Effect of Osmosis on Gummy Bears in Salt Solutions
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INTRODUCTION

In this lab, the effect of osmosis on a gummy bear placed in a salt solution will be examined. Prior to starting the lab, knowledge on cell transport and how materials enter and leaves a cell is required. In a living organism, the cell membrane is what allows different molecules to enter and leave the cell. It is selectively permeable in living organisms and can differentiate molecules, even if they are the same size. This is the main difference between a living organism and a non-living item, like a gummy bear. Items that are non-living are semi-permeable. They do allow certain substances or molecules to leave and enter the item, but cannot differentiate the specific molecules.

The gummy bear in the lab is going to be a prime example for osmosis, which is the flow of water from an area of high concentration to low concentration. What determines the concentration is tonicity. In comparison to the cell's (or item's) concentration, a solution can be isotonic, hypotonic, or hypertonic. When the concentration of solute in the cell's cytoplasm and in the solution is equal, it is deemed isotonic. This means that the cell will not gain or lose any water. If the concentration of the solute in the cell's cytoplasm is greater than the concentration of the solute in the solution, then it is referred to as hypotonic. In a hypotonic solution, the cell will swell and may possibly burst. Lastly, if the concentration of solute in the cell's cytoplasm is less than the concentration of solute in the cell's solution, then the solution is hypertonic. In hypertonic solutions, the cell will shrink and crenate.

The knowledge of tonicity and cell transport will help guide the experiment along. The gummy bears in this lab are non-living, therefore, they are semi-permeable. Water is going to be entering and leaving its semi-permeable "membrane". The gummy bear will be placed in water and salt solutions to observe the effect of osmosis. Water is predicted to enter the gummy bear when it is placed in a regular solution of water, due to its hypo tonicity. Water should also leave the gummy bear and shrink it when it is placed in a salt water solution because of its hyper tonicity. These key concepts will all be observed in the lab as the gummy bear will be carefully observed in mass and volume after being put into different solutions of water and salt.

PREDICTION

If a gummy bear is placed in water, then the gummy bear will swell. If a gummy bear is then placed in a higher salt water concentration, then the gummy bear will decrease in volume and mass.

HYPOTHESIS

The mass and volume of a gummy bear that is placed in a salt solution will decrease due to the effect of osmosis. When placed in water, a hypotonic solution, the gummy bear will expand in size and volume due to the water entering it. However, if it is placed in a salt solution, it will decrease in size and volume due to the water leaving and entering the solution to create an isotonic solution.

MATERIALS

- 5 250ml beakers
- Electronic scale
- Ruler
- Table salt
- 5 Orange Gummy Bears
- Paper Towel
- Glass Rod
- Tap Water
- Glass Plate
- Permament Marker
- Tape

PROCEDURE –

Day 1 –

1) Measure the volume of each gummy bear by using a ruler to measure its dimensions (width, length and height in mm). Record results in a table.
2) Measure the mass in grams of each gummy bear by using the electronic scale. Record results in a table.
3) Using tap water, fill 5 different 250mL beakers with 100mL of water.
4) Label beakers from A-E.
5) Place each gummy bear on the electronic scale and measure the mass in grams. Record results in a table.
6) Place one gummy bear in each beaker.
7) Cover each beaker with a glass plate.
8) Record qualitative observations of each gummy bear in a table.
9) Leave the apparatus overnight.

Day 2 –

1) Record qualitative observations of each gummy bear in a table.
2) One at a time, remove a gummy bear from each beaker and place on the electronic scale to measure the mass in grams.
3) Measure the volume of each gummy bear by using a ruler by measuring the height, width and length in mm. Record results in a table.
4) Drain the beakers and refill each beaker with 100mL of water.
5) To beaker A, measure and add 0.5 grams of salt. Stir the mixture with a glass rod.
6) To beaker B, measure and add 1.0 grams of salt. Stir the mixture with a glass rod.
7) To beaker C, measure and add 3.0 grams of salt. Stir the mixture with a glass rod.
8) To beaker D, measure and add 5.0 grams of salt. Stir the mixture with a glass rod.
9) To beaker E, measure and add 8.0 grams of salt. Stir the mixture with a glass rod.
10) Add the designated gummy bear to each beaker.
11) Cover each beaker with a glass plate.
12) Record qualitative observations of each gummy bear in a table.
13) Leave the apparatus overnight.

Day 3 –

1) Record qualitative observations of each gummy bear in a table.
2) One at a time, remove a gummy bear from each beaker and place on the electronic scale to measure the mass in grams.
3) Measure the volume of each gummy bear by using a ruler by measuring the length, width and height in mm. Record results in a table.
4) Drain the beakers and refill each beaker with 100mL of water.
5) Add the designated gummy bear to each beaker.
6) Cover each beaker with a glass plate.
7) Record qualitative observations of each gummy bear in a table.
8) Leave the apparatus overnight.

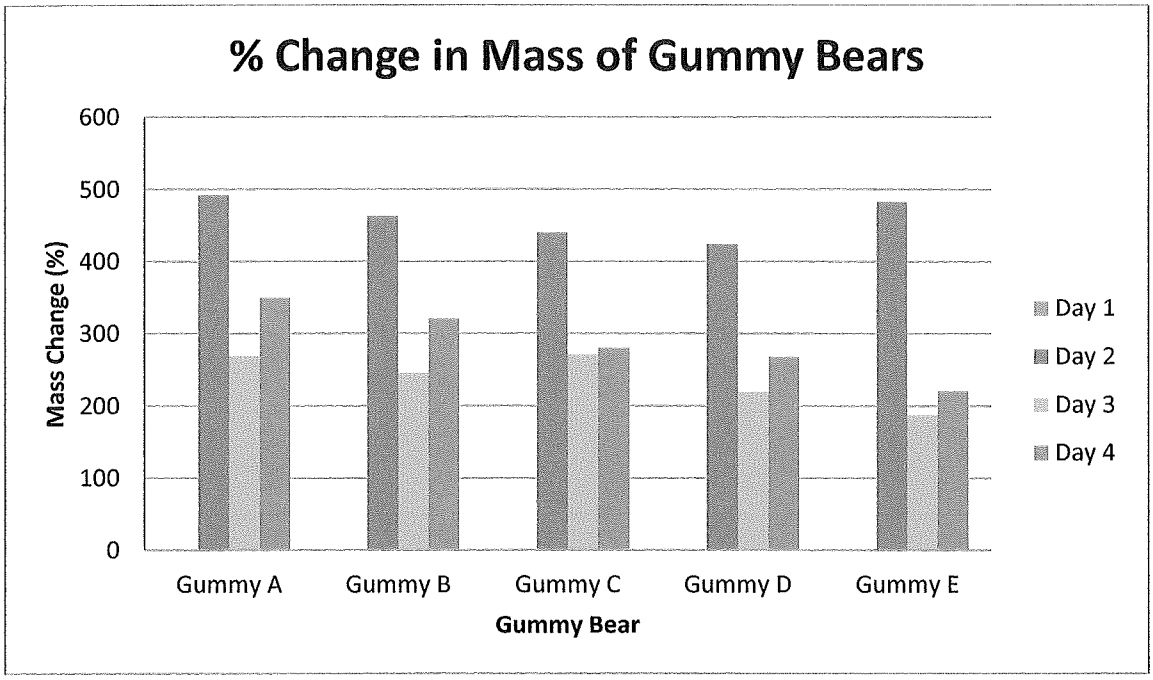
Day 4 –

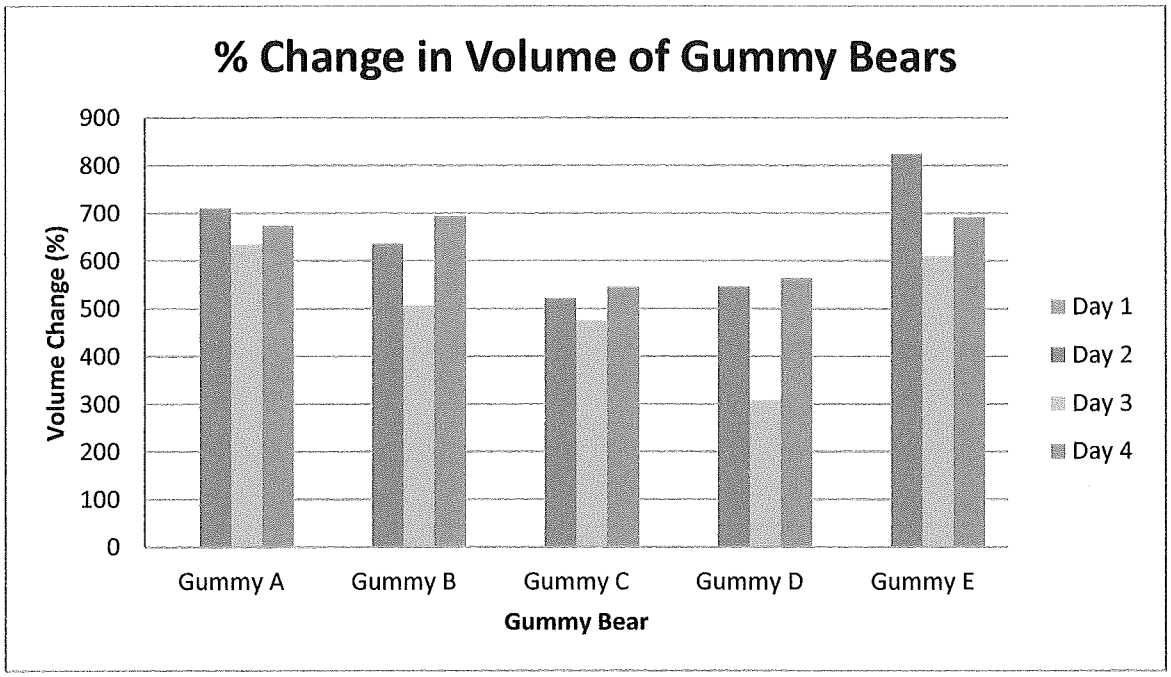
1) Record qualitative observations of each gummy bear in a table.
2) One at a time, remove a gummy bear from each beaker and place on the electronic scale to measure the mass in grams.
3) Measure the volume of each gummy bear by using a ruler by measuring the length, width and height in mm. Record results in a table.
4) Compare and contrast the size and characteristics of the gummy bear from day 1 to day 4.
5) Record all final observations and comparisons in a table.
6) Clean up the stations and dispose of materials appropriately.

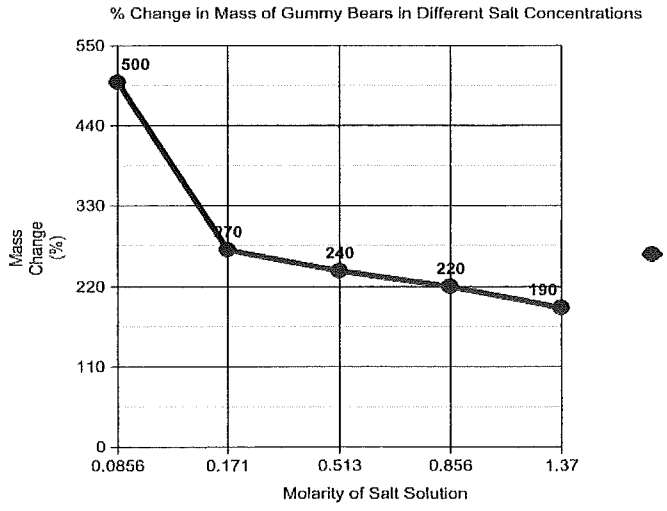
EXPERIMENTAL DATA AND GRAPHS

	Physical Observations		
Day 1			
Gummy A	Original size, clear water, no reaction		
Gummy B	Original size, clear water, no reaction		
Gummy C	Original size, clear water, no reaction		
Gummy D	Original size, clear water, no reaction		
Gummy E	Original size, clear water, no reaction		
Day 2			
Gummy A	Bloated, fragile, pale yellow colour, transparent at edges	Sank to bottom of beaker	
Gummy B	Bloated, fragile, pale yellow colour, transparent at edges	Sank to bottom of beaker	
Gummy C	Bloated, fragile, pale yellow colour, transparent at edges	Sank to bottom of beaker	
Gummy D	Bloated, fragile, pale yellow colour, transparent at edges	Floating	
Gummy E	Bloated, fragile, pale yellow colour, transparent at edges	Floating	
Day 3			
Gummy A	Fragile , Bubbles form around gummy , water turned yellow Gummy is most yellow	Sank to bottom of beaker	
Gummy B	Fragile , Bubbles form around gummy , water turned yellow Gummy is less yellow than A	Sank to bottom of beaker Broken pieces	
Gummy C	Fragile , Bubbles form around gummy , water turned yellow Gummy is less yellow than B	Sank to bottom of beaker	
Gummy D	Fragile , Bubbles form around gummy , water turned yellow Gummy is less yellow than C	Floating	
Gummy E	Fragile , Bubbles form around gummy , water turned yellow Gummy is least yellow	Floating Broken pieces	
Day 4			
Gummy A	Fragile & deformed	Sank to bottom of beaker	Most yellow
Gummy B	Fragile & deformed	Slightly floating	Less yellow than A
Gummy C	Fragile & deformed	Floating in middle of water	Less yellow than B
Gummy D	Fragile & deformed	Floating near top of the water	Less yellow than B
Gummy E	Fragile & deformed	Floating at the top of the water	Least yellow

	Length (mm)	Width (mm)	Height (mm)	Volume (mm^3)	Mass (g)	Density (g/mm^3)
Day 1						
Gummy A	10	9	20	1800	2.4	$1.3x10^{-3}$
Gummy B	11	9	18	1782	2.4	$1.35x10^{-3}$
Gummy C	12	11	18	2376	2.5	$1.05x10^{-3}$
Gummy D	11	10	23	2530	2.5	$9.88x10^{-4}$
Gummy E	9	8	17	1224	2.4	$1.96x10^{-3}$
Day 2						
Gummy A	17	22	39	14586	14.2	$9.74x10^{-4}$
Gummy B	16	20	41	13120	13.5	$1.03x10^{-3}$
Gummy C	19	21	37	14763	13.9	$9.42x10^{-4}$
Gummy D	21	19	41	16359	13.1	$8.01x10^{-4}$
Gummy E	19	17	35	11305	14.0	$1.24x10^{-3}$
Day 3						
Gummy A	18	21	35	13230	8.9	$6.73x10^{-4}$
Gummy B	15	19	38	10830	8.3	$7.66x10^{-4}$
Gummy C	19	20	36	13680	9.3	$6.80x10^{-4}$
Gummy D	17	19	32	10336	8.0	$7.74x10^{-4}$
Gummy E	17	16	32	8704	6.9	$7.93x10^{-4}$
Day 4						
Gummy A	21	17	39	13923	10.8	$7.76x10^{-4}$
Gummy B	23	15	41	14145	10.1	$7.14x10^{-4}$
Gummy C	22	17	41	15334	9.5	$6.20x10x^{-4}$
Gummy D	21	20	40	16800	9.2	$5.48x10^{-4}$
Gummy E	17	15	38	9690	7.7	$7.95x10^{-4}$


% Change in Mass of Gummy Bears
Mass Change (%)
600
500
400
300
200
100
0
Gummy A
Gummy B
Gummy C
Gummy D
Gummy E
Gummy Bear
Day 1
Day 2
Day 3
Day 4


% Change in Volume of Gummy Bears
Volume Change (%)
900
800
700
600
500
400
300
200
100
0
Gummy A
Gummy B
Gummy C
Gummy D
Gummy E
Gummy Bear
Day 1
Day 2
Day 3
Day 4


% Change in Mass of Gummy Bears in Different Salt Concentrations
Mass Change (%)
550
440
330
220
110
0
500
270
240
220
190
0.0856
0.171
0.513
0.856
1.37
Molarity of Salt Solution

ANALYZE AND INTERPRET

1) We predicted that if a gummy bear is placed in water, it will swell. If it is placed in a salt water solution, it should decrease in volume and mass. Both of our predictions were confirmed with this experiment. For example, with Gummy bear A, after being placed in water, the gummy bear increased in mass and volume from 2.4 grams to 14.2 grams and 1800mm^3 to 14586 mm^3. When it was placed into a salt water solution overnight, the gummy bear shrunk in mass and volume from 14.2 grams to 8.9 grams and 14586mm^3 to 13230mm^3. This trend followed for the gummy bears B,C,D, and E, and therefore confirmed our predictions.

2) For Day 1's solution, the solution was hypotonic in respect to the gummy bear. There was a greater concentration of water particles in the solution than what was in the gummy bear. The salt water solution used on Day 2 was hypertonic in respect to the water-saturated gummy bear. The water concentration in the solution was lower than what was inside the gummy bear, therefore to create an equilibrium, water left the gummy bear and entered the solution. For Day 3, the solution was again hypotonic to the gummy bear that was saturated in a salt water solution, as it was placed in a tap water solution. The increase in water particles in the tap water would cause the gummy bear to swell to reach an equilibrium. The only time where the solutions were isotonic was during the points where the gummy bear was saturated and at an equilibrium with the solution.

3) In our experiment, a normal orange gummy bear was used as a control. This was necessary in the experiment because it allowed us to compare and contrast the effects of the water and salt water solutions each day on the gummy bear. We would be able to see any physical changes in comparison to the original gummy bear.

CONCLUSION

4) For this lab, the effect of osmosis on gummy bears was to be examined. Over the span of four days, gummy bears were placed in water and different concentrations of salt water solutions to observe the effect of osmosis. Osmosis is the movement of water molecules from an area of higher concentration to lower concentration over a semi permeable surface. The gummy bear in this experiment will act as the semipermeable surface, allowing water molecules to flow in and out of the gummy bear.

After the gummy bears were placed in water on the first day, they swelled significantly the next day. They became very fragile and soft. The gummy bears were initially a vibrant orange colour, but after being placed in water, they turned a pale yellow colour that was quite translucent. Their length, width, height, and volume increased significantly over night. Their mass also increased. They initially weighed around 2.45 grams prior to being placed in the water, but on the next day, their mass increased to an average of 13.6 grams. Their volume expanded from an average of 2000 mm^3 to 14000mm^3.

This was a prime example of osmosis. Water flowed into the semipermeable membrane of the gummy bear to create an isotonic solution in regards to the gummy bear. The gummy bear initially had a low concentration of water in comparison to the solution of water. Therefore, to create an equilibrium in this hypotonic solution, water needed to flow into the gummy bear. This caused it to swell and gain mass and volume.

After observing what happened to the gummy bears after being soaked in water on the second day, they were then placed into salt solutions of different concentrations. They ranged from a 100ml solution with 0.5 grams of salt (Gummy A) to a solution of 8.0 grams of salt (Gummy E). After leaving them in the solution over night, they were once again examined the next day. The gummies were still very fragile, but this time, Gummies A,B, and C all sank to the bottom of the beaker. However, Gummy D and E were still floating. This means that they were the

densest of the gummies. The colour of the gummies also changed. Gummy bear A was the most pigmented, but was still a pale yellow. It gradually decreased with each gummy, where Gummy E ended up being almost a translucent yellow.

In terms of volume and mass, they also changed depending on the concentration of salt water that the gummy was placed in. All of the gummies shrunk, but at different amounts. Through observation, it can be concluded that a higher concentration of salt water will affect the gummy more significantly. For example, Gummy A was placed in a 0.5 gram salt water solution. Its volume decreased from $14586mm^3$ to $13230mm^3$ and its mass decreased from 14.2 grams to 8.9 grams. It was not as extreme in comparison to Gummy E, which was placed in a solution with 8.0 grams of salt. Gummy E's volume dropped from $11305mm^3$ to a staggering $8704mm^3$. Its volume dropped significantly from 114.0 grams to 6.9 grams.

The gummies were placed into a hypertonic solution when they were placed in the salt water solutions. The varying concentrations of salt water determined how much the gummy bear would shrink. With a higher concentration, the gummy bear would shrink more. This occurred because the solution had a lower concentration of water in comparison to the gummy bear. Therefore, water would flow from the area of high concentration (the gummy) to an area of lower concentration (the salt water solution) to create an isotonic solution.

The gummies were placed in water for the last day to gain further evidence that osmosis would affect the gummy bears. They all swelled slightly and caused the mass and volume to increase. The gummies progressively became less dense starting from Gummy A to Gummy E. Their colour was similar to Day 3 , with Gummy A being the most yellow and Gummy E the least yellow. This lab, over the course of the four days, allowed us to observe and investigate osmosis and gain a greater understanding of the concept.

5) The gummy bears that were provided for the lab were initially bright orange, small, and stiff. Once they were placed in water, they became a pale yellow colour. With the water entering the gummy bear through its semipermeable membrane to create a isotonic solution, the colour began to fade. On Day 3 , the concentration of the salt water solution also affected the gummy bear's colour. With a higher salt water concentration, the gummy became more translucent. This was seen with Gummy E, which turned almost translucent after being placed in a solution of water and 8.0 grams of salt.

The concentration of salt water also affected the size of the gummy. Because they were placed in a hypertonic solution, there was a natural tendency for water to leave the gummy to create an isotonic solution. The greater amount of salt in the salt water solution would cause more water to leave the gummy. Therefore, the gummy would shrink more in a higher concentration of salt water.

6) The size of the gummy bear is dependent on the amount of salt in the salt water solution. With a higher concentration of salt, this means that there is less water in the solution. With less water in the solution, the gummy bear will end up containing a higher concentration of water. Therefore, when it is placed in the hypertonic solution of salt water, there is a natural tendency for water to want to leave the gummy bear to create an equilibrium. This means that the gummy bear will shrink more if the salt water solution is of a higher concentration. This was seen in the lab as Gummy A, the gummy that was placed in the lowest concentration of salt water, shrunk the least. Gummy E, which was placed in a solution of 8.0 grams of salt , shrunk significantly.

7) If the gummy bear was placed into distilled water for another day, I predict that it would end up breaking because it was already saturated from the tap water solution. The tap water contains impurities that the gummy bear was already at an equilibrium with. Therefore, if it is placed in distilled water; it would be placed in a hypotonic solution. This would cause it to swell even more and become more fragile. This might cause the gummy bear to break into small pieces due to its fragility.

8) If we were to use a potato and execute a similar experiment on it, I believe similar results would occur. We could examine osmosis on the potato by replacing the gummy bear in this particular lab with the potato. I believe water would still be entering and leaving the potato through its "semi permeable membrane". Therefore, the results should be similar to those of this experiment. I predict that the potato would swell if it is placed in water, and if it is placed in a salt water solution, then it should shrink in volume and mass. My hypothesis would be similar to this experiment as well. The salt water will cause the potato to shrink due to the effect of osmosis. The salt water solution acts as a hypertonic solution and water will want to leave the potato to create an isotonic solution. The opposite will happen if it is placed in a water solution. Water will act as a hypotonic solution and it will cause the potato to swell as it reaches an equilibrium.

SOURCE OF ERROR

The experiment's results could have been altered due to sources of error that were out of one's control. Because the gummies became so fragile after being placed in water, it was difficult to measure them precisely. They would be lopsided and some parts did break off. This would have given us inaccurate measurements, no matter how hard we tried to keep the gummy in one piece.