# Investigating The Effect Of Osmosis On Two Different Plant Tissues

The aim of the investigation is to find out the effect water potential has on osmosis in two different plant tissue; apple and potato.

To help me on this investigation I decided to conduct a preliminary experiment. This allowed me to have an overall impression of the experiment, and I could spot any weaknesses in my experiment which I can modify to ensure that the real experiment has no flaws, so that the result obtained are accurate and reliable.

The preliminary experiment involved cutting five 'chips' of each tissue sample, to equal size, and placing each into different concentrations of salt solutions. After an hour, the samples were taken out of the solution and measured. The results and graph are in appendix 1.

## Possible variables

There are a number of factors I shall be keeping the same:

1. **Temperature:** the temperature must be kept constant throughout the experiment as it may affect the results, and the movement of water molecules.

2. **Volume of salt solution:** the volume must be kept the same; in this experiment, each 'chip' will be immersed in 40ml of salt solution.

3. **Initial volume of plant tissue 'chips':** this will be kept the same using a core borer.

4. **Initial length of plant tissue 'chips':** this will be cut to 50mm

5. **Initial mass of 'chips':** this is difficult to control, however each 'chip' will be the same mass and to 2 decimal place.

6. **Plant tissue type:** all the samples will come from the same type **(and age)** of potato/apple to ensure that the investigation is kept fair and accurate.

7. **Time in solution:** all the 'chips' will be kept in the solutions for the same period of time. The timing will be staggered, each chip will be placed in the solution two minutes after the previous so each have been in the solution for an equal period of time, and measured.

The factor that will be changed during the experiment is the concentration of salt solution.

## Measurements

The measurements I will be taking during this experiment are mentioned above; the volume of salt solution, volume, length & mass of 'chips' and the time in solution. Also the concentration of the salt solution is measured when making the dilutions.
In my preliminary experiment, I used 4 concentrations of solution; 0.00M, 0.25M, 0.50M 1M. This would not give me a reliable and precise conclusion therefore I will use a more varied range of concentrations.
Serial dilutions were made, the table below shows how the dilutions were made:

| Concentration of salt solution (M) | Amount of 1M salt solution (ml) | Volume of distilled water added (ml) |
|---|---|---|
| **0.00** | 0 | 40 |
| **0.20** | 8 | 32 |
| **0.40** | 16 | 24 |
| **0.60** | 24 | 16 |
| **0.80** | 32 | 8 |
| **1.00** | 40 | 0 |

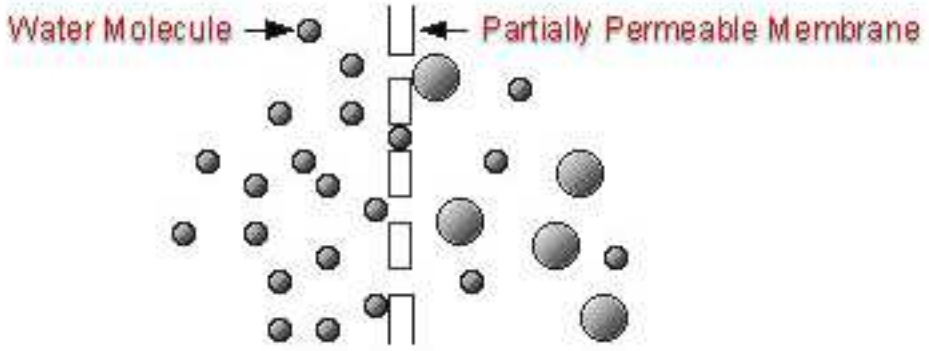
In my preliminary work, I used a measuring cylinder (accuracy of +/- 0.1ml) to measure the solution for the serial dilution. It is more accurate to use a pipette (accuracy of +/- 0.05ml), so I will use a pipette to enhance the reliability of the results.
The mass of the samples were not taken in the preliminary, however, looking at the results I obtained, some samples did not change in length, but they may have changed in mass, therefore this is a measurement I will be taking for the experiment. It will improve the reliability and accuracy of the results.
In the actual experiment, the period of time that the chips are immersed in the solution for will be an hour. They were placed in the solution for 40 minutes in the preliminary and the results obtained had not changed by much.
Also, in the preliminary I used 1 chip of each plant tissue for each concentration, so I had all together 4 results for each plant tissue. If I was to have the same amount of result for my experiment, the conclusion I would come to would not be reliable. More results are needed for a solid reliable conclusion; therefore I will be using 5 chips for each concentration of salt solution, of each plant tissue.

The null hypothesis is that there is no difference in water potential between apple and potato.
The hypothesis is that there is a different in water potential between apple and potato tissue.

I have done some background research on osmosis and related topics. The sources of the research are: 'A-level Biology' (page 214) by W.D. Phillips And T.J. Chilton. Also, another book, 'Biology' (page 121) by Julian Sutton.

Osmosis is the net movement of water molecules from a region of high water potential to a region of lower water potential, across a partially permeable membrane. The diagram below shows this process; the water potential on the right of the membrane is lower than that on the left. Over time, the net movement of water molecules will be

from left of the membrane to right until the water potential on both sides is at equilibrium.




The significance of the process described above for plant cells is that if a plant tissue is immersed in a solution of a higher water potential than itself, the net movement of water molecules will be into the cells, thus causing the cells to swell up. Due to the fact that plant cells are surrounded by a strong cellulose cell-wall, the membrane will not burst but the tissue will become increasingly turgid until a point is reached where the pressure potential exerted by the cell wall on the membrane prevents further uptake of water by the cell. At this point the cell is said to be fully turgid. In whole plants it is the turgidity of their cells that helps hold them upright and spreads the leaves out to the sun so that they can photosynthesise efficiently.
If plant tissue is placed in a solution of lower water potential than its own, the process described above will occur in reverse; the net movement of water molecules will be into the surrounding solution and the cell will become increasingly flaccid as pressure exerted by the membrane on the cell wall decreases. If this process continues, the membrane will start to pull away from the cell wall as the contents of the cell are steadily depleted. This process is known as plasmolysis.
If plant tissue is placed in a solution with a water potential that is equals to its own, water molecules will still move between the external solution and the contents of the cell, but the system will be at equilibrium as the net movements into and out of the cell will be the same. The cell will therefore neither swell up nor shrink. When the two solutions have the same solute concentration it is said to be isotonic.

**Prediction**

I have researched into the content of apple and potato and have found that although apple may have more water content than in potato, the water potential is lower than that of potato. This is because apples have a higher concentration of sugars within its cells which would lower the water potential. Potato has not as much water as apples however, they do not contain as high concentration of sugar molecules than apples.
*"Osmosis is the net movement of water molecules from a region of high water potential to a region of lower water potential".*

**At 0M concentration:** In distilled water I believe that the apple will gain in mass and length significantly turgid. The apple will have a lower water potential inside its cell than

the distilled water therefore the water molecules will move across the membrane into the cell.
The potato chips will only also increase in mass and length however, only a small amount. The water potential is lower in the potato chips than distilled water so the water molecules will enter the potato tissue cells becoming slightly turgid.

**At 0.2M concentration:** I think the same will happen as said in my prediction for distilled water. The apple chips will still have a water potential lower than in the salt solution and therefore will gain in mass and length significantly, becoming turgid.
The potato chips will also have a very slightly lower water potential than the salt concentration, or this will be the isotonic point, therefore I think there will be a very small change in mass and length or not any at all.

**At 0.4M concentration:** I think this is the isotonic point for the apple tissue. The water potential in the solution and the apple tissue will be either at equilibrium or very near it. The water potential in both will be almost or will be the same. The cell will neither swell up nor shrink (neither become more turgid or flaccid). When the two solutions have the same solute concentration it is at its isotonic point.
The potato tissue, immersed at this concentration, will have a higher water potential that the solution. Therefore since water molecules move from a region of high water potential to a region of lower water potential, the molecules diffuse through the cell membrane into the salt solution. The potato chips will decrease in mass and length slightly, becoming flaccid, also very slightly.

**At 0.6M concentration:** The apple tissue will have a slightly higher water potential than in the salt solution. If this is the case, the apple chips will decrease in mass and length, and the cell will become slightly flaccid.
The potato tissue will again have a higher water potential than in the salt solution and decrease in mass and length, with the cell becoming flaccid, more than that I predict in **0.4M.**

**At 0.8M concentration:** Again I think that both the tissue samples have a greater water potential than the salt concentration, this time being significantly higher, therefore both tissue samples will decrease in mass and length, and the cell becoming flaccid.

**At 1.0M concentration:** My prediction to the tissue samples being immersed in 1.0M concentration is the same as the previous concentration however a more significant decrease in mass and length will be measured.

**Apparatus**

Test Tube/Petri Dish x 60 (place tissue sample in this)
Stop Watch (time experiment)
Core Borer
Knife
White Tile (to place tissue being cut)

Pipette (50ml)
Measuring cylinder (25ml & 10ml)
Beaker
Ruler
Weighing Scales
Distilled water
1.0M Salt solution
Potatoes
Apples

**Procedure**

1. Using distilled water and the 1.0M salt solution, make up the different concentrations (*see serial dilutions table)*
2. Using the core borer, and knife, cut 30 chips out of the apple. Each chip must be exactly 50mm in length and of equal depth and width. **Record initial length of each chip.**
3. Place one chip in each of the distilled water solutions and start timer. After two minutes have passed, place one chip in each of the 0.2M solutions. Again after another 2 minutes, place one chip in each of the 0.4M solutions and so on.
4. After one hour has passed for the chips placed in **distilled water**, remove them, dry them carefully and measure the length and mass. Record it in the table.
5. After one hour has passed for the other chips in each concentration, remove them, dry them carefully and measure.

Repeat steps 1 -5 with the potato.

| Plant tissue | Concentration of Salt Solution | Initial Length (mm) | Final Length (mm) | Difference in Length | % Change | Initial mass (g) | Final mass (g) | Difference in mass | % Change in mass |
|---|---|---|---|---|---|---|---|---|---|
| Potato | 0 | | | | | | | | |
| | 0 | | | | | | | | |
| | 0 | | | | | | | | |
| | 0 | | | | | | | | |
| | 0 | | | | | | | | |
| | Total | | | | | | | | |
| | Average | | | | | | | | |
| | 0.2 | | | | | | | | |
| | 0.2 | | | | | | | | |
| | 0.2 | | | | | | | | |
| | 0.2 | | | | | | | | |
| | 0.2 | | | | | | | | |
| | Total | | | | | | | | |
| | Average | | | | | | | | |
| | 0.4 | | | | | | | | |
| | 0.4 | | | | | | | | |
| | 0.4 | | | | | | | | |
| | 0.4 | | | | | | | | |
| | 0.4 | | | | | | | | |
| | Total | | | | | | | | |
| | Average | | | | | | | | |
| | 0.6 | | | | | | | | |
| | 0.6 | | | | | | | | |
| | 0.6 | | | | | | | | |
| | 0.6 | | | | | | | | |
| | 0.6 | | | | | | | | |
| | Total | | | | | | | | |
| | Average | | | | | | | | |
| | 0.8 | | | | | | | | |
| | 0.8 | | | | | | | | |
| | 0.8 | | | | | | | | |
| | 0.8 | | | | | | | | |
| | 0.8 | | | | | | | | |
| | Total | | | | | | | | |
| | Average | | | | | | | | |
| | 1.0 | | | | | | | | |
| | 1.0 | | | | | | | | |
| | 1.0 | | | | | | | | |
| | 1.0 | | | | | | | | |
| | 1.0 | | | | | | | | |
| | Total | | | | | | | | |
| | Average | | | | | | | | |

| Plant tissue | Concentration of Salt Solution | Initial Length (mm) | Final Length (mm) | Difference in Length | % Change | Initial mass (g) | Final mass (g) | Difference in mass | % Change in mass |
|---|---|---|---|---|---|---|---|---|---|
| **Apple** | 0 | | | | | | | | |
| | 0 | | | | | | | | |
| | 0 | | | | | | | | |
| | 0 | | | | | | | | |
| | 0 | | | | | | | | |
| | Total | | | | | | | | |
| | Average | | | | | | | | |
| | 0.2 | | | | | | | | |
| | 0.2 | | | | | | | | |
| | 0.2 | | | | | | | | |
| | 0.2 | | | | | | | | |
| | 0.2 | | | | | | | | |
| | Total | | | | | | | | |
| | Average | | | | | | | | |
| | 0.4 | | | | | | | | |
| | 0.4 | | | | | | | | |
| | 0.4 | | | | | | | | |
| | 0.4 | | | | | | | | |
| | 0.4 | | | | | | | | |
| | Total | | | | | | | | |
| | Average | | | | | | | | |
| | 0.6 | | | | | | | | |
| | 0.6 | | | | | | | | |
| | 0.6 | | | | | | | | |
| | 0.6 | | | | | | | | |
| | 0.6 | | | | | | | | |
| | Total | | | | | | | | |
| | Average | | | | | | | | |
| | 0.8 | | | | | | | | |
| | 0.8 | | | | | | | | |
| | 0.8 | | | | | | | | |
| | 0.8 | | | | | | | | |
| | 0.8 | | | | | | | | |
| | Total | | | | | | | | |
| | Average | | | | | | | | |
| | 1.0 | | | | | | | | |
| | 1.0 | | | | | | | | |
| | 1.0 | | | | | | | | |
| | 1.0 | | | | | | | | |
| | 1.0 | | | | | | | | |
| | Total | | | | | | | | |
| | Average | | | | | | | | |