Lavender Nguyen's Internal assignment
BIOLOGY SL

Internal assignment: Measure water potential of a potato's cells

Research question: how is water potential of potato cells differ in different sucrose concentration?

Background information: Investigate the water potential of a potato's cells in different sucrose concentrations. The concentrations will be: 0.8M, 0.4M, 0.2M, 0.15M, 0.075M and 0.00M.

Terminologies used in this experiment:

- Hypertonic solution: solution that has higher osmosis pressure (or has more solutes) than another solution to which it is compared.
- Hypotonic solution: a solution that contains less solute (more water) compared to the cytoplasm of the cell.
- Isotonic solution: Solutions of equal solute concentration[1]
- Diffusion: the spread of particles through random motion from regions of higher concentration to regions of lower concentration.
- Osmosis: movement of solvent molecules through a selectively-permeable membrane into a region of higher solute concentration, aiming to equalize the solute concentrations on the two sides. It may also be used to describe a physical process in which any solvent moves, without input of energy, across a semi-permeable membrane (permeable to the solvent, but not the solute) separating two solutions of different concentrations
- Water potential: potential energy of water per unit volume relative to pure water in reference conditions. Water potential quantifies the tendency of water to move from one area to another due to osmosis, gravity, mechanical pressure, or matrix effects such as surface tension. Water potential has proved especially useful in understanding water movement within plants, animals, and soil. Water potential is typically expressed in potential energy per unit volume and very often is represented by the Greek letter Ψ.

Hypothesis: in this experiment, 6 different concentrations of sucrose solution will be used to find the water potential of potato cells. They are 0.8M, 0.4M, 0.2M, 0.15M, 0.075M and 0.00M.

[1] Pearson

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Different concentration will have different affect on potato cells, hence, I will find out the water potential of a potato cells.

If the sucrose solution's concentration is lower than the potato's cells, the water molecules in the solution will move to the potato's cells, so that the mass of potato tissues will increase. Vice versa, if the sucrose concentration is higher than the potato's cells, the mass of potato tissues will decrease because the water molecules in the potato cells will move outside of the cells to the concentration and the particles in the solution will move to the potato's cells. The movement of water molecules and sucrose solution's particles is the result of a balance process between potato's cells and sucrose concentrations. When the concentrations are balance, the movement will reach their equilibrium point (water potential).

I think the graph of percentage change in potato's mass in 6 concentrations of sucrose will show a negative trend. The water potential value of potato cells will be the cut of the x-axis and the best fit line.

Method:

1) Prepare 50cm^3 of each of 0.8M, 0.4M, 0.2M, 0.15M and 0.075M sucrose solutions, each in a separate beaker or flask. Add a sixth tube of water to complete the series.
2) Label each solution and another tube to match eg. 5 tubes labelled 0.8M, 10 tubes labelled 0.4M
3) Cut up about 50g potato tissue into small cubes about 2mm square. Weigh accurately about 0.75g potato tissue into each empty tube. Blot the tissue before weighing and be sure the balance is carefully zeroed.
4) When all the weighings are complete, cover the tissue in each tube with the corresponding solution (5cm^3 is sufficient) and note the time. ie. cover the tissue in the 0.2M tube with 0.2M sucrose etc. Note how the potato looks when this is complete.
5) Leave the tubes for 15 minutes, swirling occasionally.
6) Remove the tissue from each tube, blot it on a paper towel and weigh each amount separately; making sure that the balance is carefully zeroed before each weighing.
7) Record your raw data. You will need to process and graph the data. Use the processed data to estimate the water potential of the potato tissue in MPa.

Uncertainties:

Instrument	**Uncertainty**	**Minimum amount measured**	**Maximum result error (uncertainty x100/minimum amount measured) (%)**
10 ml measuring cylinder	+/- 0.2 ml	5cm^3	4
Electrical balance	+/- 0.01g (digital)	0.75 gram	1.3

Ruler	+/- 0.5 mm	2 mm	25

Variables:

Controlled variables:

- Length of time potato put in sucrose solution
- Size of potato cubes
- Volume of sucrose solution in a tube ($5cm^3$)
- Initial mass of potato cubes
- Temperature of experiment's environment

Independent variables

- Sucrose solution's concentration

Dependent variables:

- Potato cells' water potential

Test's results:

Raw data:

Raw data of mass of potato tissues (gram) after 15minutes putting in Sucrose solution at different molarity. The initial mass of potato cubes was 0.75 gram exact.

Molarity	Tube 1	Tube 2	Tube 3	Tube 4	Tube 5
0.8	0.55	0.66	0.60	0.65	0.68
0.4	0.72	0.78	0.70	0.73	0.74
0.2	0.81	0.85	0.82	0.83	0.87
0.15	0.87	0.85	0.84	0.88	0.84
0.075	0.99	0.93	0.90	0.94	0.97
0	1.01	1.17	1.04	1.03	1.10

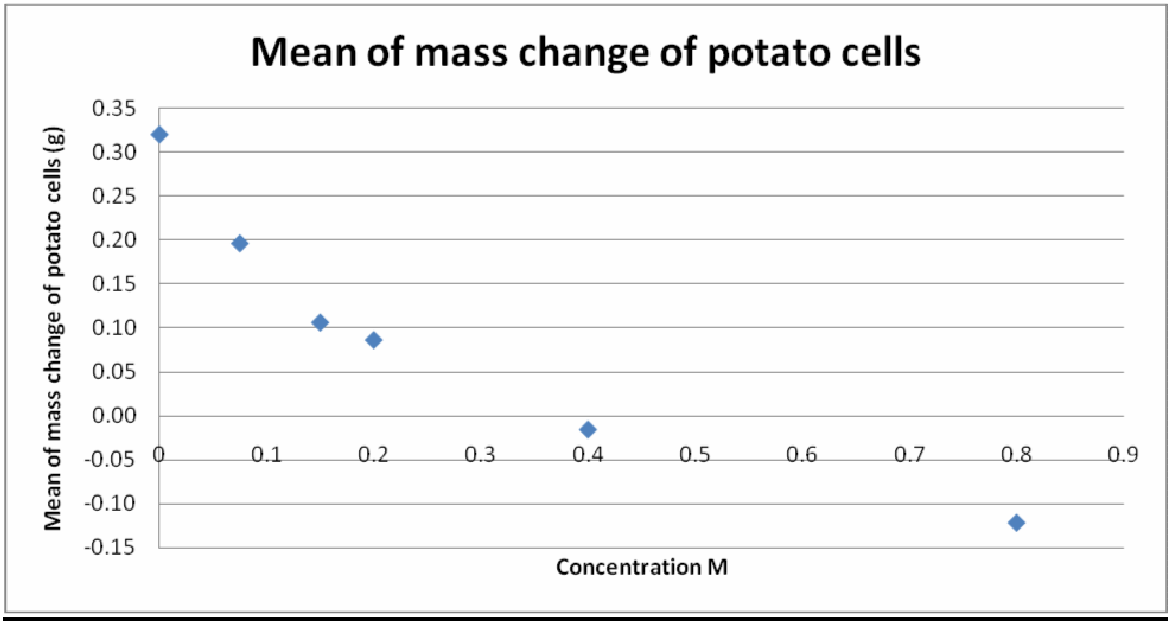
Quantitative data:

At first, when the sucrose solution as just added to the potato cubes, all of them sank. But the cubes floated slowly in the sucrose solution. There are differences between the float of the cubes in different concentration. In the 0.8M concentration, the cubes floated the most. The float of the cubes in other tubes is proportional to the dense of the concentration.

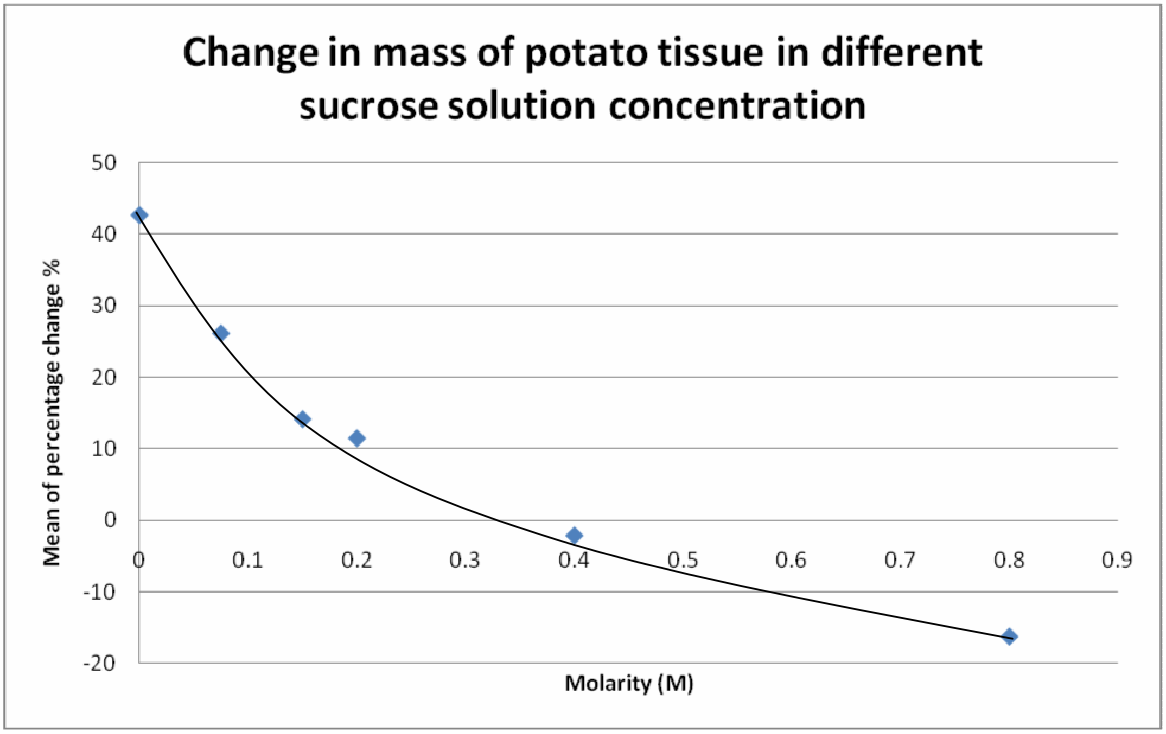
Processing data:

Change in mass of potato cubes

Molarity	Tube 1	Tube 2	Tube 3	Tube 4	Tube 5	Mea n
0.8	-0.20	-0.09	-0.15	-0.10	-0.07	-0.12
0.4	-0.03	0.03	-0.05	-0.02	-0.01	-0.02
0.2	0.06	0.10	0.07	0.08	0.12	0.09
0.15	0.12	0.10	0.09	0.13	0.09	0.11
0.075	0.24	0.18	0.15	0.19	0.22	0.20
0	0.26	0.42	0.29	0.28	0.35	0.32



Percentage of mass change of potato cubes						
Molarity	Tube 1	Tube 2	Tube 3	Tube 4	Tube 5	Mean
0.8	-26.67	-12.00	-20.00	-13.33	-9.33	-16.27
0.4	-4.00	4.00	-6.67	-2.67	-1.33	-2.13
0.2	8.00	13.33	9.33	10.67	16.00	11.47
0.15	16.00	13.33	12.00	17.33	12.00	14.13
0.075	32.00	24.00	20.00	25.33	29.33	26.13
0	34.67	56.00	38.67	37.33	46.67	42.67



From the graph, we can see that the overall trend is negative. To be in details, the change in mass of potato tissue at concentrate 0.2M, 0.15M, 0.075M and 0.00M have positive value and stay above the x-axis, whilst at 0.4M and 0.8M the value have negative value and stay under the x-axis. This is because the concentration of potato tissues is higher than 0.2M, 0.15M, 0.075M or 0.0M; hence the water molecules in sucrose solution moved to potato cells and made the mass of them increase. In this case, the sucrose solution is a hypotonic solution. At the concentration of 0.4M and 0.8M, the water molecules in potato cells move to sucrose solution because potato cells' concentration is lower than sucrose solution – the hypertonic solution. The result for this movement is the decrease in mass of potato cells.

In addition, as we can see from the graph, the percentage of mass change of potato cells at 0.8M and 0.00M is most significant. Compare to the initial value 0.75gram, the mass change at 0.00M is 0.32gram, equal 42.67% which is big. In the other hands, the mass change at 0.8M is also big -0.12 = -16.72%. The two biggest change in mass of potato cubes show two opposite trends very clearly.

Comparing the graphs, they have same trend even though the value of each element is different.

The water potential formula is: Water potential (Ψ) = Solute potential (Ψs) + Pressure potential (Ψp). While there is no pressure in this experiment, we can conclude that the formula will be water potential = solute potential. The formula calculate the equilibrium of movement of water molecules and solute particles from high concentration to lower concentration and vice versa. Because there is no pressure so that the water molecules movement will be equal to solute

movement. Hence, the intersection between trend of percentage change and the x-axis, which mean the point where the water molecules equal to the amount of solutes cut.

Evaluation:

The hypothesis and the result of the experiment were similar, we can conclude that the experiment was accurate. But there are still some errors in the experiment.

One, the biggest error was using more than 1 potato. This is the result of not being quick enough when doing the experiment. After coming back to the lab in the next day, we used another potato to continue. This would affect badly on the result of the whole because the water potential of different potatoes' cells is different.

Two, the second error is that while putting the potato cubes on the table for a long time without any cover, the water in potato cells evaporated, which might change the water potential of it.

Three, while blotting the cubes, I might have blotted them so strongly, this made the water in cells come out, which also lead to the inaccurate.

Four, because the amount of potato cubes was big, and we don't have enough time so that we only estimated the size the cubes. The size might not be exact $2mm^3$

LIMITATION AND SUGGESTIONS

Limitations	*Suggestions*
Potato cubes stick together, hence the surface of potato cubes in sucrose solution might decrease	Shake the tubes contain potato cubes gently and frequently in order to make the cubes separate.
Water in potato cells will be lost because of evaporation	Put the potato cubes in a box with lid or Petri dish with wrap after cutting.
Using different potatoes	Use one potato only. If the surround of the potato is dry and turn dark brown, cut it off and use the inner parts.
The sensitiveness of digital balance can cause to an imprecise in measuring the potato cubes' masses because just a touch can change the result of a measure.	Keep the condition of doing experiment constant by standing still and gently put the potato cubes on the balance to avoid vibration

BIBLIOGRAPHY:

Wikipedia. (2011). *Water potential.* Available: http://en.wikipedia.org/wiki/Water_potential. Last accessed 6th June 2011.