.
- 2.) Put in a water bath and let the temperature get up to 30C. Leave for 5-10 mins.
- 3.) Then add 2g of yeast.
- 4.) Stir gently to ensure that yeast is thoroughly mixed. Let it sit for a few minutes to activate the yeast.



- Step 4: Equipment set up.
- 1.) Measure 15ml of the activated yeast mixture the boiling tube. Leave room for the CO2 production.
- 2.) Insert a rubber stopper which is connected to the delivery tube of each boiling tube.
- 3.) Submerge the open end of the boiling tube into the water, making it upside down. Ensure that it remains below the water level. Start the stopwatch after doing so.
- 4.) Observe the gas collection/respiration rates through looking at how much the water has gone down in the boiling tube and measure the volume of gas collected at regular time intervals which is every 1 min for every 10 mins.
- Record the volume of gas collected for each temperature condition.
- Empty and rinse the boiling tubes after each experiment.

- Step 5:
- 1.) Repeat Steps 3 and 4 for each temperature conditions (T2, T3, T4, T5) to obtain a complete data set.
- 2.) Make sure that all other variables remain the same except for temperature.

Raw Data Obtained:

Temperature	Trial	Vol. of CO2 - 2 mins	Vol. of CO2 - 4 mins	Vol. of CO2 - 6 mins	Vol. of CO2 - 8 mins	Vol. of CO2 - 10 mins	Average Respiration Rate(ml/min)
20	1	0.0ml	0.0ml	0.0ml	0.0ml	0.0ml	0
	2	0.0ml	0.0ml	0.0ml	0.0ml	0.0ml	0
	3	0.0ml	0.0ml	0.0ml	0.0ml	1.0ml	0.2
	4	0.0ml	0.0ml	0.0ml	1.0ml	2.0ml	0.2
	5	0.0ml	0.0ml	0.0ml	1.0ml	1.0ml	0.4
						Average Respiration Rate	0.16

Temperature		Vol. of CO2 - 2 mins	Vol. of CO2 - 4 mins	Vol. of CO2 - 6 mins	Vol. of CO2 - 8 mins	Vol. of CO2 - 10 mins	Average Respiration Rate(ml/min)
30	1	0.0ml	0.0ml	0.0ml	0.0ml	1.0ml	0.2
	2	1.0ml	1.0ml	1.0ml	2.0ml	2.0ml	1.4
	3	1.0ml	2.0ml	2.0ml	2.0ml	2.0ml	1.8
	4	1.0ml	1.0ml	1.0ml	2.0ml	2.0ml	1.4
	5	1.0ml	2.0ml	4.0ml	4.0ml	4.0ml	3
							1.56

Temperature		Vol. of CO2 - 2 mins	Vol. of CO2 - 4 mins	Vol. of CO2 - 6 mins	Vol. of CO2 - 8 mins	Vol. of CO2 - 10 mins	Average Respiration Rate(ml/min)
40	1	1.0ml	1.0ml	2.0ml	4.0ml	6.0ml	2.8
	2	2.0ml	2.0ml	3.0ml	5.0ml	7.0ml	3.8
	3	1.0ml	1.0ml	1.0ml	2.0ml	2.0ml	1.4
	4	1.0ml	1.0ml	3.0ml	3.0ml	11.0ml	1.6
	5	1.0ml	1.0ml	2.0ml	3.0ml	4.0ml	2.2
							2.36

Temperature		Vol. of CO2 - 2 mins	Vol. of CO2 - 4 mins	Vol. of CO2 - 6 mins	Vol. of CO2 - 8 mins	Vol. of CO2 - 10 mins	Average Respiration Rate(ml/min)
60	1	1.0ml	1.0ml	1.0ml	1.0ml	3.0ml	1.4

	2	1.0ml	1.0ml	1.0ml	1.0ml	1.0ml	1
	3	1.0ml	1.0ml	1.0ml	1.0ml	1.0ml	1
	4	1.0ml	1.0ml	1.0ml	1.0ml	1.0ml	1
	5	0.0ml	0.0ml	0.0ml	0.0ml	1.0ml	0.2
							0.92
Temperature		Vol. of CO2 - 2 mins	Vol. of CO2 - 4 mins	Vol. of CO2 - 6 mins	Vol. of CO2 - 8 mins	Vol. of CO2 - 10 mins	Average Respiration Rate(ml/min)
80	1	0.0ml	0.0ml	0.0ml	1.0ml	1.0ml	0.4
	2	0.0ml	0.0ml	0.0ml	0.0ml	1.0ml	0.2
	3	0.0ml	0.0ml	0.0ml	0.0ml	0.0ml	0
	4	0.0ml	0.0ml	0.0ml	0.0ml	0.0ml	0
	5	0.0ml	0.0ml	0.0ml	0.0ml	0.0ml	0
							0.12

Summarizing Raw Data:

Temperature	**Average Respiration Rate**
20	0.16
30	1.56
40	2.36
60	0.92
80	0.12

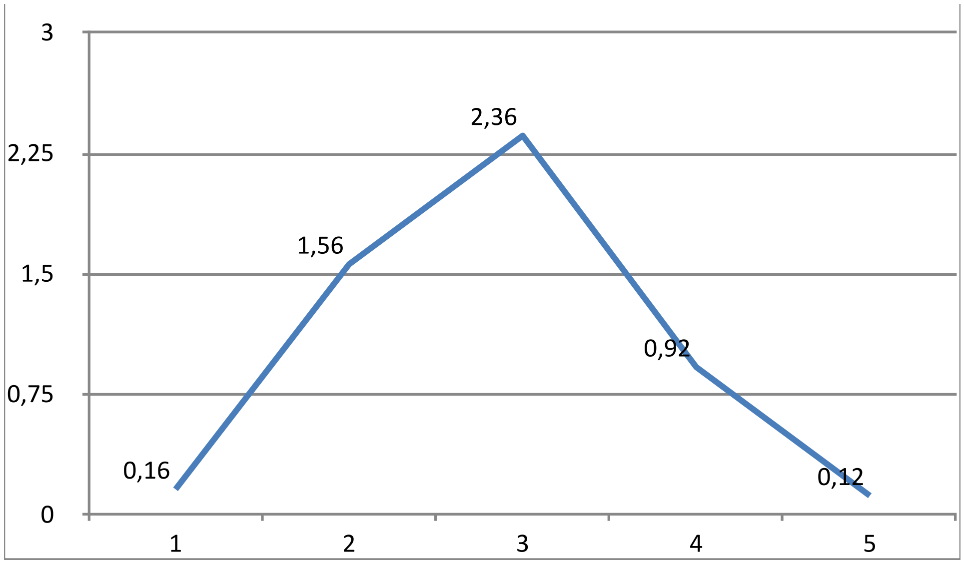


Fig 1. Line Graph Showing Relationship Between Temperature and Respiration Rate

Statistical Analysis:

Result Details & Calculation

X Values

$\sum = 230$

Mean = 46

$\sum(X - Mx)2 = SSx = 2320$

Y Values

$\sum = 5.12$

Mean = 1.024

$\sum(Y - My)2 = SSy = 3.647$

X and Y Combined

N = 5

$\sum(X - Mx)(Y - My) = -26.32$

R Calculation

$r = \sum((X - My)(Y - Mx)) / \sqrt{((SSx)(SSy))}$

$r = -26.32 / \sqrt{((2320)(3.647))} = -0.2861$

Meta Numerics (cross-check)

r = -0.2861

The value of R is -0.2861

Although technically a negative correlation, the relationship between both variables is only weak (nb. the nearer the value is to zero, the weaker the relationship).

Discussion and analysis:

Respiration Rate Trends:

Looking at the data, we can see that average respiration rates generally follow changes in temperature. The average respiration rate of the yeast is highest at 40°C (2.36), and lowest at 80°C (0.12). There may be a temperature range where yeast respiration is most efficient, yet there appears to be a drop in respiration rate at 60°C compared to 40°C.

Data show that the yeast respires at its greatest rate at 40°C. Optimal Temperature Range. This shows that the highest effective temperature range for yeast respiration exists. Beyond this point, respiration rates are lowered at both higher and lower temperatures. This is consistent with the theory that temperature affects enzyme activity and metabolic processes, with an ideal point and decreased activity at extreme temperatures.

Effect of Extreme Temperatures: Enzyme denaturation is probably to blame for the reduced respiration rate at 80°C. Enzymes' tertiary structures can be damaged by high temperatures, making them inactive. The precipitous decrease in respiration rate between 60°C and 80°C supports this.

association Coefficient: A modest negative linear association between temperature and respiration rate is shown by the negative correlation coefficient of -0.28. According to this coefficient, the rate of respiration tends to slightly decrease as temperature rises. The association is weak, indicating that other factors could possibly be having an impact on respiration rates.

Limitations:

- Sample Size: A limited sample size may have been utilised in the experiment, which might have exacerbated the unpredictability of the outcomes. Data that are more reliable and representative would come from a bigger sample size.
- Biological variety: There is some intrinsic biological variety in yeast populations. Even under the identical experimental circumstances, this could lead to variations in respiration rates.
- Fluctuations in temperature: It could be difficult to keep the experiment's temperature consistent. The reported respiration rates may be inconsistent due to temperature changes in the water bath.
- Substrate Availability: The substrate's (like glucose's) availability may not have been entirely under control. Respiration rates could be impacted by variations in substrate concentration.

- The experiment presupposes that the concentration of enzymes is constant, however this may not always be the case. Variations in enzyme concentrations may affect how an enzyme acts.
- The experiment did not take into account possible oxygen constraints at higher temperatures. At high temperatures, oxygen supply may become constrained, which might have an impact on respiration.

Considerations:

- Repetition: Performing the experiment several times and computing averages might assist to lessen the influence of random mistakes, improving the dependability of results.
- Statistical Analysis: Using the right statistical tests (such as the t-test or an ANOVA) might lead to more conclusive findings on the importance of variations in temperature.
- Control of Variables: Ensure that the experiment's controlled variables—like pH, incubation period, and yeast concentration—are genuinely constant.
- Recording Accuracy: Make sure that respiration rates are accurately recorded because even a small inaccuracy can have a big impact on the outcome.
- Investigate enzyme kinetics to gain a better understanding of how temperature influences enzyme activity, which has an impact on respiration rates.
- Comparative Studies: To have a better knowledge of how temperature affects yeast respiration, compare studies should be done with other parameters (such other yeast strains or substrates).
- Discussion of Anomalies: If any data points dramatically vary from predicted patterns, these anomalies should be examined in terms of their possible causes and how they may have affected the outcomes.

Conclusion:

In conclusion, this study investigated the effect of respiration rate in yeast, providing information on the complex interplay between temperature and metabolism Experimental results revealed a clear pattern : yeast respiration rates reflect normal temperatures, with average peak respiration rates recorded at about 40°C Essential for proper respiration.

The fact that respiration rates decline at suboptimal low and high temperatures indicates the sensitivity of enzymes to temperature changes resulting in enzymatic complexity and reduction in respiration rates due to loss of activity resulting from high temperature. Temperature and respiratory rate show a slightly negative linear relationship as measured by a negative correlation coefficient of -0.28.

The analysis took into consideration factors including biological variability, substrate accessibility, and experimental constraints. The precision of the results may have been impacted by constraints, but the broad patterns are consistent with recognised biological principles.

This study advances our knowledge of yeast metabolism while also shedding insight on the wider effects that temperature has on enzyme-catalyzed processes. The development of biofuels and other businesses that depend on ideal metabolic rates are two examples of where these findings are applicable.

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