

The effect of substrate on the rate of respiration on yeast essay sample

[Science](#), [Chemistry](#)



In order to determine the effect of the substrate on the rate of respiration of yeast, Durham test tube method was used in the first experiment. In this method two test tubes were obtained, where test tube one contains distilled H₂O with the 7 ml substrate glucose while test tube two contains distilled H₂O and with the cofactor in the form of Magnesium sulphate MgSO₄. Both tubes have 7 ml 10% yeast suspension. The height of the area filled with gas was measured, after thirty minutes the test tube containing the cofactor MgSO₄ revealed the higher amount of carbon dioxide evolved, which is one of the products of cellular respiration. Thus, it was accepted that "If a coenzyme, such as MgSO₄, helps during catalyst, then coenzymes affect the rate of cellular respiration".

In the second experiment, Smith fermentation tube method was used to test "If the nature of substrates makes cellular respiration in yeast faster or slower, then the simpler the sugar, the quicker the rate of respiration in yeast will be". The height of the area filled by the carbon dioxide for each Smith fermentation tube was measured. After 30 minutes, tube 4 (glucose substrate) showed the fastest formation of carbon dioxide which was the effect of the rate of respiration in yeast, followed by tube 5 (fructose substrate) then by tube 3 (sucrose substrate) then tube 2 (lactose substrate) and lastly tube 1 (starch substrate) that had no CO₂ formation. Among these substrates glucose is the simplest sugar while starch is the most complex, this validates that our hypothesis is true.

INTRODUCTION

To obtain energy needed to live, cells must undergo in the process called

respiration. Cellular respiration is a sequential metabolic reactions important to all living cells. Respiration produces energy from sugars in the form of ATP or adenine triphosphate which is the basic energy currency of the cells.

There are two kinds of cellular respiration it can be aerobic where oxygen is needed and anaerobic where the presence of oxygen is not needed. Though some cells produce ATP using both aerobic and anaerobic respiration (Lagunzad, 2004). One example would be muscle cells, they usually implement aerobic pathway but when these cells do not receive enough oxygen, which can occur in a stressful event such as exercise, i. e. heavy lifting, muscle cells use anaerobic respiration as a last resort. Basically all living things require basic sugars to accomplish respiration. In yeast, anaerobic respiration takes place, can also be called as fermentation, this produces ethanol and carbon dioxide as its products (Campbell, 2012).

Anaerobic respiration (fermentation) has two types. Lactic acid fermentation is the first type, in which molecules of glucose are transformed into lactate that speeds up the reaction by lactate dehydrogenase (Campbell, 2012).

Alcohol fermentation is the latter type, in which molecules of pyruvate are transformed into ethanol by first releasing carbon dioxide which is then transformed into acetaldehyde, in which NADH reduces it, producing ethanol.

Yeast is a facultative anaerobe, in other words it can do aerobic respiration when the environment permits it to, but can respire anaerobically when the environment lacks oxygen. Yeast produce and release digestive proteins also known as enzymes into their surroundings where sugar molecules are present (Reece, Urry, Cain, Wasserman, Minorsky and Jackson, 2011).

Complex sugar then break down into simpler form (monosaccharide) before it can be absorbed by yeast which will then produce energy and carbon dioxide as its waste (product of breaking down of glucose) Sugars can be group into three classifications. (1)

Monosaccharide, simplest sugar, the building block of all carbohydrates. (2)

Disaccharide, formed when two molecules of monosaccharide bonds via glycosidic bond. And lastly (3) polysaccharides, formed by linking together of many monosaccharides. It can be then hypothesized that “ If the nature of substrates makes cellular respiration in yeast faster or slower, then the simpler the sugar, the quicker the rate of respiration in yeast will be”

Cellular respiration can speed up by enzymes. Coenzymes, usually metal ions, are chemicals that can support enzymes during catalysis of reactions. In the smith fermentation tube experiment, coenzyme Magnesium sulphate was used. Two sets were arranged with one having the coenzymes and the other without acting as the control. Since it is known that respiration has a waste product of carbon dioxide, and can be observe by measuring the volume of the gas evolved it can be then tested that “ If a coenzyme, such as $MgSO_4$, helps during catalyst, then coenzymes affect the rate of cellular respiration” The specific objectives of the study were

1. To observe the rate of cellular respiration in anaerobic (fermentation);
2. to enumerate factors that can affect cellular respiration;
3. to test the hypotheses using Durham tube method and Smith tube method;
- and 4. to determine the effects of these factors

MATERIALS AND METHODS

In determining the effect of coenzyme on the rate of respiration in yeast, Durham tube method was used. Two test tubes were obtained. On test tube 1 contained 7 ml of distilled H₂O with 7 ml glucose. On the other hand test tube 2 contained 7 ml glucose and 7 ml 0.2 Moles of Magnesium sulphate (MgSO₄). Both of test tubes were poured 7 ml 10% yeast suspension and shaken the mixture gently. An inverted Durham tube was slide down into each of the test tubes. To remove air bubbles in the inverted Durham tube, the test tube's bigger opening was covered securely with the palm of one hand and let the bubbles escaped from the tube by tilting the test tube from side to side. Pasteur pipette was used to remove excess suspension that covers the tip of the inverted Durham tube. This was done to measure the carbon dioxide trapped at the bottom of the inverted tube. The bigger openings of the tubes were plugged using cotton balls. The height of the area occupied by the CO₂ inside the inverted tube was measured for every 5 minutes for 30 minutes. The following formula was used.

Volume = $\pi r^2 h$ whereas: $\pi = 3.1416$,

r^2 = radius of the Durham tube in cm

h = height of the area occupied by the CO₂ in cm

To determine the effect of the nature of substrates on the rate of cellular respiration, Smith fermentation tube method was obtained. Five of these tubes were used. Each tubes was labelled from tube 1 to tube 5 and contains 15 ml of the following solutions at 10% concentration were poured to the respective tubes: 1 - starch, 2 - lactose, 3 - sucrose, 4 - glucose, 5 -

fructose. After, add 15 ml distilled H₂O and 15 ml 10% yeast suspension to each tube. The mixtures were shaken gently. To remove trapped bubbles, cover the opening with one palm of the hand and tilt the tube horizontally. The openings of the tube were covered with cotton balls. It was then tied at their vertical arms to keep them upright. The height of the area occupied by the CO₂ evolved was measured in cm every five minutes for thirty minutes. The volume of the gas evolved and its rate of CO₂ formation was computed and the results were tabulated. The rate of respiration in yeast for each tube was then determined using the formula: Rate of Respiration = Final Volume of CO₂

30 minutes

RESULTS AND DISCUSSIONS

Table 1 and Figure 1 showed the height (cm) of the area and volume occupied by the CO₂ evolved inside the Durham tube measured every five minutes for thirty minutes. Results showed that after thirty minutes Tube 2 containing MgSO₄ as its coenzyme/cofactor yielded more carbon dioxide than distilled water. Based on these results the hypothesis “ If a coenzyme, such as MgSO₄, helps during catalyst, then coenzymes affect the rate of cellular respiration” was confirmed and proven correct.

Table 1. Height of the area and volume occupied by the CO₂ that evolved inside the inverted tube (in cm) measured every 5 minutes for 30 minutes

Figure 1. Line Graph of the area occupied by CO₂ in Distilled H₂O (test tube 1) and MgSO₄ (test tube) inside the inverted tube measure every five minutes for thirty minutes

In experiment two, table 2 and figure 2 here shows the result in determining the effect of the nature of substrates on the rate of cellular respiration in yeast. Starch and Lactose in Tube 1 and Tube 2 respectively showed that there is almost no CO₂ build up, meaning that fermentation in yeast almost didn't happen at all. Sucrose in Tube 3 and Fructose in Tube 5 both yielded 0.11 cm³ of CO₂, while Glucose yielded the highest CO₂ with 0.23 cm³.

Table 2. Height of the area occupied by the CO₂ that evolved inside the smith fermentation tube (in cm) measured every 5 minutes for 30 minutes

Figure 2. Line graph of the height of the area occupied by the CO₂ that evolved inside the smith fermentation tube (in cm) measured every 5 minutes for 30 minutes

As can be seen in Figure 2, Glucose had the highest volume of CO₂ build up while the lowest is Starch followed by Lactose. Let us see the structures and natures of each of the substrates that were tested. The group categorized the substrates into whether they are monosaccharide, disaccharide or polysaccharide. Starch belongs to the polysaccharide group, which explains it why it doesn't have any CO₂ build up because of its complexity, it would take a long time before it can be converted into simpler substances and thirty minutes is just not enough. Sucrose and Lactose belong to the disaccharide group, lactose, a milk sugar, needed to be hydrolysed first to

become an effective substrate. And sucrose composed of two glucose sugars that's why it would took some time to become simpler sugar. Glucose and fructose, was the simplest sugar of them all, they belong to the monosaccharide group. And when the simpler the substance the faster the build of CO₂. Thus proving our hypotheses that " If the nature of substrates makes cellular respiration in yeast faster or slower, then the simpler the sugar, the quicker the rate of respiration in yeast will be"

SUMMARY AND CONCLUSION

In the experiment conducted using the Durham tube method we determined the effect of the coenzymes/cofactors on the rate of cellular respiration in yeast. The group prepared a two set of Durham tube where one set contained distilled H₂O as its cofactor, and the other set contained the cofactor Magnesium ion in the form of MgSO₄ Magnesium SO₄. The results were true to what the expected result would be. The one that the cofactor MgSO₄ has produced more carbon dioxide than the other one. Since it is known that when carbon dioxide is produced, cellular respiration happened. In this case it happened in a faster rate than the first set of tube. We therefore infer that cofactors support the enzymes and speed up the process in cellular respiration.

In the second experiment where Smith fermentation tube method was used, we determined the effect of different natures of substrates on the rate of cellular respiration. Five tubes were obtained containing starch in tube 1, lactose in tube 2, sucrose in tube 3, glucose in tube 4, and fructose in tube 5.

Their yielded carbon dioxide were measured and obtained 0 cm³, 0. 01 cm³, 0. 23 cm³, and 0. 11 cm³ respectively. Starch did not produced any CO₂, and seconded by lactose. Next high CO₂ yielder were both sucrose and fructose, while Glucose obtained the most CO₂ produced.

This was because of their molecular structure, glucose is the easiest to break down since it is the simplest substrate, it the resulted to higher CO₂ yields than the others, while on the other hand starch, the most complicated sugar of them all, did not undergo cellular respiration. Though this experiment was said to be successful, the group thought that more thorough test and experiment should be carried out to test its validity. It is recommended that other microorganisms other than yeast should be tried under the same procedure if applicable. Nevertheless it was proved that the hypothesis “ If the nature of substrates makes cellular respiration in yeast faster or slower, then the simpler the sugar, the quicker the rate of respiration in yeast will be” was true and valid.

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