Planning

Research

Yeast is a microorganism, and therefore is a living cell. Yeast cells require glucose to make energy. Yeast can break down and respire this glucose in the presence of oxygen, and in the absence of oxygen. This is called aerobic and anaerobic respiration.

Aerobic Respiration (with oxygen)

Glucose + Oxygen → carbon dioxide + Water

$C_6H_{12}O_6 + O_2 \rightarrow 6CO_2 + 6H_2O$

Anaerobic Respiration (without oxygen)

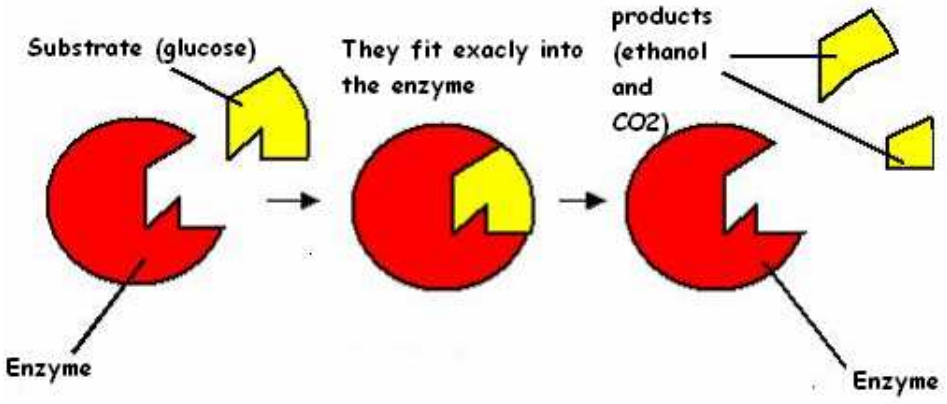
Glucose → methane + carbon dioxide

$C_6H_{12}O_6 \rightarrow 3CH_4 + 3CO_2$

As a culture of yeast is merged with solution of sugar, a reaction called fermentation occurs. Fermentation is chemical changes in organic substances produced by the action of enzymes. As products, ethanol and carbon dioxide are produced, in forms of liquid and gas. The rate of reaction can be illustrated by doing appropriate calculation involving the volume of gas produced.

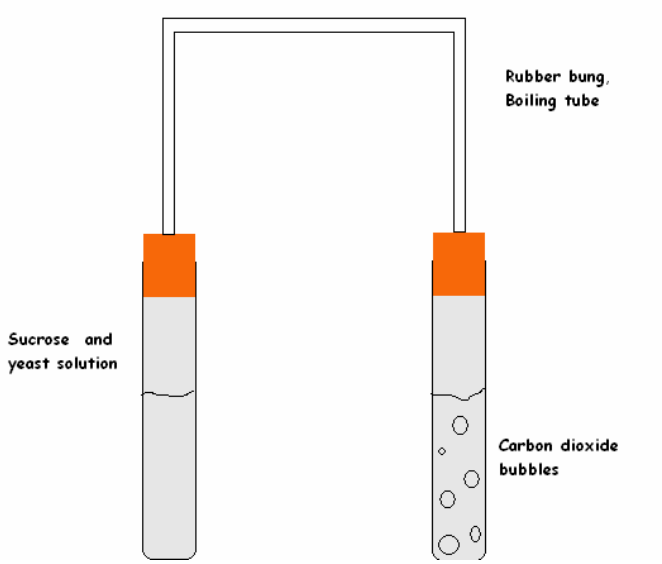
In order to react the glucose molecules need enough energy, known as the activation energy. Increasing the temperature increases the numbers of glucose molecules that have sufficient energy to react. Enzymes lower the activation energy needed for the reaction to occur.

Research by Ann Fullick shows that at a lower temperature there is very slow fermentation. This is because the glucose molecules haven't got very much kinetic energy and so are moving extremely slowly leading to a small amount of Carbon dioxide being made. As the temperature begins to increase the amount of carbon dioxide increases also. This is due to the lock and key mechanism. In the yeast enzyme there is an active site. This has a specific shape especially for use in fermentation. Only a glucose molecule is the right shape to be a substrate for the yeast enzyme active site. When the glucose molecule has enough kinetic energy it slots into the yeast enzymes active site (key fitting into lock). The reaction has then been catalysed and the products can't stay in the active site so they are released. These products are ethanol and carbon dioxide.



Aim

To investigate the affect of changing temperature on the amount of Carbon Dioxide created in the fermentation of yeast



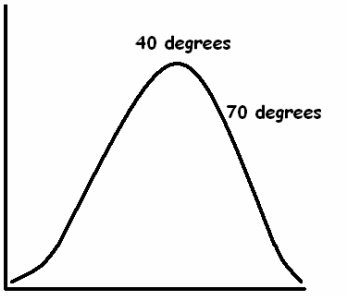
Apparatus

- Measuring tube
- Test tube rack
-Test tubes
- Water bath
- Stop Watch
- Kettle
- Thermometer
- Syringe
- Distilled water
- Bung
- 100cm^3 of water.
- 80cm^3 of sucrose and yeast.

Prediction

Studying my research the optimum temperature for the reaction is 40°C because it is the activation energy. The glucose molecules have enough kinetic energy to collide and lock onto the yeast enzymes active sites.

After 40°C some of the enzymes begin to denature (change shape) but not all at once. When they denature the glucose molecules can't lock onto the active sites anymore. At around 70°C all of the enzymes become denatured and the active sites have changed shape so no glucose molecules can lock on therefore there is no fermentation. This is a prediction of what my graph will look like.



Safety

To guarantee that my experiment will be done safely and accurately I will:

-Tie back all loose hair and clothing

-Make sure that the water bath is at an safe temperature, by using a thermometer, before letting it come into human contact

-Place all bags and chairs under desks to prevent any accident

-Handle all the glassware with caution

-Wear safety goggles at all times

-Leave an appropriate amount of space between each working group

The equipment used in this experiment is reasonable safe. However, care is needed in handling glassware, as they are easily broken.

Fair Test

To guarantee that the experiment is fair and that my results are trustworthy I will keep certain variables the same. These are my fixed variables. This will be the amount of yeast and water used. I will ensure this by measuring the yeast and water out with a syringe carefully each time. I will use the same equipment each time and make sure that the thermometer has restored to room temperature before using it again. Every repeat I will use fresh water and use new yeast and sucrose.

By keeping these things constant will ensure that the experiment is totally fair. I will repeat my experiment 3 times in order to obtain reliable and fair results. This is very important as the bubble counting may be unreliable as its counting by a person manually so by repeating the experiment will make the result more accurate. This will help me find the average, which will reduce the risk of anomalies.

Obtaining evidence

Method

For my investigation I will be altering the temperature of the yeast and sucrose is and observing how much carbon dioxide is released by counting the bubbles.

-I Put 80cm³ of yeast in a test tube and 80cm³ of sucrose in separate test tube.
-I heated 100cm³ of water to the temperature, which I was testing
-I put both the test tubes containing yeast and sucrose in the water and put thermometers in each of them, then I waited until they settled to the temperature I was testing.
-I Attached the two tubes together quickly to try and not let any gas escape, then observed the amount of bubbles produced and recorded my results every 10 seconds for 1 minute.
-I did this for 30°c, 40°c, 50°c, 60°c, 70°c, and 80°c.
-Then I repeated the experiment 3 times to ensure accurate and reliable results.

Results

Temperature (°C)	Reading 1 (Number of bubbles in 1 minute)	Reading 2 (Number of bubbles in 1 minute)	Reading 3 (Number of bubbles in 1 minute)	Average (Number of bubbles in 1 minute)
30	2	2	3	2
40	11	10	9	10
50	16	16	17	16
60	20	22	24	22
70	40	42	40	41
80	65	67	63	65

Number of Bubbles (3 Repeats)

Time (Seconds)

Temperature (°C)	10	20	30	40	50	60
30	1	1	1	1	2	2
40	2	4	6	8	9	10
50	5	8	11	14	15	16
60	4	7	11	15	18	22
70	11	21	29	34	38	42
80	22	39	47	53	60	67

Time (Seconds)

Temperature (°C)	10	20	30	40	50	60
30	1	1	1	2	2	2
40	1	3	5	8	9	11
50	8	10	13	15	16	16
60	10	14	15	17	20	20
70	18	26	30	33	37	40
80	22	34	44	50	62	65

Time (Seconds)

Temperature (°C)	10	20	30	40	50	60
30	1	1	2	2	2	3
40	2	4	6	8	9	9
50	4	6	8	13	15	17
60	7	9	14	17	20	24
70	14	21	29	34	38	40
80	20	34	40	53	58	63

Analysis

Analysis

These results do not comply with my prediction. I predicted that after 40°C the enzyme would start to denature and become less effective. However this was not the case, as the carbon dioxide bubbles kept increasing all the way up to 80°C in a strong positive correlation. However this is not a one off anomalies, as I repeated the experiment 3 times and took all safety and fair test precautions. From this experiment I could come to the conclusion that the higher the temperature the more carbon dioxide produced in fermentation. However, as this does not complied with my research I will try and find a reason why my experiment is unreliable. I believe that these results have occurred because the enzymes did not have enough time to denature, as I only carried out the experiment for 1 minute, and this is why they carried on producing carbon dioxide.

Conclusion

I believe the method I used was not unreliable, however I should have used a longer time scale to gave the enzymes time to denature. The results I obtained were accurate up to 50°C, however, after that they began to rise when I predicted that the carbon dioxide levels would fall, these were my anomalous results.

If I would repeat this experiment then I would have carried it on for a longer span of time to give the enzymes a chance to denature. I would have also used larger scale of temperatures so my results would be more reliable.

I do not believe that counting the bubbles was a reliable method, because sometimes the bubbles were being released too quickly to count all of them, and the size of the bubbles were not taken into consideration, only the amount of bubbles. I think to improve this you could use a gas syringe to measure the amount of gas produced or put a balloon over the neck of the bottle so you can visually see how much gas is produced. I also think in the higher temperatures some of the bubbles would not be carbon dioxide but because of the higher temperatures they could be from the heat. I believe the results could have been slightly off, by human errors, however if I was to repeat the experiment I would be more careful.

If I was to carry out more experiments I could use different concentrations of yeast, or use different pressures and temperatures. To conclude, I believe that I carried out the experiment well and completed my method accurately, fairly and safely. However the results I obtained were not as I predicted and as a result I would like to repeat the experiment with a longer time span, to give the enzymes time to denature at higher temperature.