Investigation to see the effect of temperature on the expansion of dough

Prediction: The higher the temperature the faster and higher the volume of dough will rise.

Method

1. 25g of flour was weighed and put into a beaker. A level teaspoon of sugar was then added.
2. 30cm of yeast suspension was measured in a 50cm measuring cylinder and was added to the flour and sugar. This was then stirred with a spatula until a smooth paste was achieved.
3. The paste was poured into a 250cm measuring cylinder, making sure it did not touch the sides.
4. The volume was recorded and the measuring cylinder was placed into a water bath. The water baths' temperature was recorded and the volume of the paste was recorded every 2 minutes for about half an hour.
5. A graph was plotted showing how the volume of dough increased with time. On the same graph, the results for the same experiment but with water baths at different temperatures were plotted, so that there were three graphs on one piece of graph paper.

Results

Time in minutes	Temp of WB: 22 c Volume (cm)	Temp of WB: 33 c Volume (cm)	Temp of WB: 37 c Volume (cm)
0	46	48	44
2	48	49	46
4	48	49	46
6	48	49	46
8	48	50	48
10	48	50	51
12	49	54	56
14	50	58	60
16	51	62	64
18	53	66	68
20	55	70	70
22	57	74	79
24	60	78	84
26	62	82	88
28	64	86	93
30	66	90	100

The results were then plotted on the graph, shown on the next page

Key	
Water bath Temperature at	
Water bath Temperature at	
Water bath Temperature at	

The colours were used so that the plots were not mixed up.

Analysis

The graph shows the rise in volumes of dough for each water bath. You can see that the dough in the water bath with the temperature of 22 c rises steadily to a volume of 66cm. Compared to the dough in the water bath with a temperature of 37 c which rises moderately to a volume of 100cm. This can also be seen by the line of best fit. Straight away you can see that the volume of dough in the water bath with the highest temperature 37 c raises the most to 100cm, and the volume of dough in the water bath with the lowest temperature of 22 c only rises to 66cm. From the graph you can draw the conclusion that the higher the temperature the higher the volume of dough rises. From the table you can draw the conclusion that at the point of 14minutes the dough at the highest temperature had risen the fastest. Both support the prediction that the higher the temperature, the faster and higher the dough rises.

All the plots at the beginning of the graph for each temperature do not go up evenly, as they are not in line with the line of best fit. The plots for the temperature of 33 c start off steadily and then rise evenly with a space of 4cm between each two minutes starting from 10minutes.This may have something to do with the insulator being made of glass. However, this even rise in volume may suggest something about the temperature at which dough can rise steadily and evenly, but to be able to draw a conclusion about the temperature at which dough should rise, we have to know how dough rises.

Bread is basically flour and water mixed together and cooked. When yeast is added it gives a way of raising the dough, giving it a lighter, softer texture. In the method above, you can see that the dough was made with yeast suspension and sugar; this gives the yeast substrate for it to respire. Flour was also added and the mixture was mixed, just like kneading when making bread, to make sure the yeast was evenly spread out through the dough. The yeast grows and respires, producing carbon dioxide which makes the dough rise.

Yeast contains single celled organisms that can respire aerobically, breaking down sugar to provide energy for the cells and producing water and carbon dioxide as waste products. This aerobic respiration shows that the yeasts cells are using the oxygen from the air. This reaction is summed as follows:

Glucose + Oxygen → Carbon Dioxide + Water (+ energy)

However, when all the oxygen is used up yeast keeps on respiring. This is when the yeast cells break down sugar in the absence of oxygen they produce ethanol and carbon dioxide. This reaction is summed up as follows:

Glucose → Carbon Dioxide + Ethanol + Energy

Aerobic respiration is necessary because it provides more energy than anaerobic. It is needed so that the yeast cells can grow and reproduce. However, when the yeast cells have reached a sufficient number they can survive for a considerable amount of time in low oxygen conditions, such as the oven, and will break down the available sugar to produce ethanol. Fermentation is the anaerobic respiration of yeast. After the concentration of ethanol has reached 12%, the yeast cells are killed and fermentation stops.

Increasing the temperature speeds up the reaction. The molecules gain more energy and move faster and travel at greater distances, which results in more collisions. This refers to the collision theory that in order for a reaction to take place there must be substances to collide. For collision to take place the particles must collide fast enough but in the right direction. Therefore, the higher the number of collisions means the faster the rate of reaction. So by increasing the temperature will therefore increase the number of collisions.

This explains how the yeast has risen in the experiment. The temperature allows the yeast cells to collide. This results in a reaction producing carbon dioxide so the dough expands. The higher the temperature, the obvious more carbon dioxide will be produced as the result of a faster reaction and making the dough rise higher. The water bath with the temperature of 22 c shows that the reaction has taken place slower. The particles are not colliding very fast and so the reaction is taking place slower than usual. All this supports my prediction, and my results came out the way I expected. The volume of dough in the water bath with the highest temperature rose the highest and fastest.

<u>Evaluation</u>

The method that was done was successful in backing up my prediction. However it was not successful in giving perfect results. One error in the experiment was that the tubes in which the dough was placed in varied in material.

The first and third water baths had plastic tubes in, but the second one used glass. This was not fair as glass could have verified the results, and could explain why the results evened out in the end. Glass is a better conductor of heat and so this could have allowed the heat to get to the dough slowly, and then reach the water baths temperature. Compared to plastic which is not a good conductor of heat and so that is why the results were not evenly spread towards the end of the 30 minutes.

Another fault is that the volumes of dough to start off with were at different levels; however that did not seem to disclaim the prediction. If the dough levels were the same to start of with then the results would have started from the same place on the graph, this would allow a fair conclusion to be drawn. Also when concocting the experiment the dough had to be poured carefully so that it did not touch the sides, otherwise when reading the tube it would distort the results. All these reasons could have explained why the results are not straightforward at the beginning.

The reason for the uneven differences in temperature at the beginning could have been due to the fact that the material had not yet conducted all the heat for the dough to rise. This would mean that each material worked at different speeds, causing the temperature of dough to rise at different speeds and heights.

From the graph you cannot really say that there were any anomalous results because that is already explained as above, due the time taken for the material to conduct the heat.

The method does not seem to have any major faults, so does not really need improving in the sense of actually doing the experiment. However, if this experiment was to be done again the measuring cylinders would have to be made of the same material, and must have an even amount of dough to start off with. Also the time span in which the dough was recorded could be longer, for example forty minutes. This could be used to see whether the dough reaches a certain level and stops rising after a certain number of minutes at a certain temperature. Also by adding another water bath with a higher temperature, we could observe how fast the dough rises compared to it at 37 c.

To further the investigation, some factors could be changed to see the effect on how dough rises but not only with temperature.

- Add more yeast suspension but keep the others the same. This is because then the dough will rise quicker, as the enzyme in yeast known as zymase would be more, available for a faster reaction.
- More sugar could be added. This would also increase the rate at which the collisions take place, and the reactions, causing the dough to rise quickly.
- The quantity of flour. If there is more flour than yeast then the reaction slows down, so the flour has to preferably be in proportion to the yeast.
- Temperatures cannot be too high, otherwise the enzymes will die, and they cannot be too low otherwise they would react more slowly.

- The pH level was not considered for this experiment, but in a future experiment the pH level is best at pH6. This is recommended level for the yeast enzymes to grow, and by keeping the level at six, the rate of reaction would increase.
- The oxygen that the yeast can reach could be increased and would mean a faster reaction.

All these factors could be changed but not at the same time to make it a fair test. This would lead to more collisions and an increase in rate of reaction, exploring other factors that may cause dough to expand.