Science Coursework: **Fermentation**

How does the sugar level affect the rate of Fermentation?

Aim:
The aim of this experiment is to find out whether the rate of Fermentation is affected by the amount of sugar.

Apparatus:
The equipment used is:

- Bunsen burner.
- Heat proof mat.
- Boiling tube.
- Delivery tube.
- Water bath.
- Water flask.
- Thermometer.
- Stop watch.
- Yeast and Sugar.
- Digital weighing scale.
- Water.
- Measuring cylinder.
- Test tube.
- Tripod

Method:

- Fill the water bath with water (not to the maximum).
- Fill the boiling tube with 10ml of water.
- Add 2g of yeast to the water and add sugar (1g, 2g, …up to 5g).
- Put the Boiling tube into the water bath.
- Connect a delivery tube onto the boiling tube.
- Fill a test tube with a reasonable amount of water.
- Place the other end of the delivery tube into the test tube.
- Put the Bunsen burner on a heatproof mat.
- Place the water bath on the tripod and heat the water.
- Measure the temperature of the water (in the water bath) with the thermometer. Stop the heating until it reaches 40°.
- Start the stop watch after the first bubble has appeared in the test tube.
- Count the bubbles that appear in 1 minute then stop the stopwatch.
- Repeat the process but this time adding another gram of sugar until 5 grams.
- Then repeat the whole experiment again starting from 1g to ensure the reliability of the results obtained.

Planning a fair test:

The factor chosen is the concentration of sugar solution, so the other factors are to be kept constant as control factors in order to make this investigation fair. Here are the control conditions and other procedures I must take. I should make sure that the test tubes are thoroughly washed each time I repeat the experiment. This is because remains of yeast or sugar could affect the results. I must use the stopwatch rather than counting or guessing the time so that I do not count the wrong number of bubbles. The yeast which I will use is to come from the same source so they are at the same age otherwise, bubbles might not appear as frequently as they should because of difference in freshness of yeast. The level of water in the boiling tube must always be exactly 10 ml otherwise; the concentration of the yeast and sugar mixture might increase of decrease depending on the amount of water added which will affect the number of bubbles. The mixture should be gently shaken to blend the solution and the culture together, as the culture tends to settle at the bottom over a certain time. The whole experiment should be repeated again to obtain a more accurate result and to calculate an average result. A thermometer must be always used when heating the mixture and is to be made sure that the temperature of the mixture in the boiling tube is at 40° so that there is enough energy and the enzymes do not denature and slow down the experiment. I must make sure that the Fermentation lock is not damaged so that it allows the escape of CO2 gas without the entry of oxygen, which could oxidize the ethanol produced. All these procedures must be taken into account in order to produce precise and reliable evidence. The variables that can be changed are the amount of yeast, amount of sugar and the temperature of each reaction. The only variable that will change is the amount of sugar as it goes up by 1 gram each time. The temperature shall remain at 40° degrees and the amount of yeast will always be 2g.

Safety precaution:

The equipments used in this experiment are quite safe. However, care is needed in handling glassware, as they are easily broken. I will use a heat proof mat so that the table doesn't catch fire.

Prediction:

Theoretically, the higher the amount of sugar, the faster Fermentation should happen. The GCSE chemistry revision guide states that yeast contains an enzyme which converts sugar into Carbon dioxide and alcohol (ethanol). So, if we add more sugar, the yeast will have more to work on. In a brief summary, the more sugar added, the quicker Fermentation should happen.

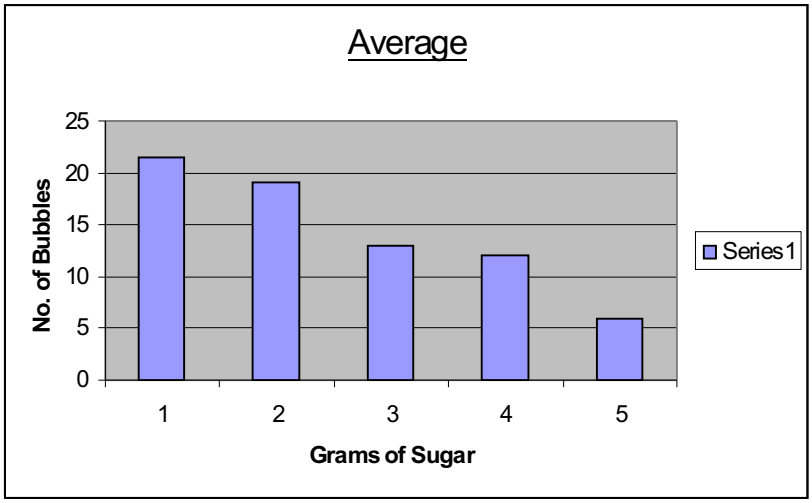
I have tried to use the equipment with precision and skill as much as possible in order to obtain and record reliable data. Here are my results:

	(First Time)	*(Second Time)*	
Amount of Sugar (g):	**Bubbles per Minute:**	**Bubbles per Minute:**	**Average:**
1	20 Bubbles	23 Bubbles	21.5
2	19 Bubbles	19 Bubbles	19
3	6 Bubbles	20 Bubbles	13
4	10 Bubbles	9 Bubbles	14.5
5	7 Bubbles	5 Bubbles	6

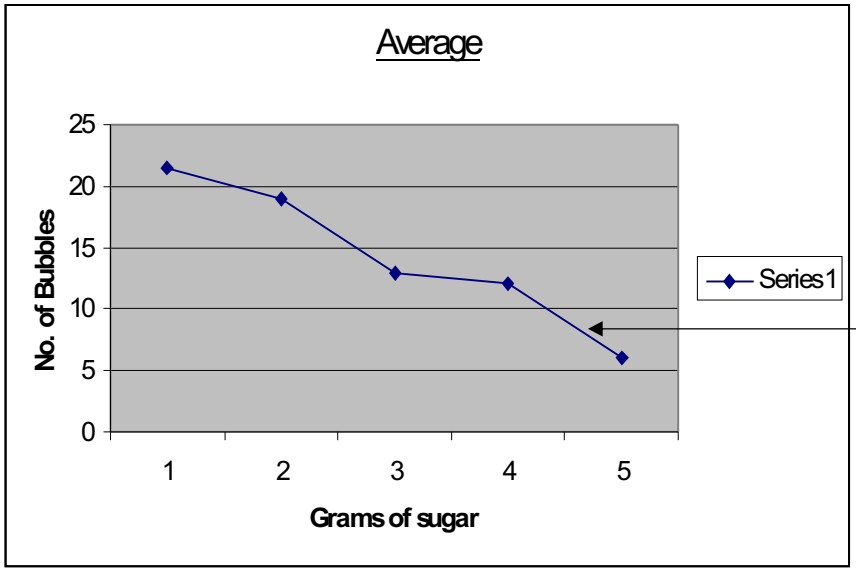
Results:

I have constructed a bar graph and a line graph to represent the data. The information can now be interpreted in 2 different ways.

Bar chart:

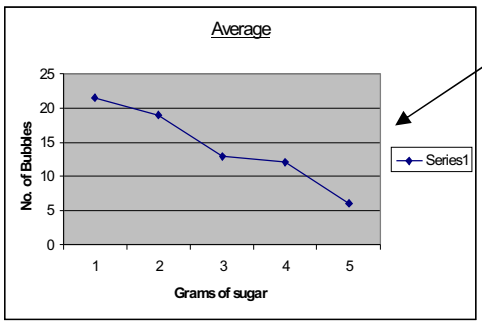


Line graph:



Conclusion:

The results obtained are sufficient for the conclusion to be drawn about this topic. As they are plotted on to the graph, they are more or less on the same lines of accuracy - there is no anomalous result obtained.



As the grams of sugar went up, the number of bubbles went down. This shows that the more sugar you add, the slower the rate of Fermentation.

This conclusion has opposed my prediction. I predicted that the more sugar you add, the more bubbles that appear (the higher the rate of Fermentation). The reason that the rate of Fermentation is decreased as more sugar is added is because if there is too much sugar in the mixture, some of the enzymes in the yeast (zymase) gradually die. Jams sugar levels are very high which kills any enzymes that allow reactions to occur. This is why Jam takes a very long time to mould

Evaluating Evidence:

The results obtained were fairly reliable. No anomalous results were obtained confirming precision. I think that the evidence which I have collected is sufficient enough to support a firm conclusion. I think that further work could have been useful to propose improvements i.e. repeat the experiment 3 times rather than twice. I could have also used a Digital Thermometer in order to obtain more accurate measurements. The procedure which I took was reasonably suitable. This is because the results obtained were seemingly precise and consistent. For the matters concerning the accuracy of the experiment's layout, there are several inaccuracies - which some can be improved; some cannot.

-Carbon dioxide gas is soluble in water; some is not included in the results.

- Intoxication by ethanol, some yeast cells may be intoxicated and die.

-The tubes have to be lifted out of the water bath to take measurements - the environmental temperature could have affected the rate of Fermentation every time measurements are taken.

If a further investigation is to be carried out, the temperature of the environment and the types of the sugar used are the interesting fields to head forth towards.

Background information about Fermentation:

Fermentation is a biological process involving the breakdown of sugars by bacteria and yeast using a method of respiration without oxygen (anaerobic respiration). It involves a culture of yeast and a solution of sugar, producing ethanol and carbon dioxide with the aid of the enzymes. This process can be slowed down by denaturing of the enzymes at a certain temperature. As products, ethanol and carbon dioxide are produced, in form of liquid and gas respectively. The reaction follows this equation:

Glucose solution + Yeast (zymase) $\longrightarrow$ Carbon dioxide + Ethanol + (Energy)

$$C_6H_{12}O_6 (aq) \rightarrow 2C_2H_5OH (aq) + 2CO_2 (g)$$

Fermentation is also used for bread-making. The reaction that occurs in bread making is exactly the same as that in brewing. When bread is put in the oven, the yeast is killed and the reaction stops.

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