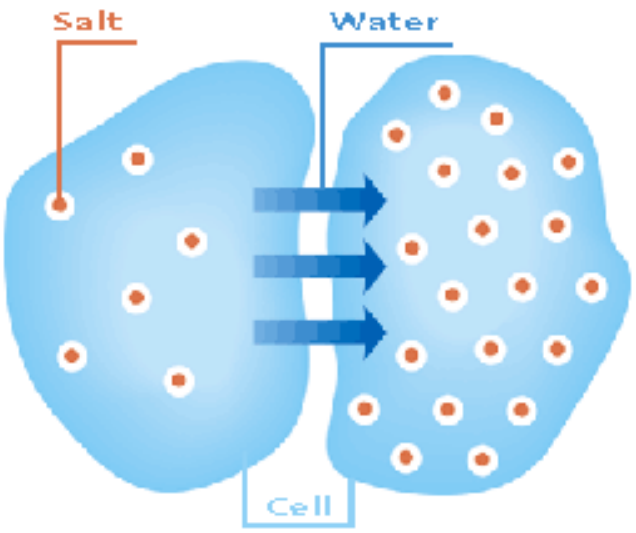
A Design Investigation of Osmosis - the Relationship Between the Amount of Salt in Water and the Mass of the Potato in Water

Research Question

How does changing the amount of salt in water affect the mass, in grams, of a potato slice in the water, through osmosis?

Background Information

Osmosis is a type of passive transport where the movement of water through a membrane from an area of high concentration of water to low concentration of water. Osmotic pressure is when water moves a semi-permeable membrane through osmosis into another solution and pressure is built up to halt the flow of pure water into the solution (Sheppard). Water moves from an area of high osmotic pressure to an area of low osmotic pressure (Sheppard).



Hence, if there is more salt in one area, because there is lower concentration of water there, water from the area with less salt will move there.

Similarly, if a potato is left in salt water, the mass of the potato will decrease as water moves out of the potato into the salt water, as long as there is higher concentration of water in the potato than in the salt water.

Hypothesis

If the potato slices are put in the water with different amount of salts, 1g, 2g, 3g, 4g, and 5g, and left for the process of osmosis, the mass of the potato will decrease, and the biggest change in mass will take place with the potato slice that is left in 5 grams of salt. This is because water will be transported from high concentration to low concentration, and the water with the most salt will have the highest difference of concentrations between the waters for more amount of water to move from the potato to the salty water.

Variables

Variables	Description / Units	How to measure / control
Independent Variable	Amount of salt in the water (grams)	1 gram, 2 grams, 3 grams, 4 grams, 5 grams
Dependent Variable	Mass of the potato slice (grams)	Measure with electronic scale.
Control Variables	Amount of time the potato slice is potato is left in the water (minutes)	2 days
	Type of water	Use tap water
	Amount of water (ml)	100ml in each beaker. Measure with the same measuring cylinder.
	Temperature of water (degrees Celsius)	Room temperature (water just directly from the tap)
	Type of beaker (same beaker to contain the water)	Use 400ml beaker
	Size or thickness of potato slice (cm)	10cm-10cm-2cm
	Type of potato	Use the same type of potato, about the same size.
	Type of salt	Same salt
Control Group	(Positive) Potato slice left in water without any salt	0g of salt in the water
	(Negative) Potato slice left in water with 5g of salt	5g of salt dissolved in the water

Materials

- 1800ml of tap water
- 45 grams of salt
- 3 potatoes
- 6 400ml-beakers
- Spatula
- Electronic scale / balance
- Measuring cylinder

Safety

- Be careful not to cut yourself when using the knife to slice the potatoes.
- Do not place beakers or the electronic scale on the edge of the table because they could break or drop onto your toes.
- Do not eat the salt; even though it might be okay, it is not for eating purpose.

Procedure

1. Cut the potato into slices of 10cm-10cm-2cm size. Cut until you have 6 slices.
2. Label the 6 beakers - 0g, 1g, 2g, 3g, 4g, 5g - to indicate which beaker contains which salt water.
3. Using the electronic scale, measure and record the mass of one potato slice. (This is initial mass.)
4. Using the measuring cylinder, measure 100ml of water and pour it into a 400ml beaker with the assigned label.
5. Drop the potato slice into the water in the beaker.
6. Repeat steps 3 to 4 with another potato slice.
7. Using the electronic scale, measure 1g of salt and pour it into the water.
8. Using the spatula, stir the water so that the salt can dissolve in the water.
9. Drop the potato slice into the salt water in the beaker.
10. Repeat steps 6 to 9, using 2g of salt instead.
11. Repeat steps 6 to 9, using 3g of salt instead.
12. Repeat steps 6 to 9, using 4g of salt instead.
13. Repeat steps 6 to 9, using 5g of salt instead.
14. Let the potatoes sit in the water for 2 days.
15. After 2 days, take out each potato slice from the water, and measure and record their mass using the electronic scale. (This is final mass.)
16. Calculate the change in the mass by subtracting the final mass from the initial mass.
17. Calculate the percentage change in the mass by dividing the change in mass by the initial mass and then multiplying 100%.
18. Repeat steps 1 to 17 two times, so that there are 3 trials in total.

Further directions for using the electronic scale:

1. Turn on the electronic scale by pressing on the on/off button.
2. Place the container (in which you are going to place whatever you want to actually measure) on the electronic scale.
3. Press the “Tare” button.
4. In the container, place whatever you are going to measure.
5. Read off the electronic scale and record the mass.

Raw Data

Table 1: Mass of the potato slice before and after it was left in the water with different amounts of salt

Amount of salt in the water (g)	**Mass of the potato slice (g)**					
	Trial 1		Trial 2		Trial 3	
	Before	After	Before	After	Before	After
0 (Control)	5.65	7.82	5.58	7.60	5.78	6.29
1	6.77	8.68	7.65	9.49	7.56	9.49
2	8.74	10.43	7.27	8.90	7.03	8.64
3	7.26	8.68	7.77	9.34	7.68	9.21
4	6.84	7.86	6.04	7.14	6.78	7.89
5	6.45	6.66	6.69	6.80	5.62	5.78

Table 2: Qualitative Data (Observations) of the potato slices after they were in the water with different amounts of salt for two days

	Observations of the potato slice		
	Trial 1	Trial 2	Trial 3
All 6 potato slices	The potato slices disintegrated into smaller parts when I tried to pick it up to measure its mass. They felt very soft and squishy. The color of the potato turned a little green. They all had a strong sour, nasty smell.	The potato slices were very soft and squishy, but they did not disintegrate.There was not much change in the color. They still had some smell, but not as strong as the ones in Trial 1.	The potato slices were very soft and squishy; those left in waters with 1g and 2g of salt disintegrated into smaller parts when I tried to pick them up. There was not much change in the color. Like those in Trial 2, they still had some smell, but not as strong ast the ones in Trial 1.

Data Processing

Table 3: Change in the Mass of the Potato Slice According to the Different Amount of Salt in the Water

	Change in the Mass of the Potato Slice (g)				
Amount of salt in the water (g)	Trial 1	Trial 2	Trial 3	Average	Uncertainty (+0.1g, -0.1g)
0	2.17	2.02	2.09	0.51	0.61, 0.81
1	1.91	1.84	1.93	1.89	1.99, 1.79
2	1.69	1.63	1.61	1.64	1.74, 1.54
3	1.42	1.57	1.53	1.50	1.60, 1.40
4	1.02	1.10	1.11	1.08	1.18, 0.98
5	0.23	0.11	0.16	0.17	0.27, 0.07

Table 4: The Percentage Change in the Mass of the Potato Slice According to the Different Amount of Salt in the Water

	Percentage Change in the Mass of the Potato Slice (%)			
Amount of salt in the water (g)	Trial 1	Trial 2	Trial 3	Average
0	38.41	36.20	36.16	36.92
1	28.21	24.05	25.53	25.93
2	19.34	22.42	22.90	21.56
3	19.55	20.21	19.92	19.89
4	14.91	18.21	16.37	16.50
5	3.57	1.64	2.85	2.69

Calculations:

Change in the Mass of the Potato slice
= Final mass after it was in the water - Initial mass before it was in the water

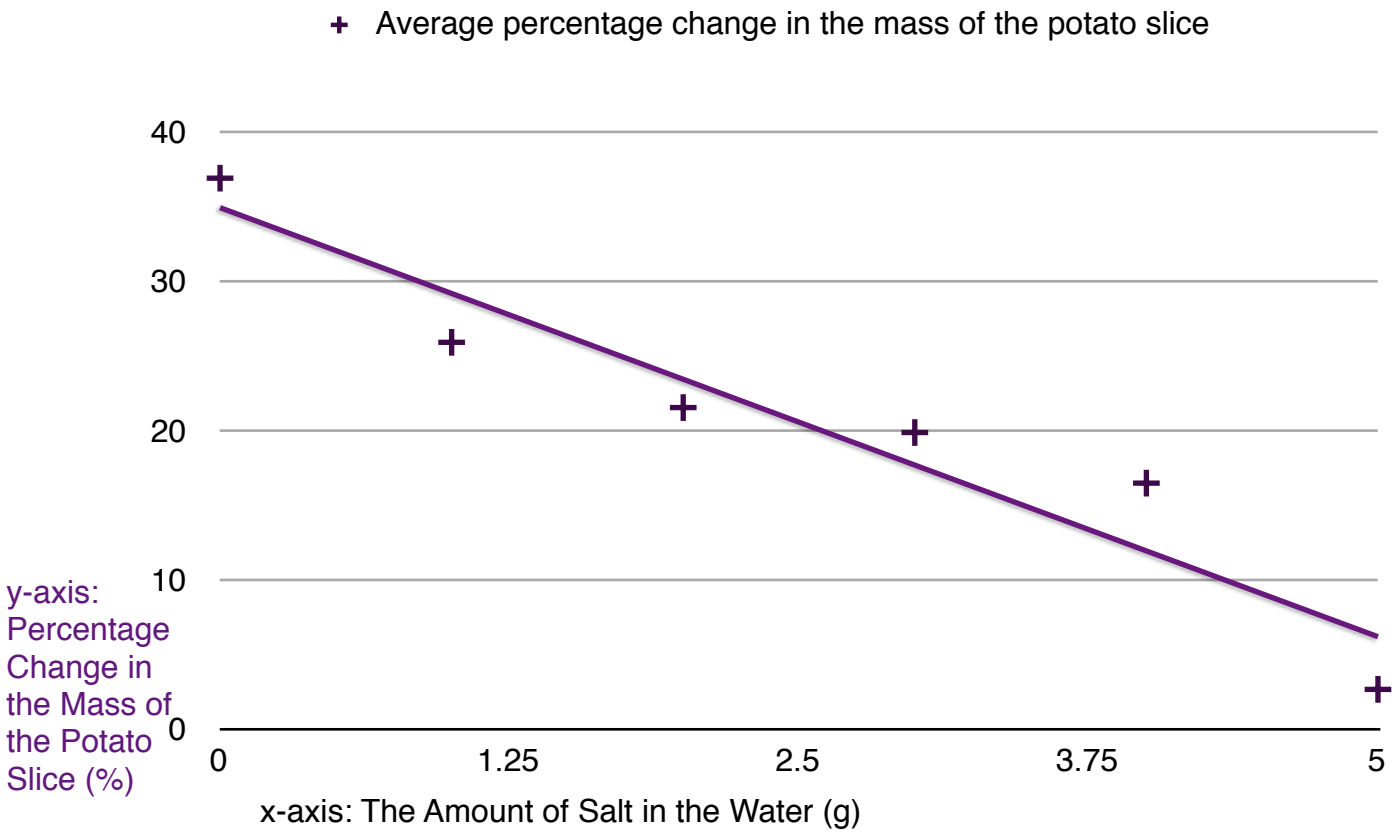
In Trial 1, for 0g: 7.82g - 5.65g = 2.17g

Percentage Change in the Mass of the Potato Slice
= (Change in the Mass of the Potato Slice / Initial mass before it was in the water)*100%

In Trial 2, for 3g: (1.57g / 7.77g)*100% = 20.21% [Rounded to 2 decimal places]

Graph

Graph 1: The Relationship between the Amount of Salt in the Water and the Average Percentage change in the Mass of the Potato Slice



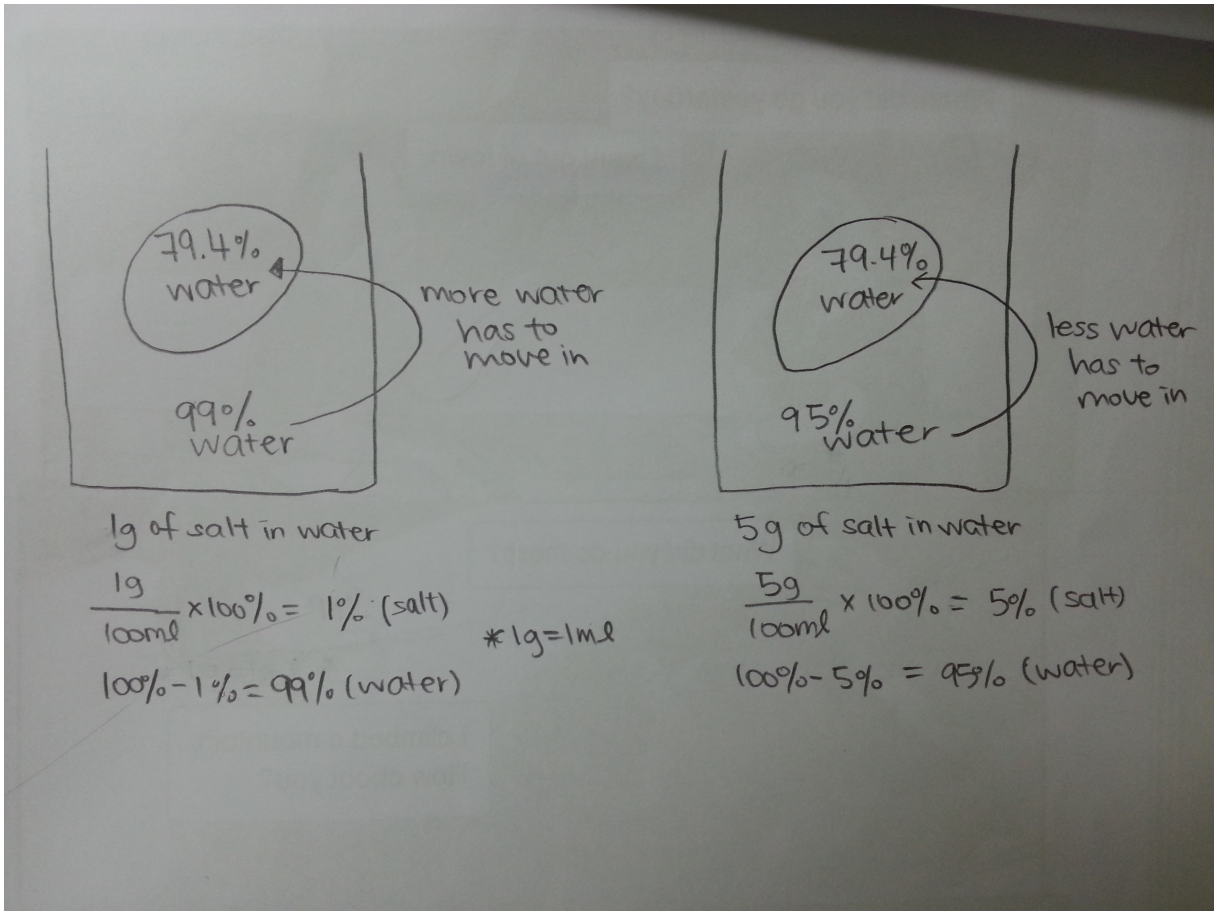
Conclusion

Through my experiment, I was able to answer my research question of how changing the amount of salt affects the mass of a potato slice in water. My results do not support my hypothesis. My hypothesis that the mass is going to decrease was proved wrong; instead, the mass of all the potato slices increased after it was in the water for two days. Also, the biggest change in the mass did not take place in 5g of salt; the biggest change in the mass took place in the control, with 0g of salt in water. Consequently, I found out a relationship: the greater the amount of salt in the water, the smaller the increase in mass of the potato slice.

As seen in Table 4 and Graph 1, the greatest percentage change in the mass of the potato slice occurred in the positive control of 0g of salt, with 36.92%. Then, there is a pretty sharp decrease in percentage change in 1g of salt, and the second greatest increase in the mass of the potato slice happened in 1g of salt, with 25.93%, which is about 11% difference from 36.92%. Following is a continuous decrease in the percentage change in the mass of the potato slice. Water with 3g of salt had 19.89%, and water with 4g of salt had 16.50%. After that, there is another sharp decrease in the percentage number; water with 2.69%. This steep decrease is also portrayed in Graph 1, as there is a significantly bigger distance between the points on 4g of salt and 5g of salt.

My lab supports the science behind it, and the results make sense. Basically, according to my data, osmosis took place, with the water moving from higher concentration to lower concentration. According to research, there is 79.4% of water in a potato (“Nutrition Facts”). This means that with 1g to 5g of salt in 100ml of water outside, the water outside still has higher concentration of water, so water will move from the saltwater into the potato, resulting in an increase in the mass of the potato. Also, referring to Diagram 1 below, the reason there is smaller increase of mass as there is more salt in the water is because there will be less difference in the concentration of water outside in the saltwater and inside the potato, hence less water has to move in order to reach the equilibrium.

Diagram 1: The Explanation Behind the Increase in the Mass of the Potato Slices



However, what I really wanted to test wasn't achieved. What I meant to show through this experiment was finding the equilibrium and the decrease in the mass of the potato, resulting from the salt water outside that has lower concentration of water, so the water in the potato (because it has higher concentration of water) will move out into the salt water. This is why I was puzzled with my results at first. I thought that there would be higher concentration of water in the potato. However, I was wrong; there was higher concentration of water in the salt water even with the greatest amount of salt of 5g. This means that there was not enough salt in the water that would make the water in the potato move out because there was still higher concentration of water in the salt water outside the potato.

Evaluation

I believe my lab was reliable, as I got the results that I was supposed to get, but there were a lot of room for errors. For data recording itself, I rounded up all my data to 2 decimal places, which is accurate enough. However, the level of accuracy can be doubted if all the possible errors are taken into account. There were no significant outliers in my data, but the human errors and other factors probably affected my data.

First of all, the potato slices weren't exactly the same in size, even though it was stated in my control variables chart that they should be. This was because it was impossible to cut and slice them into exactly equal sizes by just using a knife, which was the only equipment that I had. They were just similar in sizes, so they varied in their mass too. This difference in the thickness/size of the potato slices could significantly impact the results; according to theory, the surface area of the membrane affects the rate of osmosis, and since there was difference in the surface area of the different potato slices, the results could have been affected. I could have improved this by using something like a cookie cutter to cut the slices into exactly the same size.

Secondly, I left the potatoes sit in the water for two days.This could have affected the results because some of the potato slices, especially in trial 1, disintegrated into pieces when I tried to pick it up from the water, so I had to scrape it altogether to measure its mass. I think I left them in the water for too long. Just one day would have been enough to get the results and for the potatoes to stay solid for accurate measurements.

Adding on, leaving them for two days also means that they had to go through more changes in the temperature in the biology room. This is an uncontrollable factor, and it is a valid error. The different temperatures and humidity of the room throughout the day could affect osmosis because temperature could have affected the rate of osmosis and higher level of humidity could have created more water molecules. To improve this, I should have not only left it for just a day, but also cover the beakers with foil on top, so that there is less exposure to the surrounding air and thus ends up in a more secured environment.

Lastly, what I have to also consider is the fact that there is different amount of water in every potato; the concentration of water should be similar, but it still varies, so that could have affected the results. I should have made sure that the slices were from the same potato if possible, so that they have about the same amount of water.

If a same experiment is carried out, I think there will be different results in terms of numbers, even though the trend of the relationship in the data will be similar. There were

too many external factors that affected this lab. If I improve it like how I mentioned in the above paragraphs, I will get a far more accurate set of data.

Discussing the validity of my experiment, it yielded the correct results that made sense and could be explained. All my variables were controlled well, except for the size of the potato slices which I mentioned above. I also included a positive and negative control to regulate my experiment. The positive control was the potato slice left in the water without any salt, and it resulted in the greatest percentage change in the mass. The negative control, on the other hand, was the potato slice left in the water with 5g of salt, and it resulted in the smallest percentage change in the mass. Those two controls were the two extreme numbers in my experiment, which clearly defines the relationship: the greater the amount of salt in the water, the smaller the percentage change in the mass of the potato slice. Therefore, my experiment is valid. However, as I already mentioned in my conclusion, I did not really accomplish what I wanted to test. What I wanted to test was the process of the water moving from the potato to the salt water to reach equilibrium, but the salt water did not contain enough salt for it to have lower concentration of water.

Hence, to further the investigation, I should expand my independent variable. I should try putting more salt in, like 6g, 7g, 8g, 9g, 10g, and more if needed. To better understand the process of osmosis, I could put more salt in the water to find out how much water has to move across to reach the equilibrium point. Also, I could do another experiment where I record the progress of the potato's transformation and other vegetables' transformation over a period of time (like 24 hours), check and observe the progress every hour or two hours, and perhaps compare the osmosis process between the vegetables. By looking at that, we can also find out the rate of osmosis. In real life, this investigation could relate to finding out the water content of the vegetables by looking at how much water moves. Finding out the equilibrium leads to finding out how much water there is in vegetables. More specifically, we could also find out how much water should be squirted on top of the vegetables to keep them fresh the longest.

Works Cited

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