Student's Name

Professor's Name

Course

Date

Investigating how different concentration of sugar in water and milk affect the rate of osmosis in almonds

Research question

To what extent do different concentrations of sugar in water and milk affect the rate of osmosis in almonds.

Introduction:

Osmosis refers to the passage of water or solvents molecules across a partially permeable membrane from a low solute concentration region to a region of high solute concentration (Liua et al 50). Two different solutions will be used in this experiment that is a concentration of sugar in water and a concentration of sugar in milk. The experiment tests the rate of passage of solution through a semipermeable membrane of almond seed.

When the almond seed is placed in the different sugar solutions in water and milk, a concentration gradient is formed, water from a low sugar concentration will move inside the almonds (region of high sugar concentration).

Through osmosis, water molecules will penetrate the semipermeable membrane into the almond seeds. The different solutions of sugar in water and milk will be used to determine whether the availability of molecules in the solution affects the rate of osmosis. This research question was picked to determine whether what was learned in class is true and is applicable in real life. From

this experiment, the test results will be used in determining how some biological processes such as the reabsorption of water in the kidney.

In the human body, kidneys use osmosis to maintain water balance in the body. The kidney helps in the removal of harmful materials. In kidneys, the recovery of water from waste materials is helped by osmosis. Dialysis is an excellent example of osmosis. Waste materials from the body are removed by a kidney dialyzer. Dialysis is a process of removing body waste materials using a machine mimicking a normal kidney in a human body. The patients' blood passes through a dialyzing membrane, which acts as a partial membrane and passes into the dialysis tank containing solution (Ronco et al 120). This process is done when a functioning kidney fails. Since the red blood cells are large, they do not pass through the membrane and are maintained in the body. This osmosis process only removes waste materials from the body.

In this experiment, two solutions will be used (a concentration of water in sugar and milk), which will therefore determine the rate of osmosis in the two solutions. Almond seeds will be dipped in a low water concentration. Water molecules are more concentrated and move to a high water concentration region, making the almond seed decrease in Mass. The experiment will be conducted within 24 hours, submerging almond seeds in both solutions and measure the Mass of seeds after 24 hours. The almond will be removed and dried for them to be weighed. The mass of almond will be recorded using the scale for reliable data, which will be used in the analysis to make a satisfactory conclusion. The use of a scale is sufficient in measuring how fast or slow the almond seed decreases in size due to osmosis. During the experiment, scale accuracy will be vital for accurate conclusions.

Hypothesis:

In this experiment, I foresee that the almond mass will decrease faster in water solution than in milk concentration.

Variables:

Variables	**How will they be changed/measured/controlled**
Independent variables - The different substances - Water Solution - Sugar Solution	The choice of water concentration and sugar concentration with different concentration levels indicates that osmosis can occur in different solutions and produce different results. When a concentration is high in sucrose (hypertonic), low in sucrose (hypotonic), and or has an average amount of sucrose (isotonic). The solutions result in the almonds to increase in size, decrease, or remain the same size. The water solution and sugar solution will help to give a variety of data by having a different solution with certain levels of sucrose. There will be a liquid with little to no sucrose solution, other with high sucrose solution, thus giving me various data in the analysis. The recorded variables will be manipulated as there are two substances the almonds are dipped in which their mass will vary in each test as this will change the data by providing changes within the 24 hours the experiment is conducted. After analyzing the

	change in almond mass, the rate of osmosis will be determined using the two solutions.
Dependent Variable - The rate of osmosis - Calculating the percentage change in Mass (g)	The rate of osmosis will be determined by calculating the Mass of almond in grams on an electric balance before and after being placed in each substance to indicate change. After some time, I will calculate the change in Mass, the total percentage change in Mass, and determine the standard deviation. For accurate data sets, the almond mass will be measured using different trials, thus making the experiment fair for drawing meaningful conclusions. The change in Mass of almonds will increase or either decrease depending on the substance it is placed in during the osmosis process. Therefore, when the substance is changed (water solution or milk solution),

	the Mass of the almond will be altered as water will either exit or enter the almonds membrane.
Control Variable: - Type of water - Amount of almonds (30) - Amount of milk (300mL) - Duration of almond being soaked in the substance (24 hours) - Amount of sugar (500g) - Amount of water (300mL)	The amount of water will be controlled by pouring it into five different glass jars until 200mL is reached for an accurate amount. Certain levels of sugar will be added to the glass jars containing water. Similarly, milk will be poured into different glass jars until 200mL is reached for an accurate experiment. Sugar levels of a certain level will be added in separate glass jars. Where sugar is added, I will stir the solvent until it diffuses completely in the solute. In each test jar, I will insert two almonds. Before inserting the almonds, I will record the initial weight using an electric balance. I will set the alarm at 24 hours using a stopwatch, which will make sure the duration is accurate. When I get a notification from the stopwatch, I will remove the almonds in the substances, rinse them and weigh their masses. The type of almond

	that will be used are average in size, fresh for more reliable results. The importance of having a specified amount of time in trials is to make sure that the data collected is accurate, fair, and reliable since all trials have been conducted equally in a specific amount of time for the osmosis to take place. In this experiment, I will use distilled water to make sure that no additional factors are affecting the outcome of the experiment. The type of milk used will be dairy fresh milk from a cow that does not contain impurities.

Apparatus:

Apparatus	**Quantity**	**Uncertainty**
Almonds	30	-
200mL jar	10	±1mL
Sugar	500g	±0.05g
Distilled water	200mL per jar	±1mL
Milk	200mL per jar	±1mL
Weigh balance (in grams)	1	±0.05g
Jars	20	-
Stopwatch	1	±1minute
Book for data record	1	-

Methodology:

1. Collect all the materials needed and place them in an orderly manner.
2. Carefully wash the almonds and dry them and thoroughly rinse the jars making sure there is no residue.
3. Place 20 open jars on a surface where you're working on and label each one with a maker, 5 labeled jars of the water solution, and 5 jars for milk solution.
4. Pour 200mL of water in each jar labeled ware and 300mL of milk in jars labeled milk. Then, add different amounts of sugar (0, 10, 20, 30, 40) in each jar containing water and milk and stir to dissolve.
5. Measure the initial Mass of two almonds in the weighing scale and record the Mass.

6. Next, carefully insert two almonds in separate glass jars after recording their Mass and loosely place the lids on the jars and leave them. Step the stopwatch alarm for 24 hours.
7. On the next day, record any qualitative data which you observe before taking out the almonds from the substances.
8. Dry the almonds, measure the Mass of almonds on the scale, and record the data in the writing book.
9. Repeat step 8 with all almonds from both the water and milk solution.
10. Lastly, thoroughly was the glass jars, dispose of the almonds, and return all equipment to their initial placement.

Risk assessment:

Safety issues: it is dangerous to contact, consume, or drink raw milk since it can contain harmful pathogens such as salmonella, campylobacter, E. coli Listeria among others. Therefore, safety gloves were worn when handling the milk to ensure the safety of the person experimenting and minimize any possibility of food poisoning.

Ethical concerns:

The almonds used were bought from the market; hence they were not fresh, and they might have been tampered with. Furthermore, there may also be some ethical issues related to the farming process of the almonds, although not the use of almonds in the experiment. This issue could not be dealt with.

Environmental concerns: there were no environmental issues to be taken into account.

Analysis:

Raw Data Table:

Table 1: The initial and final Mass of the almonds before and after being immersed in water solution and milk solution for 24 hours

The initial and final Mass of the two almonds ±0.5g					
Trials	**Level of sugar (g) in 200mL of solution**	**Milk solution**		**Water solution**	
		Initial Mass of almond (g)	**Final Mass of almond (g)**	**Initial Mass of almond (g)**	**Final Mass of almond (g)**
1	0	4.8	4.665	4.8	4.640
2	20	4.7	4.600	4.9	4.775
3	40	4.9	4.825	4.8	4.795
4	60	4.7	4.655	5.0	4.925
5	80	4.6	4.575	4.9	4.850

Processed Data Table:

Table 2: change in Mass (g), the percentage change in Mass of the almonds after being dipped in a water solution and milk solution for 24 hours.

The change in Mass (g), the percentage change in Mass, and the standard deviation of the almonds ±0.01g				
Trials	**Milk Solution**		**Water Solution**	
	Change in Mass (g)	**% change in Mass**	**Change in Mass (g)**	**% change in Mass**

1	0.135	2.60	0.150	3.19
2	0.125	2.13	0.125	2.55
3	0.070	1.53	0.100	2.08
4	0.045	1.06	0.075	1.50
5	0.02	0.54	0.050	1.02

Table 3: The change in Mass, the mean percentage change in Mass, and the standard deviation of the almonds immersed in water solution and milk solution for 24 hours

Mean change in Mass and the mean percentage change in Mass of almonds ±0.5g			
The type of solution the almonds was immersed in	**Mean change in Mass**	**Mean % change in Mass**	**Standard deviation**
Water Solution	0.1	10.34	0.0403
Milk Solution	0.076	7.89	0.0447

Calculating the mean change in mass in water solution:

Mean (x) = $\sum \frac{xi}{n}$

= 0.5/5

=0.1

Calculating the mean percentage change in mass in water solution:

Mean (x) = $\sum \frac{xi}{n}$

= 10.34/5

= 2.068

Calculating mean change in mass in milk solution:

Mean ($\bar{x}$) = $\sum \frac{xi}{n}$

= 0.38/5

=0.076

Calculating the mean percentage change in mass in milk solution:

Mean ($\bar{x}$) = $\sum \frac{xi}{n}$

= 7.89/5

= 1.572

The formula used for standard deviation:

SD = $\sqrt{\frac{\sum|x- \bar{x}|^2}{N}}$

The Standard deviation of the mean change of Mass for almond in water solution = 0.0403

The Standard deviation of the mean change of Mass for almond in sugar solution = 0.0447

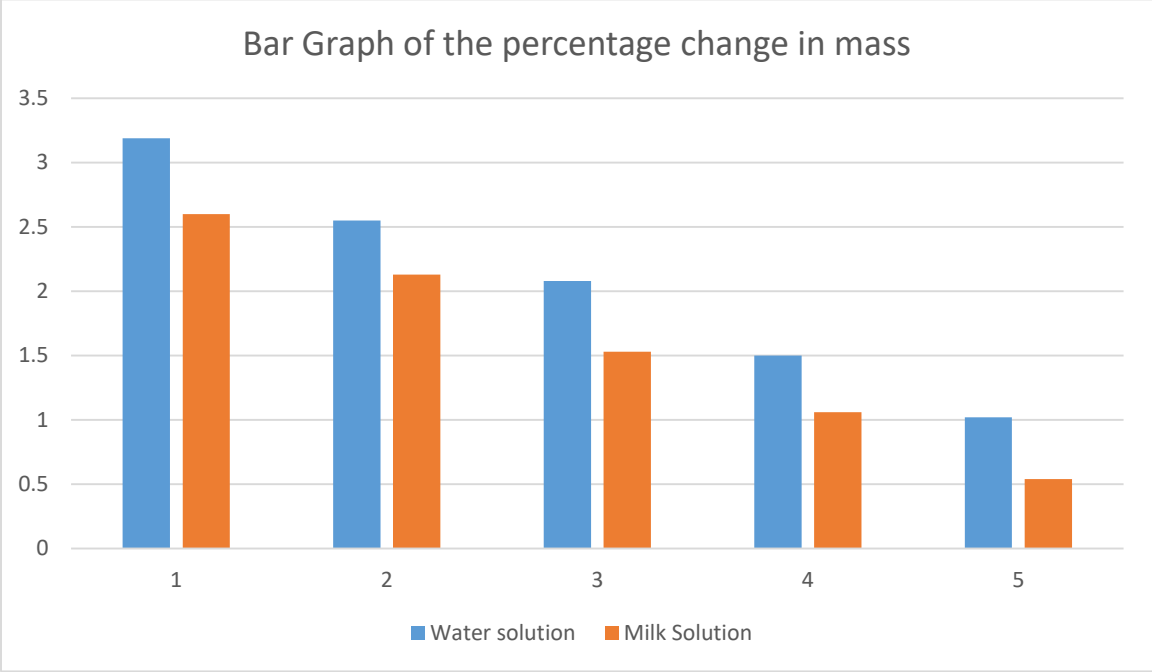
From the standard deviation, the change in Mass differs in both states (when the almonds are inserted in water solution and when submerged in milk solution). This shows that the process of osmosis has taken place. The standard deviation of change in the Mass of almonds in water

solution is greater than that of almonds in milk solution. This indicates that the rate of osmosis process was great in water solution than in sugar solution. From the analysis, a conclusion can be made that the rate of osmosis for almonds was different when placed in two different solutions. Water solution has more water molecules compared to milk solution hence a high rate of osmosis.

Graph:

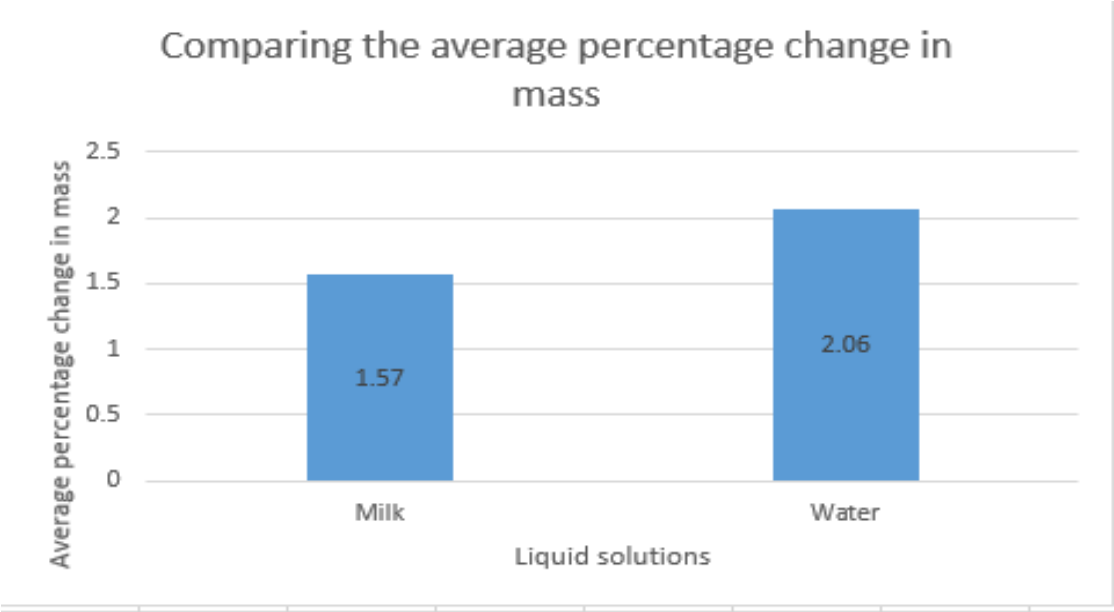
The bar graph shows the percentage change in mass of almonds placed in two different solutions.

Figure 1: Percentage change in Mass



From the graph, the percentage change in Mass of almonds is highest in a water solution that does not has any sugar particles. The graph also shows that the change in Mass in water solution was greater in all the trials compared to milk solution.

Figure 2: The average percentage change in Mass



The graph above shows the significant difference between the average change in Mass of almonds inserted in milk solution and the almonds submerged in water solution. From the graph, it is clear that the water solution had a greater effect on the rate of osmosis as more water molecules were able to penetrate out of the semipermeable membrane. In the milk solution, the graph indicates that the movement of water in exiting the semipermeable membrane was much slower.

Conclusion:

From the analysis, it is clear that the almonds that were placed in water solution lost water through osmosis faster than almonds that were placed in milk solution.

The results of the study support my stated hypothesis. My hypothesis stated that the almonds greatly lose Mass when placed in the solution with high water concentrations (water solution) than that with low water concentration milk solution). The scientific theories previously learned in the class indicated that through the process of osmosis, there would be

various outcomes as a result of the impact of different liquids on a semipermeable membrane, which the experiment and study conducted proved correct. Therefore, the hypothesis that was stated was strongly correct and was verified and the results supported it.

Evaluation:

Evaluating the experimental errors		
Limitation/Weakness	**Effect on investigation**	**Suggested improvement**
<u>Independent Variable</u> The use of milk solution, sugar, and water solution	The independent variable used was enhanced the experiment process in regards to collecting data needed in answering the research question as it showed how osmosis was different in different liquids.	To improve the next experiment, more trials must be conducted to be to have extra data for major comparisons.