Student Name

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Course

Date

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

Introduction

Osmosis is a solvent's movement from a region of high solute concentration to a low solute concentration region through a semi-permeable membrane. A solvent is a substance that dissolves a solute like water. A solute can be defined as a substance that dissolves in a solvent like sugar (Marbach et al 3103). This experiment will be used to investigate the rate of osmosis using different mixtures. The first mixture will be water mixed with different sugar concentrations, and the second mixture will be milk mixed with different concentrations of sugar. Sugar in this experiment is used as a solute, and when mixed with a solvent, in this case, water and milk will result in solutions with different concentrations.

Based on the definition of osmosis, when almonds are submerged in plain water and milk, the molecules of water will move from where they are highly concentrated in this case, they are highly concentrated in water and move to where they are less concentrated in this case they are less concentrated in almonds. When the same almonds are placed in the highly concentrated solution, the whole process will reverse, and water molecules will now tend to move from almonds where they are highly concentrated to the solution where they are less concentrated. This research was picked to prove whether what was covered in theory proves to be realistic and how it can be implemented in real life. The findings in this experiment will be used in understanding different real-life biological activities.

There will be two liquids in this experiment (Water and Milk), both with different sugar concentrations, which will be ideal for the process of osmosis to take place. When the

almonds are placed in water, water concentration is less in almonds, and hence the almonds will absorb water molecules, therefore increasing mass and volume. In contrast, when almonds will be submerged in milk, there is high water potential in milk than in almonds; hence the water molecules will move from the milk to almonds where there are less concentrated causing the almond to increase in size and mass, but the increase is minimal compared to the almonds placed in water solution. I will conduct two different sets of experiments. In the first experiment, I will put almonds in different jars containing 250mL of water with different sugar concentrations. In the second experiment, I will put almonds of the same mass in different jars containing 250mL of milk with different sugar concentrations in a period of 48 hours. In this experiment, I will conduct five different trials, and after each trial, the mass of the almond will be recorded, and the data that will be obtained will be used to draw conclusions based on the calculations.

Hypothesis

In this experiment, I forecast that the almonds placed in a sugar solution will have a high increase in mass depending on sugar concentration. In the jar with plain water, the almond mass will be high than the almond that will be placed in the jar containing a high level of sugar concentration. In contrast, the almonds placed in a jar containing milk solution will have a minimal increase in mass compared to the almonds placed in water solution. This increase in mass will take place until an equilibrium level is reached. Equilibrium is the state where the water molecules in the almond are equal to the number of water molecules in any solution; hence the process of osmosis will stop.

Variables

Variables	How they will be controlled
Independent Variables -Water with different concentration -Milk with different sugar concentration	Water and milk solution with different sugar concentration is ideal for osmosis to take place. The concentration of water molecules in both solutions is different. The concentration of water molecules in sugar solution is concentrated compared to the water solution in milk solution, which is less concentrated. Almond submerged in both sets of solutions will determine if the almond size will increase or decrease depending on the type of solution and the concentration of the solution, thus providing me with a different set of data. The concentration of sugar will be manipulated, and the results will change in each experiment, thus leading to data that is quantitative. By changing these solutions and manipulating their concentration, the osmosis rate will change, and each almond's mass will increase or decrease.
Control Variable -Almonds 10 different pieces -250 ml plain water -250 ml water and 5g sugar -250 ml water and 10g sugar -250 ml water and 15g sugar -250 ml water and 20g sugar	The amount of water and milk in the jar will be controlled by measuring 250mL of water and milk in different jars and then measuring the corresponding mass of sugar using an electronic beam balance to enable the accuracy of the results. Labelling of jars is critical to make sure the accuracy of the results. The time the almonds will be socked in the solution is 48 hours, and this should be the

-250 ml milk -250 ml milk and 5g sugar -250 ml milk and 10g sugar -250 ml milk and 15g sugar -250 ml milk and 200g sugar	same in all the experiments to ensure the accuracy of the results; hence a stopwatch will be used. The mass of almonds must also be recorded as the initial mass. After every experiment has been set up, it is imperative to record the time to enable the integrity of the results that will be produced.

Apparatus

Apparatus	Quantity	Uncertainty level
Almond seeds	10	-
250mL glass jar	2	-
Sugar	100 grams	±1g
Water	250mL per glass jar	±1mL
Milk	250mL per glass jar	±1mL
Electronic weighing balance	1	±0.05g
Stopwatch	1	±1minute
Glass beaker 300ml	2	±1mL
Labels	10	-
A computer for data recorder	1	

Methodology

1. Collect all the materials needed and place them on a bench. Label the glass jars depending on the amount of sugar and label the jar with plain water (1).
2. Take the electronic balance and measure each almond seed's mass and then record the mass as initial mass. Put the almond seeds into the labeled glass jar.
3. Measure 250ml of water and put it in five different jars.
4. Take electronic balance and measure the mass of sugar (5g, 10g, 15g, and 20g) and put in the jars that have been labeled, and stir the mixture.
5. Put the almond seeds in a jar labeled jar (1) and record the time. Repeat this with other jars and record the time, respectively.
6. Label the second set of jars depending on the amount of sugar that will be placed in each jar as a jar (1) containing no sugar, jar (2) containing 5g of sugar, jar (3) containing 10g of sugar, jar (4) containing 15g of sugar and jar (5) that contains 20g of sugar.
7. Measure 250mL of milk and put the milk in five different glass jars.
8. Repeat steps 2 and 4 above.
9. After 48 hours, measure each almond's mass and record the mass as the final mass against the initial mass recorded above.
10. Dispose of the almond seeds and milk solution, wash the apparatus, and return the storage apparatus.

Risk Assessment

Safety Issues

Drinking raw milk may contain harmful bacteria, which may be harmful to human health. This bacteria associated with raw milk may lead to the foodborne disease commonly referred to as food poisoning (Wenten 123). Much care hence must be taken into consideration to make sure the milk is not taken raw. Handling this apparatus, which is glass in nature, must be done with great care to avoid accidents in the laboratory or the place the experiment is taking place.

Ethical concerns

The use of milk and almonds in this experiment may be deemed as ethical as they are believed to be food; however, this is an issue that cannot be solved.

Environmental issues

The disposal of the end products (Almonds and milk) must be put into consideration. This product must be disposed of in designated locations to ensure these concentrated items are destroyed and not consumed by human beings as they are maybe poisonous. Milk that is mixed with a high level of sugar and stored for 48 hours will be impure.

Analysis

Table 1. The final and initial mass of almond in water with different sugar solution in 48 hours.

Mass of sugar (grams)	**The initial mass of almond (grams)**	**The final mass of almond (grams)**	**Change in mass (Final change – initial change) (grams)**	**% change in mass**
0	1.40	1.46	0.06	6.0
5	1.46	1.50	0.04	4.0
10	1.43	1.46	0.03	3.0
15	1.45	1.47	0.02	2.0
20	1.49	1.50	0.01	1.0
Total (x)			0.16	

The average change of the whole dataset can be calculated as follows.

$$\text{Average mean (x)} = \sum \frac{x}{n}$$

X is the average number of mass and n is the number of times an experiment was carried out.

0.16/5

=0.032

The average percentage change for the whole dataset can be calculated as follows. The

$$\text{Average Mean (x)} = \sum \frac{x}{n} * 100$$

(0.16/5)*100

=0.032*100

=3.2%

Standard deviation is the amount of dispersion in respect to the relative mean. The formula for standard deviation is:

S.D= $\sqrt{\frac{\sum|x-\mu|^2}{n}}$

Where S.D is the standard deviation and μ is the mean.

S.D= 0.0544

The standard deviation of the dataset used in this experiment is 0.0544, which is less than 1. This indicates that there is no significant deviation from the values used in this experiment.

Table 2. The final and initial mass of almond in milk with different sugar solution in 48 hours.

Mass of sugar (grams)	**The initial mass of almond (grams)**	**The final mass of almond (grams)**	**Change in mass (Final change – initial change) (grams)**	**% change in mass**
0	1.43	1.48	0.05	5.0
5	1.45	1.49	0.04	4.0
10	1.48	1.50	0.02	2.0
15	1.43	1.44	0.01	1.0
20	1.47	1.475	0.005	0.5
Average mean (x)			0.125	12.5

The average change of the whole dataset can be calculated as follows.

$$\text{Average Mean} = \sum \frac{x}{n}$$

X is the average number in mass and n is the number of times an experiment was carried out.

0.125/5

=0.025

The average percentage change for the whole dataset can be calculated as follows. The

$$\text{Average Mean} = \sum \frac{x}{n} * 100$$

(0.125/5)*100

=0.025*100

=2.5%

Standard deviation is the amount of dispersion in respect to the relative mean.

$$\text{S.D} = \sqrt{\frac{\sum |x-\mu|^2}{n}}$$

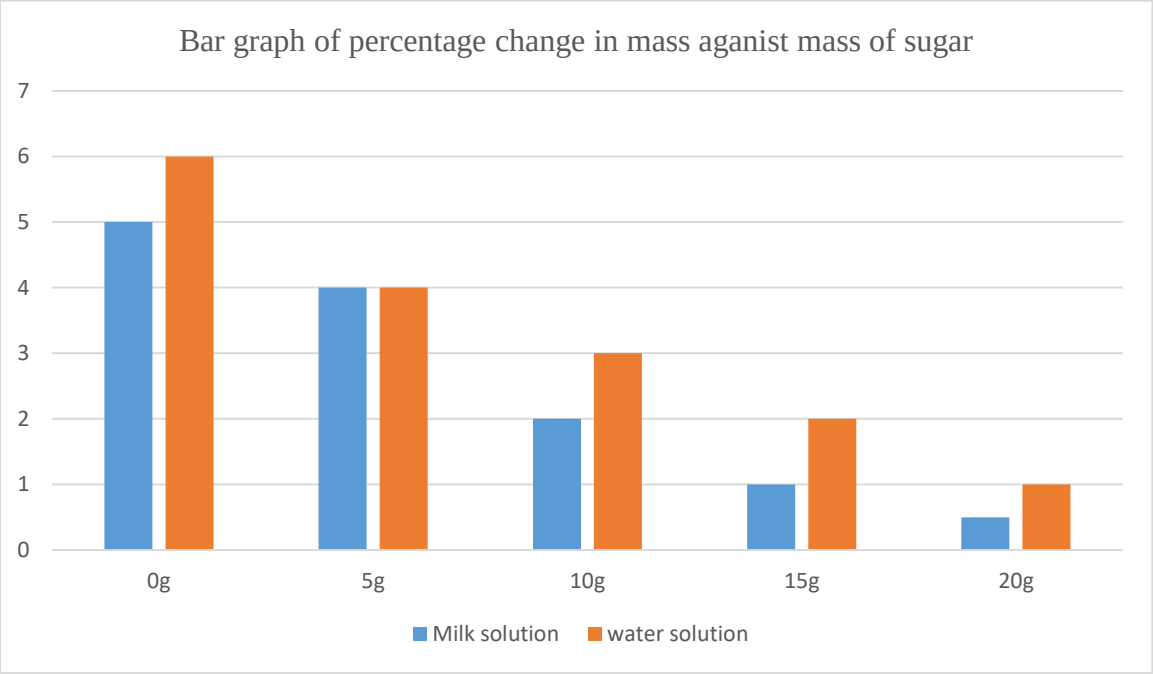
Where S.D is the standard deviation and μ is the mean.

S.D= 0.01732

The standard deviation of the dataset used in this experiment is 0.01732, and this value is less than one. This indicates no big difference or deviation from the data used and hence satisfies the research question.

Graph

The data that I have collected can be represented in graphical format. I have used bar graphs to represent this information showing the percentage change in almonds' mass against the sugar concentration of each solution (water and milk solution).



From this graph, it is evident that the highest percentage change in mass of almond is in water solution compared to milk solution hence the rate of osmosis is highest in water solution than in milk solution this is because milk solution has fewer water molecules hence slowing down the rate of osmosis.

Conclusion

This experiment's main aim was to determine the difference in the rate of osmosis in water and milk, both having different sugar concentrations. It is evident from the experiment that the almonds that were placed in water solution have the most significant difference in mass compared to the almonds that were placed in milk solution. The almond that was submerged in pure water gained more water. As the level of sugar concentration rises, almonds mass tends to rise insignificant values. Almonds that were placed in 50g of sugar has the least difference in mass. The almonds that were placed in milk also gained weight, and as the sugar concentration rises, the almonds tend to gain the least weight. The almonds in a jar with 50g of sugar had a very little mass difference, almost insignificant.

This change in almond mass can be attributed to the fact that almonds have a minimal amount of water, thus forming a low water concentration region when submerged in water and milk. In this experiment, the process of osmosis is evident by the fact that in each almond placed in both water and milk solution, they gained mass. From this experiment, it can be concluded that the rate of osmosis is directly proportional to the number of water molecules in a given solution. There are fewer water molecules in milk solution; hence there is little change in mass as compared to the change in mass for almonds placed in water and water solution. The results of this experiment prove the hypothesis was correct. In my hypothesis, I stated that the almonds that will be placed in sugar solution would have the most significant change in mass instead of the almonds that will be placed in milk solution. This experiment proved that the hypothesis was correct and legit, as proved by the hypothesis's results.

Evaluation

The table below shows and evaluates errors that might have occurred during the experiment, their effects on results, and how these errors can be corrected or minimized.

Weakness	**Effects on Experiment**	**Improvement to reduce errors**
Independent variables The use of water and milk solutions.	The use of independent variables (water and milk) solutions proved effective to the experiment. However, the solutions were not standard as sugar was added directly to come up with the solution. The weighing balance may not be accurate, and a small	This weakness can be minimized by using tailor-made solutions with specific sugar solutions, enabling the data to be more accurate and useful.

	error in measurement can result in inaccurate data.