

How does the concentration of a sugar solution affect the  
mass of a potato?

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**Introduction:**

The aim of this investigation is to examine the difference in the mass of potato after keeping the in sugar solutions of different concentrations for 24 hours. The water potential will also be calculated.

**Research Question:**

How does the concentration of a sugar solution affect on the mass of a potato?

**Hypothesis:** The larger the concentration of the sugar solution , the smaller the mass of the potato will be, as water moves to a concentration where there is less water molecules.

**Variables:**

Independent: Concentration of sugar solution

Dependent: Final mass or change in mass of potato

Controlled: The concentrations of the sugar solutions, temperature, ????

List of apparatus and materials:

### **Controlling the controlled variables:**

### **List of Apparatus:**

- Lab Quest
- Four potato cores
- 250ML Beaker
- 0M, 0,33M, 0,67M, 1,0M sugar solutions
- A scale (kg +/- 0,001 kg)
- Paper towels
- Plastic wrap

### **Method:**

Step 1: Pour 100ML of sugar solution 250ML beaker .

Step 2: Measure the mass of the potato cores together .

Step 3: Put the potato cores into the beaker of sugar solution.

Step 4: Cover the beaker with plastic wrap and allow it to stand for a 24-hour period.

Step 5: After keeping the potato cores in the solution for 24 hours remove them from the beaker, blot with a paper towel, and measure the mass of the fore cores after soaking.

Step 6: Calculate the percent change in the mass and record your data for the sugar concentration.

Step 7: Repeat the steps 1 -6 for any additional assigned sugar solutions.

### **Data:**

Collection of raw data:

Initial and final masses and percentage change of the mass of potato cores in sugar solutions of concentration 0.33M and 0.67M:

Table 1.0:

Sugar solution concentration	Initial mass (kg) +/- 0.001 kg	Final mass (kg) +/- 0.001 kg	Percentage change (%)
0.33M	0.0381	0.0347	-8.92
0.67M	0.0369	0.0241	-39.14

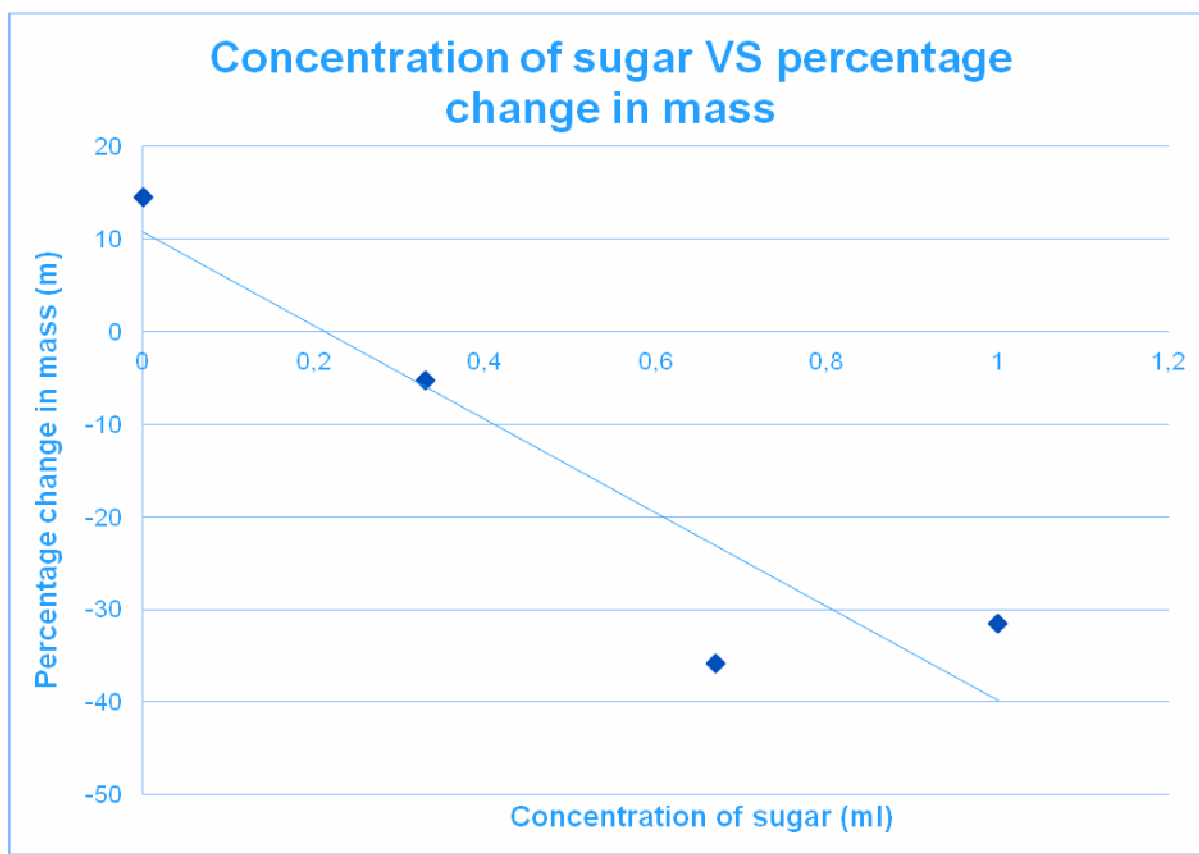
Class average of mass and change of mass in different sugar solution concentrations:

Table 2.0:

Sugar solution	Total mass (kg) +/- 0.001	Percentage change (%)
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concentration	kg	
0.00M	28.96	14.49
0.33M	-31.23	-5.21
0.67M	-143.07	-35.77
1.00M	-126.06	-31.51

Processing of data:



$$y = -50,547x + 10,774, \text{ Correlation} = 0,8542$$

**Calculations:**

Sugar molar concentration:

$$y = mx + c$$

$$y = -50.547x + 10.774$$

$$-50.547x + 10.774 = 0$$

$$x = \frac{10.774}{50.547}$$

$$x = 0.213$$

The sugar molar concentration is used to calculate the solute potential of the sugar solution:

$$\Psi_s = -iCRT$$

$$\Psi_s = (-1.0) \times (0.213) \times \left( 0.0813 \frac{\text{literbars}}{\text{mol}} - K \right) \times (297.65K) = -5.268 \text{ bars}$$

With the solute potential calculated it is possible to calculate the water potential using the formula:

$$\text{water potential} = \text{pressure potential} + \text{solute potential}$$

-Pressure potential is zero, because the solution is at equilibrium

$$\Psi = \Psi_P + \Psi_S$$

$$\Psi = 0P + (-5.268) = -5.268$$

Results:

Sugar molar concentration: 0.213

Solute potential: -5.268 bars

Water potential: -5.268

### **Conclusion:**

The results presented in the graph and table 2.0 show that the sugar solutions with higher concentration of sugar also had a bigger percentage decrease in the mass of the potato cores. The solutions 0.67M and 1.00M experienced a significantly larger percentage change, as the 0.67M solution decreased 35.77% and the 1.00M 31.51%. The mass of the potatoes cores in the 0.33M sugar solution decreased only by 5.21% and the solution with 0.0M sugar concentration caused the mass of the potatoes to increase by 14.49%. The results match the hypothesis to some extent, as the solutions with sugar concentration do cause the mass of the potatoes to decrease, and the two

highest concentrations 0.67M and 1.0M have a significantly higher decrease, because the sugar solution causes the potato to shrink, which is due to osmosis that causes the water to escape the potato cores. Hence the decrease of mass is larger in higher concentrations of sugar solution. However the percentage decrease of mass of the potato cores in the 0.67M solution was higher than in the 1.0M solution, which does not match the hypothesis. This could have been caused by an error, as the results were an average of the results of the whole class, so there could be differences in process between student's and others could have been more successful than others. The potatoes that were in the 0.0M solution, which was purely water experienced a gain in mass, because the water entered their cells by osmosis, as the concentration was higher inside the potato cells than outside.

### **Evaluation:**

The investigation was quite successful as the best fit line of the graph shows a result that is believable. The only thing that didn't go according to the hypothesis, was the percent decrease of mass in 0.67M solution being higher than 1.0M. The difference of percentage change between the two solutions was not however very big. Hence there could have been some kind of error in the results obtained by the class.

Otherwise the investigation seemed to be successful. All the variables that could be controlled were controlled, e.g. keeping temperature constant. There was uncertainty present in the experiment, as the uncertainty of the balance was  $\pm 0.001\text{kg}$ , the beaker had an uncertainty of  $\pm 5\text{ ML}$  and the thermometer was an uncertainty of  $\pm 2\text{ C}$ . These uncertainties are however so small that they have very little effect and are insignificant to the outcome of the investigation.

### **Improvements:**



The experiment could have been performed several times more to get a better and more accurate average of results.