Osmosis Investigation Coursework

Aim: To investigate the effect of varying concentration of a certain sugar solution on the amount of osmotic activity between the solution and a potato chip of a given size.

Osmosis is a special type of diffusion. Diffusion involves gas or dissolved molecules, but osmosis only involves the movement of water molecules. Osmosis occurs across a semi-permeable membrane, which has tiny holes in it.

Osmosis is defined as the movement of water or any other liquid molecules from a region in which they are highly concentrated to a region in which they are less concentrated. This is called diffusion. This movement must take place across a semi permeable membrane such as a cell wall, which lets small molecules such as water through but not bigger molecules. The molecules will continue to diffuse until the area in which the molecules are found is stable.

Hypothesis: my hypothesis is that as you increase the concentrations of the sugar solution, both the mass and length of the potato chip will decrease, therefore decreasing the amount of osmosis activity.

Equipment

Potato chips – I needed a food that had a semi-permeable membrane to allow the sugar concentrations pass through. Potato is the perfect semi-permeable food to make the experiment reliable.

Sugar Solution – the experiment is based around these solutions. I have gone from just H2O (water) up to a 0.5 sugar solution in increments of 0.1. These small increments will give me accurate results and it will be easier to spot a relationship.

Potato Chip Cutter – this is a slim, solid metal tube, approximately 5-6 cm long, which can penetrate the potato at any angle and take a rounded piece of potato out. This is a much more accurate way of getting the chip out of the potato as it smoothly cuts it, without any jagged or inaccurate edges or faces.

Metal Rod – this will be used to push the chip cleanly out of the tube. It leaves no holes or marks and will not deform the potato chip.

Knife – I will use a small, sharp knife to cut the chip to 20 mm, this is my chosen length of all the potato chips.

Standard 30cm ruler – to measure the length of the potato chips I will use a ruler, which has a 300-millimetre scale. This will make my judgments of the measurements very accurate. I would prefer to use a ruler with even smaller increments, such as, tenths of millimetres, this will enable my judgments to be even more accurate.

Test tubes – I will use in all, 15 test tubes in order to hold the potato chips and the solutions. Test tubes are perfect as they are clear and big enough to fit the small chips in.

Measuring cylinder – I will use a measuring cylinder in order to measure each solution for each test tube, and I will measure each solution at 15ml. The cylinder will enable me to make an accurate and reliable judgment on the measurements of the solution.

Scales – I am going to use electric scales in order to measure each potato chip with accuracy. The scales I am using are very accurate and measure the chip to at least 2 d.p.

Variables:

In order to make my test an accurate and reliable one, I will need to keep everything the same throughout the experiment, however one variable will be changed. I have chosen to vary the concentration of the sugar solution. This will vary my results, therefore making it easier and more reliable to make a clear conclusion on my results. Any sort of precautions has to be kept the same otherwise it could disturb any pattern on my results and therefore giving me a false interpretation on the experiment. For instance if one of the potato chips was any longer than the others it could alter the results, as osmosis would occur more in a longer chip.

- I am going to do all the experiments at room temperature.

- I am going to use the same potato, roughly all the same size, and without being washed or peeled.

- The mass of the potato is a dependent variable, and this means that it will be measured throughout the experiment. I will measure the mass in grams. The potato chip will be measured before it is put in the solution, and after. This will allow me to see whether osmosis has occurred.

- The amount of solution will be kept the same because all the potato chips are the same size.

- I am also going to use the same balance to weigh my potato chips. If I use another scale during this experiment it could change my results and therefore disturbing the results.

Method:

1. I took 4-5 average sized ground potatoes and checked that they were both healthy and hard.

2. Using a potato cutter and ruler I cut the potato into chips, which were 20mm long. I had to be very careful whilst cutting the potato, as the knife is exceptionally sharp. I then had 15 chips.

3. Taking a test tube rack I placed 15 test tubes and then labelled them H2O, 0.1, 0.2, 0.3, 0.4 and 0.5. These labels were the sugar solutions.

4. I then weighed every potato chip on an electronic balance and recorded the weights.

5. Using a measuring cylinder I measured out 15ml of each solution and then poured the solution into the corresponding test tubes. I used each solution 3 times to make my results more accurate and reliable.

6. I swiftly put 1 potato chip into each test tube and then started my stopwatch. 3 chips were used for every solution to create an average, which gave me a better set of results and more accurate graphs.

7. Whilst waiting I set out some paper towels with which I was going to dry the paper and I drew up a basic table for my results.

8. After 20 minutes I drained out the solutions in the sink and placed all the chips on the paper towel in the order I had put them in the test tubes as to not confuse myself as to which chip came from which solution.

9. I dried each chip with the paper towel and then placed each one on the scales so that I could weigh them.

10. Each potato was measured accurately on the electronic scales and then the weights were recorded.

11. I then measured the length of each potato chip again with the ruler.

Each measurement was to 2 d.p, this gave me very accurate results and I was then able to make clear and justifiable judgments.

To make the results even more reliable I measure each concentration 3 times. This would give me a lot of averages to work with, therefore giving me more accurate results. I could then put these accurate results into graphs.

There is only one major safety hazard that I have taken into consideration: the use of the sharp knife could cause a major accident and should be taken as a serious issue.

During this experiment there could be some sources of errors, for instance the temperature of the room could alter the results, encase this does happen I have made sure that the experiment and the results are taken place on the same day and in the same hour. This would make sure that my results would be accurate to a reasonable degree of accuracy. Also, if my hands were either wet or not cleaned it could contaminate the equipment, especially the potatoes, as it could contribute to the water absorption by the potato.

	Solution	Before		After		Change in Mass		Change in Length	
1									
2		Mass (g)	Length (mm)	Mass (g)	Length (mm)	(g)	(%)	(mm)	(%)
3	H2O	1	3.2	20	3.23	21	0.03	0.93	1	5
4		2	3.37	20	3.49	22	0.12	3.5	2	10
5		3	2.79	20	2.88	20	-0.09	3.2	0	0
6	0.1	1	3.28	20	3.27	22	-0.01	-0.3	2	10
7		2	3.25	20	3.2	22	-0.05	-1.5	2	10
8		3	3.14	20	3.09	20	-0.06	-1.9	0	0
9	0.2	1	3.14	20	3	20	-0.14	-4.46	0	0
10		2	3.2	20	3.04	21	-0.16	-5	1	5
11		3	3.12	20	2.94	20	-0.18	-5.77	0	0
12	0.3	1	3.23	20	2.84	21	-0.39	-12.07	1	5
13		2	3.18	20	2.78	20	-0.4	-12.58	0	0
14		3	3.07	20	2.68	19	-0.39	-12.7	-1	-5
15	0.4	1	3.18	20	2.51	19	-0.67	-21.07	-1	-5
16		2	2.84	20	2.19	18	-0.65	-22.89	-2	-10
17		3	3.29	20	2.6	19	-0.69	-20.97	-1	-5
18	0.5	1	3.33	20	2.54	17	-0.79	-23.92	-3	-15
19		2	3.21	20	2.36	19	-0.85	-26.48	-1	-5
20		3	3.1	20	2.35	19	-0.75	-24.19	-1	-5
21									

I have decided to shade in any outliers or disturbed results on my table in red. This would enable me to notice these outliers and therefore take action. If I were to leave them I could draw up an unreliable graph and a wrong conclusion.

I decided to not include these outliers during my mean averages in the change in mass and change in length. I can now continue my judgments and draw up a more accurate graph.

I could have repeated the experiment to change the outliers to possible candidates for my averages and graphs, however it was too late and the conditions surrounding the experiment could have changed, for example the temperature of the room. I didn't want to risk doing this, as I could have just ended up with even more outliers than before. So I think my decision was the correct decision to make my experiment more accurate.

C	D	E	F	G	H	I	J
Mean % Change in Mass (g)				Mean % Change in Length (mm)			
H2O		2.54%		H2O		5%	
0.1		-1.23%		0.1		6.66%	
0.2		-5.07%		0.2		1.66%	
0.3		-2.45%		0.3		0.00%	
0.4		-21.64%		0.4		-6.66%	
0.5		-23.96%		0.5		-8.33%	

From these mean averages you can clearly see that as the sugar concentration is increased the length and the mass decreases, clearly stating that the higher the concentration of sugar molecules the lower amount of osmotic activity.

Evaluation

The experiment was very successful in my opinion. I obtained accurate and reliable results, which enabled me to create revealing graphs. I believe I gained enough results in order to make an accurate conclusion on my hypothesis. The time left for osmosis to occur in the solutions and chips was a well-planned time and allowed osmosis to occur as much as possible, however perhaps a longer time would have enabled osmosis to take more effect. This is what I would try next time if I do repeat the experiment, it could improve the experiment and therefore give me a more accurate conclusion. Also I think that the range of concentrations of the sugar solutions was sufficient, however in the future I could improve it by including more concentrations of sugar solution, perhaps in increments of 0.05 molars instead of going up in 0.1 molars. This would give me a useful and large range of results to work with.

After analysing my results, one could say that the measurements of the length of the chip was less reliable than the mass, this could be simply because the standard ruler is far less accurate than the electronic scales. However as you can see in the results table, there are far more outliers in the change in mass than the change in length, this could be due to the fact of the conditions of the scales or the atmosphere. The air might have been moister as time went on or the scales could have become contaminated with more water, which would be absorbed by the chip, thus increasing the mass.

Some parts of the experiment could have been improved. For instance, the cutting of the potatoes was the most inaccurate part of the experiment as I could have cut them in different shapes or dimensions, giving the potatoes a larger or smaller surface area which could increase or decrease the rate of osmosis. So in the future I would use an electronic or a machine to cut the potatoes. Also to measure the amount of solution included in the test tubes could have been more accurate. I could have used a burette to measure the amount of solution put into the test tube instead of a measuring cylinder. Finally I could have also used smaller scales, both with the ruler and the weighing scales, e.g. instead of 0.001 it would be 0.00001. This would

give me more accurate results and making my experiment all the more reliable.

Humans could also make sources of errors. For instance, I could have dried the potato with the paper towel more on one chip than the other; this could affect my results greatly as one would have weighed more than it should have. I have realised and thought of these precautions greatly and have decided that I could have improved my experiment. However, throughout the experiment I have made sure that it was done to precision, giving me reliable results, which in conclusion corresponded very well to my predictions.

Since the results are the same as I predicted I assume I have taken the up-most precaution when dealing with the input variable to allow them to have scientific reliability when the output variables are being examined & do not have to be repeated as I have taken the responsibility to repeat & write this investigation so that my results can be seen as useful and can be referred to when an exact or similar experiment is being carried out.