Fermentation Essay, Research Paper

Aims

Aim 1

To find out what factors affect how quickly bread dough rises.

There are a number of factors that affect how quickly bread dough rises. These are:

·Amount of sugar-if the amount of sugar is increased, the rate of reaction will increase. Adding a higher concentration of sugar will increase the sugar particles in a given space. As the mixture is heated, the sugar particles will begin to move. Due to a lack of space, this would result in collisions. Thus the rate of reaction would increase, resulting in the bread dough rising quickly.

·Concentration of yeast- if more yeast is added; the quicker the bread dough rises. Yeast contains an enzyme known as zymase. As the quantity of the yeast is increased, the enzyme would increase. As more zymase’ are present, would result in more enzymes available for reaction. After these active sites are filled, only then would a reaction would take place. If less yeast is added bread dough would not rise- unleavened bread.

·Quantity of flour- if proportion of flour to yeast is greater, then the reaction would slow down. This is because zymase is very important because it is in the active sites of the zymase where the reaction would take place.

·Temperature-if the temperature is too high, the enzymes die, but if the temperature is too low, then the enzymes react more slowly. Particles move faster when heated which would result in two things:

(a)Particles travel greater distance, resulting in more collisions.

(b)Particles moving faster-large proportion of collisions will exceed activation energy, concluding in an increase in the rate of reaction.

·pH level-yeast starts growing at pH3 and die at pH9. The value in which the growth is highest is at pH6. So by keeping the pH level at six, the rate of reaction would increase. I will investigate the effect of temperature on the bread dough rising. Aim 2

To find out what affect temperature has on how quickly the bread dough rises.

Increasing the temperature increases the rate of reaction. It is a fact that a rise of 10 degrees would approximately double the rate of reaction. When the particles are heated, they begin to move faster. If the particles move fast enough and in the right direction, then a reaction would take place. In order to do this the particles must collide. For a reaction to take place, the activation energy must be reached. This is known as the Collision Theory. Introduction

Fermentation is the process of yeast, which converts sugars (glucose) into carbon dioxide and alcohol. The general formula for this is: Glucose Ethanol + Carbon Dioxide

C6H12O6 2C2H5O + 2CO2 Fermentation is a type of anaerobic respiration. Yeast contains single- celled organisms that can respire aerobically. After yeast is combined with sugar, it begins to respire. This reaction produces carbon dioxide, water and energy. So the equation so far is:

Glucose + Oxygen Carbon Dioxide + Water + Energy

C6H12O6 + 6O2 6CO2 + 6H2O + 2900kj When all the oxygen is used up, the yeast keeps on respiring. The glucose is used up. Due to a lack of oxygen, the products produced are carbon dioxide and ethanol. Therefore the overall process for fermentation is: Glucose Carbon Dioxide + Ethanol + Energy

C6H12O6 2CO2 + 2C2H5OH + 84kj There is more energy in the anaerobic reaction because the energy that the yeast needs from glucose is locked up in the ethanol. After the concentration of ethanol reaches 12%, the yeast is killed and fermentation stops.

Ethanol is produced when ethene is mixed with steam and passed over a phosphoric acid catalyst at 300ºC. Ethanol is a very important solvent. It can be used as ink, glues, paints, perfume etc. The reactions of ethanol are:

·Combustion- ethanol ignited in oxygen or air. The products are carbon dioxide and water.

·Dehydration of ethanol- could be used by passing ethanol vapour over heated aluminium oxide or using concentrated sulphuric acid:

Ethanol Ethane + Water

C2H5OH C2H4 + H2O

·Reaction with Sodium- produces hydrogen gas.

·Oxidation- when ethanol comes in contact with air, it is oxidized by oxygen. Resulting in ethanoic acid. The Lock & Key Theory

Emil Fischer originated the lock and key theory in 1894. It states that it takes the correct key to open a lock. It takes a correct enzyme to bond to the substrate and catalyse its reaction. An active site of an enzyme is made up of a binding site and a catalytic site.

This theory had some bad points and was not correct so in 1958, Koshland said that the shape of an active site of an enzyme does not have to be the same type of the substrate. This was called the Induced Fit Theory.

The Collision Theory

In order for a reaction to take place, the reacting substances must collide and energy, called the activation energy, must be reached. If the collision between the particles can produce a lot of energy, then a reaction can take place. For the collision to take place, the particles must collide fast enough and in the right direction. The higher the number of collisions, the faster the rate of reaction. Increasing the temperature of the substrate can increase the number of collisions.

Kinetic Theory

The kinetic theory is a theory, which emphasises on pressure, volume and temperature. It states that gases contain particles that are always moving. Gases then exert pressure because their particles are colliding with the wall of the container. If the volume of the gas is decreased, then the particles would hit the wall more often and the pressure would increase.

When a lump of dough, which contains air and carbon dioxide, is heated in the oven, the volumes of the gases increase, resulting in the bread rising. This process can be shown by this word equation: Increase in temperature Volume increases (Gas expands) This is because as the temperature of the gas increases, the particles get more energy. This causes the particles to move faster and collide with each other and the walls of the container. If the gas cannot expand, the pressure would increase. If the pressure is kept constant while the temperature is increased, then the gas will expand. Prediction

I predict that as the temperature increases, the dough will rise more quickly. The effect of the temperature upon the rate of reaction can be predicted by using the collision theory. The theory states that the molecules of glucose must break its bonds to form atoms of carbon dioxide, hydrogen and oxygen and then rejoin to form molecules of ethanol (carbon dioxide, oxygen and hydrogen) and carbon dioxide. However, before the atoms of carbon dioxide, hydrogen and oxygen join together, they must collide with each other. A fixed amount of energy must be reached if the products are to form. If the collisions produce enough energy (collide fast and in the right direction) a reaction would take place. Not all collisions would result in a reaction.

I predict that increasing the temperature would speed up the reaction. This is because when the mixture of glucose and yeast is heated, the molecules would gain energy and move faster and travel a greater distance, which would result in more collisions. Also, the particles are moving faster therefore a large proportion of the collisions would exceed the activation energy, thus speeding the rate of reaction.

I also predict that by doubling the concentration of zymase would double the reaction. Increasing the concentration means that there are more enzymes in a given space, therefore more active sites would be available for a reaction to take place in. Larger quantities of the substrate would enter the active sites, resulting in an increased rate of reaction. I predict that the dough would rise the most at 40ºc because the enzymes consist of protein which work best at body temperature. If the temperature is too high, then the enzymes will not be able to hold the reactant and eventually burst. We say that the enzyme will ‘denature’. At low temperature, the enzymes would be inactivated so the reaction would not take place. I think that 40âC would be the ‘optimum temperature’ because I believe that the reaction would show maximum catalytic activity at that temperature. ApparatusBeakerMeasuring Measuring

cylinder (small)cylinder (large)Filter paperSafety matStirring rod

StopwatchThermometer Bunsen burner10g flour2.5g sugar20cm of yeastWeighing scales Diagram

Method 1.Weigh out 2.5 grams of sugar onto filter paper. Add to beaker.

2.Weigh out 10 grams of flour onto filter paper. Add to beaker.

3.Measure 20cm of yeast in a small measuring cylinder. Stir and add to beaker.

4.Freeze mixture to 0âC.

5.Stir dough and add to the bottom of the large measuring cylinder, making sure it does not touch the sides.

6.Note volume of mixture at zero minutes and then record volumes of mixture every one-minute for twenty minutes.

7.Repeat experiment three times.

8.Change temperature of the mixture to 20âC and do experiment three times.

9.Change temperature of mixture to 40âC and do experiment three times.

10.Change temperature of mixture to 60âC and do experiment three times.

11.Change temperature of mixture to 80âC and do experiment three times.

12.Change temperature of the mixture to 100âC and do experiment three times.

13.Put away equipment. Safety

·Wear safety goggles.

·Be careful of hot water.

·Use safety mat.

·Handle hot beaker with care.

·Beware of cold water. Fair Testing

·Increased temperature of mixture by 20âC each time to get good range of results.

·Measured volume of mixture every minute from zero to twenty minutes to get good range of results.

·Did each experiment three times to get average volume of mixture.

·Measured sugar, flour and yeast to two decimal places to get exact quantity.

·Measured sugar, flour and yeast on weighing scales.

·Made sure yeast did not touch sides of beaker-volume of mixture would decrease.

·Measured temperature accurately.

·Used small and large measuring cylinder.

·Recorded results after every one minute to get good range of results.â

Conclusion Conclusion of the average volume of the mixture/cm to the time taken to measure it at 0âC.

At the beginning, the volume of the mixture goes up less than 1cm. It then remains constant throughout the experiment. This is because the enzymes are inactivated at this low temperature. The particles are moving very slowly. Thus they are not colliding resulting in no or little reaction. Conclusion of the average volume of the mixture/cm to the time taken to measure it at 20âC.

The reaction takes place, but it is very slow. The volume of the mixture is increasing very slowly. In my experiment, the process does not halt. I believe that after 20 minutes, the process would reach it’s maximum and therefore the volume of the mixture would remain constant. The particles are moving but not very fast. The reaction is taking place but because the particles are not moving very fast, they are not colliding that often, resulting in little reaction. Conclusion of the average volume of the mixture/cm to the time taken to measure it at 40âC.

The process increases slowly at the beginning but then vastly after 10 minutes. The process does not stop but continues throughout the experiment. I believe that this temperature is ideal for the enzymes because 40âC is roughly body temperature. It is a fact that enzymes work best at body temperature. The particles are moving fast and are colliding. The enzymes are also working because they are surrounded in their best working temperature-body temperature. This is because the enzymes consist of proteins, which work best at body temperature. Conclusion of the average volume of the mixture/cm to the time taken to measure it at 60âC.

The volume of the mixture increases a lot at the beginning at increased nearly 10cm after 5 minutes. The process then becomes very slow. This is because the particles are moving very fast, but the enzymes are slowly denaturing. As the enzymes denature, there will be no active sites for the reaction to happen in. Thus little reaction would take place. Conclusion of the average volume of the mixture/cm to the time taken to measure it at 80âC.

The reaction increases rapidly at the beginning and then slows down after 7 minutes. The reaction is greatest at the beginning because the carbon dioxide and air in the dough expands, which causes the volume of the mixture to increase and also, a high amount of activation energy is being reached. The collisions are happening but the enzymes begin to denature. The reaction begins to slow down after 7 minutes because after 7 minutes, the yeast has reaches 80âC. Here, the enzymes slowly die.

The graph shows that at 80âC, the volume of the yeast increases the most. I think that this is not correct because the enzymes should have denatured after 40âC. I believe that if I had done the experiment for another 20 minutes, I would have seen that the optimum temperature would have been at 40âC. Also, I would have seen the volume of the mixture at 80âC slowly stop increasing due to the enzymes denaturing.

Conclusion of the average volume of the mixture/cm to the time taken to measure it at 100âC.

The rate of reaction starts to increase until 5 minutes. The volumes, again expands after 9 minutes. After 9 minutes, the reaction has reached its maximum and has come to a halt. At this point, the ethanol levels have reached 12%. This kills the yeast and fermentation stops. Also, after 9 minutes, the mixture has reached 100âC and therefore, stopped. This is because the enzymes have denatured. Conclusion of graph showing effect of temperature on the initial rate of reaction.

The graph shows that the optimum temperature for the initial rate of reaction was 60âC. The shaded area shows that even if you increase the temperature after 60âC, this would not have an effect on the rate of reaction. It is because the yeast has been killed due to the ethanol reaching 12% and also because the enzymes have been denatured. General Conclusion

In my prediction, I stated that as the temperature is increased, the dough would rise quicker. This was correct because if you take the volume of the mixture at 0âC and at 100âC, you would see that the volume of the mixture increased more at 100âC than at 0âC. I also predicted that at 40âC, the reaction would be greatest. My results do not prove this but my graph shows that if more time was give, the volume of the mixture at 80âC would stop, due to the enzymes denaturing and the yeast being killed. The volume of the mixture at 40âC would overtake the volume of the mixture at 80âC and therefore be the optimum temperature. My other prediction was that by doubling the concentration of yeast would double the reaction. I could not prove this because the concentration of the yeast was constant.

Evaluation I believe that the experiment went fairly well. I measured the volume of the mixture after every one minute for twenty minutes. I then repeated the experiment until I had three results for every minute at each temperature. By increasing the temperature by 20âC resulted in me having a good range of results.

I think that the result of the volume of the mixture at 80âC was inaccurate because when I done the experiment at that specific temperature, I left the mixture for a few minutes before starting to measure the volume of the mixture. This let the temperature of the mixture cool down which had a vast effect on my results. The other reason could be that the concentration of the yeast added was different to those at the other temperatures. I think that if I had done the experiment for another twenty minutes, I would have seen that the optimum temperature for this experiment would have been 40âC. All the results show that at the beginning, when the yeast was added to the mixture of flour and glucose, it quickly starts to respire.

To make this experiment even more accurate, I think that the volume of the mixture should be measured for forty minutes. Due to a lack of time, I could not do this but in the future, I would be glad to do this experiment again and measure the volume of the mixture for forty minutes. Also I could have measured the volume of the mixture to three or maybe four decimal places. To do this, you need the correct apparatus, which I did not have. In the future, I would like to measure the pH of the mixture because it is a fact that enzymes work best at a pH of six. Alternatively, I could vary the concentration of the sugar, flour or yeast to see what effect this has on the rate of reaction. By including vast amounts of oxygen, would have increased the pressure on the particles and move them closer together. This would lead to more collisions and an increase in the rate of reaction.