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Biology Coursework SC1

Introduction to yeast

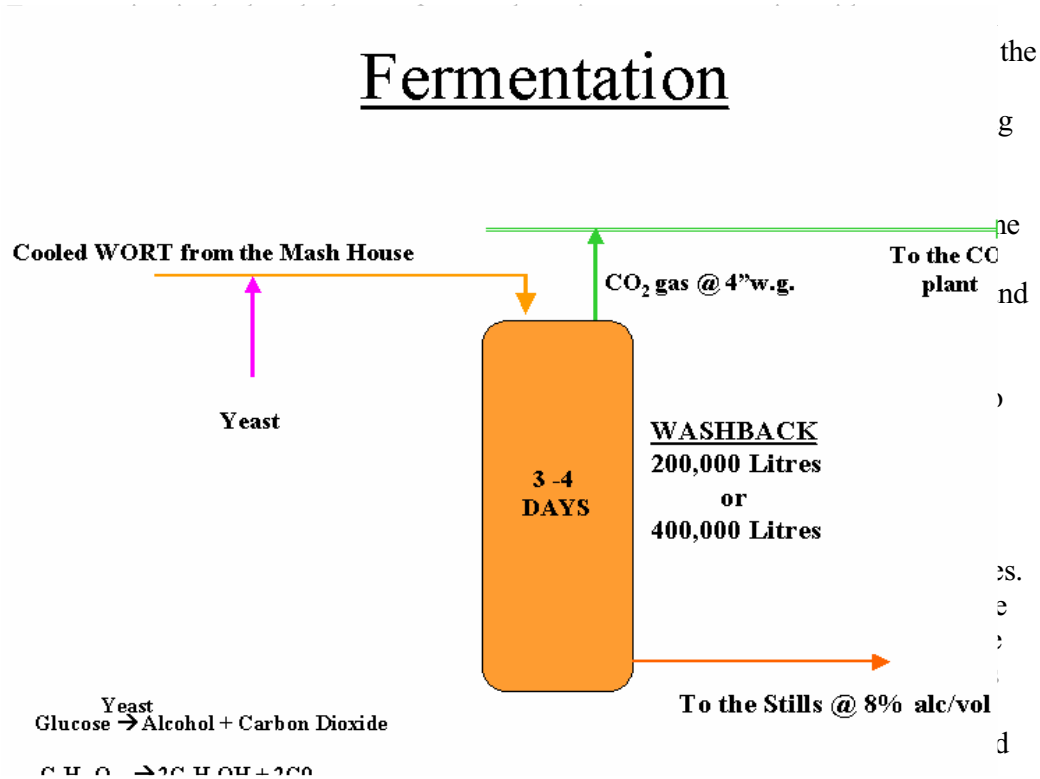
Yeast are unicellular fungi. It has been around for along time and has been involved in the making of bread, wine and other materials for man. Now yeast is used in many different industries for its fermentation properties. During this process in the industries the yeast is the waste product and is usually used for animal food or birdseeds. However the alcohol is the valuable product in the industry. Yeast has been a major material to man for a long time and is now a very expensive and profitable material for businesses and industries.

The yeast respires to produce energy. When it does respire it produces and needs products and waste products, these are shown in the word equation below. To control this reaction the yeast has an enzyme; this enzyme is called **zymase**. Enzymes are used to control the speed and the rate of the respiration in the yeast, it changes the rate and speed by the environmental surroundings it is put in.

glucose -----yeast---> ethanol + carbon dioxide + energy (210kj)

$C_6H_{12}O_6$ -----yeast---> $2C_2H_5OH$ + CO_2

The reaction shown above is also called Fermentation. Fermentation is used in the brewing industry and the picture below shows how they ferment the sugar (glucose) in the yeast to make alcohol.



how different ways can create a different result.

Variables

The respirations of yeast has many different factors that it needs to respire properly, which means that different atmospheres and surroundings will affect the way in which it respires. This could mean that the respiration could be accelerated, slowed down, vary in speed and also stop the respiration from occurring at all.

1. A variable of this experiment that I think will be the biggest factor is the temperature of which the experiment is carried out in. I think that this is the biggest variable, as the cells that are used in this process need energy to respire. The cells get this energy from the temperature that they are in. If it is a warm temperature the cells will have more energy and will be able respire quickly but if the cells are in a cold environment the energy that they will have will be smaller. This would make them respire slower and less efficiently.

2. The amount of yeast that we use in the experiment will also affect the speed of how quickly it will respire. The less we use the quicker it will respire this is because there are less cells in the yeast that have to respire and this would quicken the experiment. However if we used large amounts of yeast then the respiration of the yeast would slow down, as there is more cells which would take longer to respire the amount used. We have to be very accurate in measuring the yeast as this could create odd results and an unfair test.

3. The amount of water in the suspension around the outside of the yeast can affect the way respiration takes place. The water in the suspension could differ respiration results because the water is there to keep the temperature of the yeast constant. However if you used different amounts of water then smaller amounts would not be able to keep the yeast covered at the same temperature for as long as larger amounts of water.

4. Amount of glucose in the yeast is also I think a big factor to the respiration levels. This could affect the yeast a lot as glucose is needed for the respiration reaction to take place and without it respiration would be impossible. More glu cose in the yeast I think would make it a quicker reaction, as there is a bigger amount of material to use for the reaction to take place.

5. The amount of time that we leave the yeast in the suspension for is a possible variable, which could affect the yeast. This is because of the water that we leave to keep the yeast at certain temperatures. This water would eventually get colder and loose its heat making the yeast go down in temperature and affect the results. Also the yeast itself could have an affect on the time we leave it as well. This would because the cells that are in the yeast may have all respired after a certain time making our results suddenly drop because all of the respiring of the yeast we used would have been done.

6. The surroundings of this experiment may also be a variable on the yeast. The light that we put it in may be a variable that could affect the respiration of yeast. The light affects animal cells and especially plant cells so light could also affect the rate that

yeast respires. I think that the more light there is the quicker that the yeast will respire this is because plant cells respire quicker when more sunlight is on them and they struggle to respire in the dark where there is no sunlight.

7. The last possible variable that I thought of is the pH levels of the water in the suspension surround the outside of the yeast. This could affect the yeast just like the temperature of the water. I think that this is because yeast only respires best at certain levels and environments and acidity and alkali being one of these environmental surroundings, which could affect yeast.

I looked at all the variables that I have thought would change the way that the yeast will respire and react to. I finally decided to choose the temperature as my variable this is because I think that the temperature of the water in the suspension will be the biggest factor. I also chose this because I think the temperature will change the way yeast respires the quickest but also the biggest so that when I find my results it will show up clearly that the yeast has reacted to its environment.

Prediction

I have chosen to change the temperature of the water in the suspension. I know that an enzyme called zymase controls the yeast respiration reaction. The zymase in the yeast needs certain conditions to make the reaction possible; this reaction is shown in a word equation below.

Glucose -----yeast---> ethanol + carbon dioxide + energy (210kj)

$C_6H_{12}O_6$ -----yeast---> $2C_2H_5OH$ + CO_2

In my prediction of this experiment I think that the temperature is going to have the biggest affect on the zymase and I think this because of the theory of denaturation of an enzyme. The diagram below shows how an enzyme should work. This is also the lock and key theory, the lock being the enzyme and the reactant being the key.

This shows how the reactant enters the enzyme and how the enzyme is used to break down certain reactants in this reaction. Although this diagram shows that the enzyme is breaking up the reactant other enzymes are specifically made to make the reactants bigger and not smaller.

This diagram below shows an enzyme once it has been denatured. It shows how the enzyme can not properly create the reaction inside of the active site anymore. This is because the enzyme has been affected by certain environmental surrounding changes. The enzyme can now not work under any condition cause it has been affected by conditions that it could not live in.

I think that this denaturing theory will occur in our experiment as we are looking at the affects of temperature changes. If the enzymes can not live in certain temperatures then it will denature the enzymes, which will then affect the rate of fermentation and will stop the reactants producing alcohol, carbon dioxide and energy. Through information that I have researched before doing the experiment I think that the enzymes will denature somewhere between 40 and 50 degrees.

Another theory, which I predict will affect the rate of respiration in the yeast, is the collision theory. Below is a diagram showing how the collision theory works.

For a reaction to take place the particles in the reactants must collide together. This will then create a chemical reaction. An if the collisions cause a chemical change this is known as a fruitful collision. Meaning that a new product has been made by the collision of atoms, molecules or particles. The collision theory basically states that the more collisions between the two different particles the faster the reaction.

So from this I predict that the hotter the temperature the yeast suspension is in then the more energy that the particles will have to move around with. This will make the two reactants in the yeast collide more making the chemical reaction in yeast a quicker process. However even though I predicted that the zymase will denature around 40 to 50 degrees I think that the collision theory shows that the hotter it is the faster the rate of fermentation.

A further prediction that I shall make is what I think the results graph will look like after the experiment. Taking in the denaturing and collision theory I predict that the graph will look like this.

The graph that I have drawn shows a prediction that I have made for my results. As you can see from the graph I think that the results will show a pattern. I predict that the low temperatures that we investigate will produce small amounts of bubbles

because I predict that the enzymes will denature in cold temperatures. The middle temperatures that we will investigate I think will produce the most bubbles, as I predict that this will be around the perfect temperature for an enzyme to work in. The higher temperatures I predict will also denature the enzyme and will only produce small amounts of bubbles.

Method

To do this experiment we had to plan our investigation out; we did this by doing a practise run on our first day. This was to ensure that we could obtain good results, doing a test run through would show us any falls that we could put right in the test before we actually started.

Our apparatus were set up like the diagram on the other page. We set up our apparatus like this for specific reasons. The tin foil that we wrapped around the beaker containing the heated water was put in place so that the water would not loose as much heat as it would without insulation. We wanted to keep our test fair and to do this we needed the tin foil to keep the water at the same temperature so that the enzymes in the yeast were not constantly changing in different environments, as this would have given us in accurate results.

The water in the beaker was measured at a certain temperature. These were the temperatures that we tested the yeast in. We tested the yeast in water surroundings at 50, 45, 40, 35 and 30 degrees C. We did this buy boiling a kettle containing water. We kept the kettle away from our apparatus as well as ourselves because spillages could have ruined our results but could have also caused a safety hazard and we could burn ourselves. So keeping the kettle away was a safety measure as well. We measured the water in to the beaker and our measurement was 250ml. However to get the right temperatures because the kettle had boiled the water we had to add cold water and take some of the hot water out to get it to our temperatures which we were going to test.

The test tube that we set up was to be laid in the heated water in the beaker. In the test tube we had 20ml of yeast. We also had a bung with a glass rod going through it. Putting the bung into place on the test tube created a vacuum. This meant that if we put tap water into the top of the glass rod that it would stay in the glass rod and would not fall into the yeast in the test tube. This would then be used to obtain our results. Our results were to count the bubbles that came up through the test tube. This would indicate that a gas was being produced and the number of bubbles that came up the glass rod would indicate at what rate was the gas being produced.

Once we had used our first set of apparatus to measure the rate at which yeast respires we then repeated our experiment for each temperature to ensure that our results would be accurate. This also brought up any floors in the experiment and our results.

After we had repeated our experiment with the beaker and test tube apparatus we then changed our apparatus and we used the Ganongs Respirometer. This is a more accurate measuring instrument. Using this instrument would provide us more accurate results. To use the Ganongs Respirometer we had to set it up as the diagram is shown below.

We used the Ganongs Respirometer by placing the yeast into the cylinder beaker and we put that into the beaker with water at the desired temperature that we were going to measure. To get our results we simply needed to put the bong in to the top of the cylinder beaker. We then monitored our results using the measuring cylinders on each side of the Ganongs Respirometer.

The Ganongs Respirometer works, as the water in the measuring cylinders is a salt solution. When carbon dioxide goes in to the tubes with this solution the solution does not dissolve therefore the more carbon dioxide that goes in one end the more the salt solution will be pushed up in the other end. Using this we can measure how much carbon dioxide in cm^3 has been produced. This is a more accurate way of measuring the respiration of the yeast as you can see clearer at what temperatures the enzyme zymase works better in.

During this experiment we had to make sure that we were safe from anything that could hurt us in this experiment. The boiling kettle would have be one of these. This is why we kept it as far away as possible. We also wore safety goggles to protect our eyes just in case anything did jump out of the experiment, which could have caused damage to our eyes. To make sure that the equipment was safe we placed the experiment on a sturdy surface such as a table and we also watched the experiment and kept people away so that nothing could affect the experiment but also because the equipment could have been knocked and broke.

To keep the experiment fair we needed to measure the yeast the same time each time because if we added more or less this could speed or slow down the respiration and affect our results. We had to keep the beaker rapped in tin foil so that the temperature would stay as close as possible to the temperature that we were measuring. The tin foil acts as an insulator and keeps the heat inside the water.

The Ganongs Respirometer however was a harder apparatus to keep fair. This is because the apparatus is extremely sensitive and if someone walked passed it would move the salt solution up and down. This was hard to try and stop happening but we kept this experiment as fair as possible. We had to take the same procedure as the other experiment above with keeping the water and yeast fair.

Results

Table of Results

1. Beaker and test tube experiment

Temperature ^{o}C	***Bubbles counted***	***Time (minutes)***

50	17 41 65	1 2 3
45	48 83 117	1 2 3
40	26 46 80	1 2 3
35	25 48 72	1 2 3
30	16 34 52	1 2 3

2. Ganongs Respirometer

Temperature ^{o}C	***Carbon Dioxide content measurement cm^3***	***Time (minutes)***
50	0.2 0.2 0.2	1 2 3
45	1.1 2.5 4.8	1 2 3
40	1.4 2.2 2.6	1 2 3
35	0.3 0.7 1.3	1 2 3
30	0.2 0.6 1.0	1 2 3

Graph of results

Averages

1. Beaker and test tube experiment

For 50^{o}C the average amount of bubbles was 41
For 45^{o}C the average amount of bubbles was 82.6
For 40^{o}C the average amount of bubbles was 50.6
For 35^{o}C the average amount of bubbles was 48.3
For 30^{o}C the average amount of bubbles was 34

2. The Ganongs Respirometer experiment

For 50^{o}C the average amount of carbon dioxide present was 0.2 cm^3
For 45^{o}C the average amount of carbon dioxide present was 2.8 cm^3
For 40^{o}C the average amount of carbon dioxide present was 2.06 cm^3
For 35^{o}C the average amount of carbon dioxide present was 0.76 cm^3
For 30^{o}C the average amount of carbon dioxide present was 0.6 cm^3

Conclusion

I found that the results that are shown above tell me that the temperature has an affect on the rate of respiration. This is clearly shown in my graph. As you can see from the graph the low temperatures (30^{o}C and 35^{o}C) both resulted in low bubbles for the beaker and test tube experiment. However a steep increase is shown between 30oC and 45^{o}C. This tells me that the yeast needs hotter environments to let its enzyme, zymase, and work properly. At 45^{o}C we received the highest reading for the beaker

and test tube experiment. After this reading it then made a steep decline down to 65 bubbles at 50°C this shows that my prediction that I made before was correct. My prediction graph also shows some similarity between the real results and itself. I think that the last result proves the theory of the denaturing of the enzyme is true. I think that this is what has happened at the temperature of 50°C as suddenly the amount of bubbles produced suddenly drops down. You can also from the table of results that the other temperatures apart from 50°C all have bigger gaps between minutes where the carbon dioxide produced is speeding up, However the bubbles for the last result in the table shows smaller gaps between minutes showing that it is taking longer to produce the carbon dioxide in the respiration process. The averages of the results for the beaker and test tube experiment show 50°C has one of the lowest averages. However 30°C has the lowest average in this experiment. This could also be showing that the enzyme has denatured at low temperatures as well as high temperatures. This indicates that 45°C is the best temperature for the enzyme to work in. The graph shows this as well as averages and table of results. The collision theory prediction I made earlier as well also has made an appearance in my results. As the temperature rises the more energy the cells have the more they will collide into each other creating more chemical reactions. The only problem with this prediction that I made earlier is that 50°C is the highest temperature but it shows the least amount of results. This is because of the enzyme denaturing, so the theory does work to a certain extent in this experiment however does not work once the enzyme has denatured.

For the Ganongs Respirometer, we made more accurate readings that gave us amounts of carbon dioxide produced. This also follows the same pattern as the other experiment on the graph. You can see that the lines are similar. They show that the carbon dioxide made in the respiring of yeast is small at low temperatures and high at 45°C. The results from the Ganongs Respirometer also show that the denaturing of the enzyme at 50°C proves correct. Using this experiment though you can see more clearer that the enzyme has been denatured as the level of carbon dioxide stays they same through out the 3 minutes we tested it, you can see this from the averages and the table of results.

Overall through both experiments my predictions have been mostly correct. My prediction graph that I made also does show the same pattern that the results graph made but the curve on my prediction graph should have been a lot sharper. This is because of the major decrease after the enzyme has been denatured.

The rate of respiration in yeast has proven to be affected by the temperature changes in the suspension. This has been proven in the Ganongs Respirometer and the test tube and beaker experiments, which both came out with the same results and showed patterns and similarities between them.

Evaluation

The experiments that I have done have both proven to show accurate and predicted results. Although I have received accurate results there are some changes that I would have made throughout the experiment which could have changed our results and made them slightly more accurate.

In the beaker and test tube experiment our results seemed to be accurate. However

when we did the experiment the first time round we had anomalous results. The first time round we had results that showed us that 50°C seemed to be the best temperature for the enzyme, zymase to respire the yeast the quickest. When we did the experiment again though we received results that showed us that 45°C was the quickest temperature to respire yeast in. This shows that our experiment for the beaker and test tube apparatus seemed to be a bit in accurate. As we received different results completely, we then left this apparatus and moved on to the next one which throughout both run experiments showed us that 45°C was the quickest temperature zymase could work in. This is why we compared our results with the test tube and beaker apparatus and decided that our second run through was correct and not our first run through. This could have been a mistake that we had made, because the Ganongs Respirometer is so accurate in results the beaker and test tube could have been giving us results but only to a certain accuracy.

The beaker that contained the warm water also was unfair in this experiment even though we did try and insulate it with tin foil the water still lost heat. By the time the 3 minutes were up the temperature had dropped about 4 or 5 °C. This was unfair because we wanted to measure the temperature at exactly what we had decided. If I did the experiment again I would find someway in which the heat would not have been lost, maybe if we had kept the apparatus in a oven at the same temperature that we wanted to measure, this would have kept the whole apparatus at the right temperature and we would not have lost as much heat or energy.
The Ganongs Respirometer apparatus was a lot more accurate. However like I mentioned in the method, a major problem we had with this apparatus was reading the results. This was because the table was being knocked as people walked past making the salt solution jump up and down making it harder to read the results at the correct times. The temperature was also a problem with this apparatus as it had dropped by the time we had finished the experiment as it did in the beaker and test tube apparatus. I would probably try to change this experiment and put it in an oven at the right temperature like I mentioned above.

Overall I would have made changes to both the experiment. One of these changes would have been the time that we measured the rate of respiration for. If I did this experiment again I would increase the time that we measure it for, I think this because I would want to investigate further if the temperature that the yeast was in was the easiest one for it respire in for long periods of time. However this would have made it harder as well because the water in the beaker would have gradually lost more and more heat and if we measured the experiment for 10 minutes it may have dropped about 15°C. Doing the experiment like this would have also been very time consuming because we would want to go through the experiment twice to check for any anomalous results.

In both experiments I would have also tried to change the amount of water in the beaker. As we poured the boiling water in from the kettle we measured it however when we dropped the temperature by adding cold water the measured amount increase, and decreased when we poured water out. So we ended up with a measurement nothing like the one we had made at the start of the test with the kettle. I think that this is a flaw in the experiment as it could have changed our results slightly and made them more fair as well.

The experiments that I have done I think have obtained accurate results and have also concluded most points made in my prediction.