THE EFFECT OF DIFFERENT SALTS ON ONION CELL STRUCTURE

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A R T I C L E I N F O

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A B S T R A C T

The main structure of the onion cell consists of a cell wall which, with its strength and cellulose structure, forms a polygonal cell, the cell membrane, the cytoplasm which contains organelles, chloroplasts and central vacuole, which is the largest part of the cell and includes water and food. In this paper, we intend to compare the effect of different salts on onion cell structure based on their concentration by comparing the cell's situation before and after the experiment. Finally, the purpose of this research, is to study the factors related to the amount of cell osmosis.

Key Words : *Salt,, Onion Cell, Osmotic Pressure, Plasmolysis*

1. Introduction

Have you ever thought about the effect of various salts on the onion cell? for investigating and answering the question raised in this study first, we remove the purple epidermis of the onion cell and then take a picture of its previous state under the microscope, in the Next step, we use a dropper, and then pour a few drops of the salt solution over the sample and after that by taking some pictures at different time lapses, the changes would be recorded in the images.

Walter Stiles and Ingvar Jorgensen, who also published an article in 1918 entitled "On the Relation of Plasmolysis to the Shrinkage of Plant Tissue in Salt Solutions" were the first researchers who examined the relationship between cellular plasmolysis and shrinkage of plant tissue . A few years after Nobur, Kamiya, and Masashi Tazawa in 1955 published an article entitled "Studies on Water Permeability of a Single Plant Cell by Means of Transcellular Osmosis", which in that time this paper developed a new method for the measurement of permeability of the cell to water and other research by different scientists.

But up to now, the factors affecting cellular osmosis have not been discussed precisely, and we intend to investigate this subject more precisely in this article. Other reasons include inappropriate technology, inaccuracy in hygiene conditions, the onion product packaging and storage conditions do not allow the proper use of this product. Osmotic dehydration is a storage method that delivers the highest possible quality by transporting water out of the foodstuff tissue. and by determining the factors related to the amount of cell osmosis, the amount of product osmosis can be controlled so then by using osmotic dehydration, the characteristics quality of the processed product can be improved.

Various factors such as temperature, concentration of osmotic solutions, proportion of sample to solution, time and physical and chemical properties of an onion are effective in the osmotic process.

2. Research Method

For doing the experiments, first, we remove the purple epidermis of the onion cell and then take a picture of its previous state under the microscope, in the Next step, we use a dropper, and then pour a few drops of the salt solution over the sample and after that by taking some pictures the changes would be recorded .

We used purple onions to study the effect of different salts on the structure of the onion cell because it contains the anthocyanins pigment molecule which is purple and make the visibility of the vacuole better under the microscope. We used four types of salts, NaCl, NaBr, KBr and KCl to study the effect of salts because, these are soluble in water and also the number of particles in each molecule of those salts are equal with each other.

3. Experiments

Our experiments are divided into three parts:

Part one: In this section, the variable is type of salt, we used NaCl, NaBr, KBr and KCl solutions with the same mass concentrations (5 percent). We recorded the vacuole changes by taking pictures in this section for all of our salt solutions after 4 minutes we dropped the solution on the onion cell.

Part two: In this section, the variable is type of salt and we used NaCl, NaBr, KBr and KCl solutions with the same molar concentrations (1 molar). We recorded the vacuole changes in this section for all steps in three time lapses of 3, 4 and 5 minutes after we dropped the solution on the onion cell.

Part three: In this section, the variable is the salt concentration for which we used sodium chloride. We used different concentrations of 0.5%, 1%, 2%, 5% and 10%. We recorded vacuole changes in this section for all steps in three time lapses of 3,4 and 5 minutes after we dropped the solution on the onion cell.

Finally, in this paper, the approximate range of hypertonic, isotonic and hypotonic sodium chloride solutions equal with the red onion cell are measured and also the effect of different type of salts on the amount of plant cell osmosis is also examined.

4. The Results

The results of the first part of the experiment:

The diagram shows the plasma membrane length changes before and after the experiment. It should be noted that the cell wall length has not changed (Fig.1).

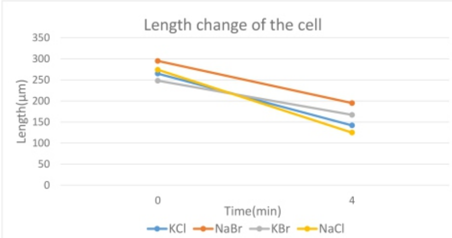

Fig. 1: Changes of the cell wall length Vs time

According to the figure (1), the cell length has decreased in all salt solutions because of the cell plasmolysis which means, the water has exited from the cell. Comparison of the amount of plasmolysis in the salt solutions:

KBr solution<NaBr solution<KCl solution<NaCl solution

According to the table and figure (1), salts with lower molar mass, have higher plasmolysis

Table 1: The molar mass of the salts

NaCl	KBr	NaBr	KCl
58.44 g/mol	119.002 g/mol	102.894 g/mol	74.551 g/mol

The pictures of the cells after the experiment are in figure (2).

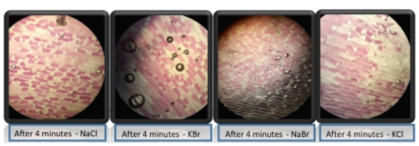

Fig. 2: Different salts on onion cells after 4 Min.

The plasma membrane length changes before and after the experiment are in figure (3). It should be noted that the cell wall length has not changed.

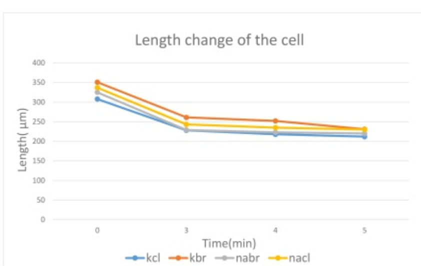

Fig. 3: Changes of the plasma membrane length Vs time

The plasma membrane width changes before and after the experiment are in figure (4). It should be noted that the cell wall length has not changed.

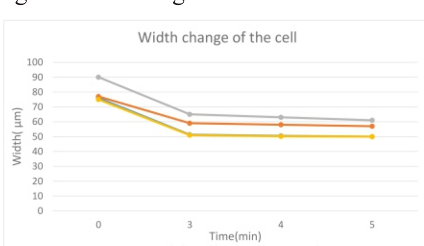

Fig. 4: Changes of the plasma membrane width Vs time

According to figure (3), the trend for all salt solutions was decreasing, so the cell length was reduced, because of the plasmolysis. Also the decreasing trend of cell length for almost all salt solutions has been the same, which can tell us that the type of salt was not effective in the amount of osmosis.

According to figure (4), the trend for all salt solutions was decreasing, so the cell width decreased from its previous state because of the plasmolysis. Also the decreasing process of cell width for almost all the salt solutions has been the same. As a result, the type of salt was not effective. The pictures of the cells before and after the 5 minutes are in figure (5).

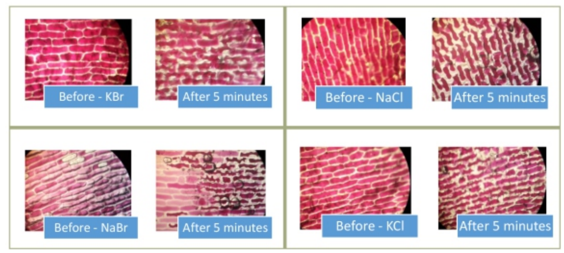

Fig. 5: Different salts on onion cells after 5 Min.

The results of the third part of the experiment:

The plasma membrane length changes before and after the experiment (Fig. 6) (by different percentage of salts). It should be noted that the cell wall length has not changed.

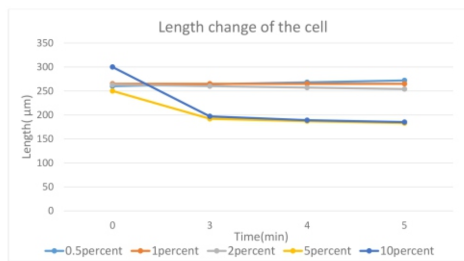

Fig. 6: The plasma membrane length Vs time in different percentage of salts

The plasma membrane width changes before and after the experiment (Fig. 7) (by different percentage of salts). It should be noted that the cell wall length has not changed.

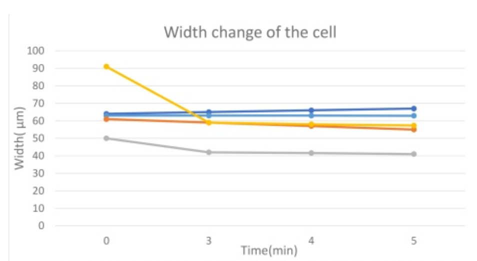

Fig. 7: The plasma membrane widthVs time in different percentage of salts

According to these figures, in 0.5 percent NaCl solution, a small amount of turgency has occurred, meaning that water has entered the cell, thereby the length and width of the cell has increased slightly. Also, in 1 percent NaCl solution, the length and width of the cell has not changed. In 2 percent NaCl solution, the width and length of the cell has decreased a little so a small amount of plasmolysis occurred, meaning that the water was exited from the cell.

In 5 percent NaCl solution, Plasmolysis occurred, meaning that water was exited from the cell, thereby cell length and width has reduced. In10 percent NaCl solution, a lot of plasmolysis has occurred, which means that the water was exited from the cell and the length and width of the cell has decreased Sharply (Fig. 8).

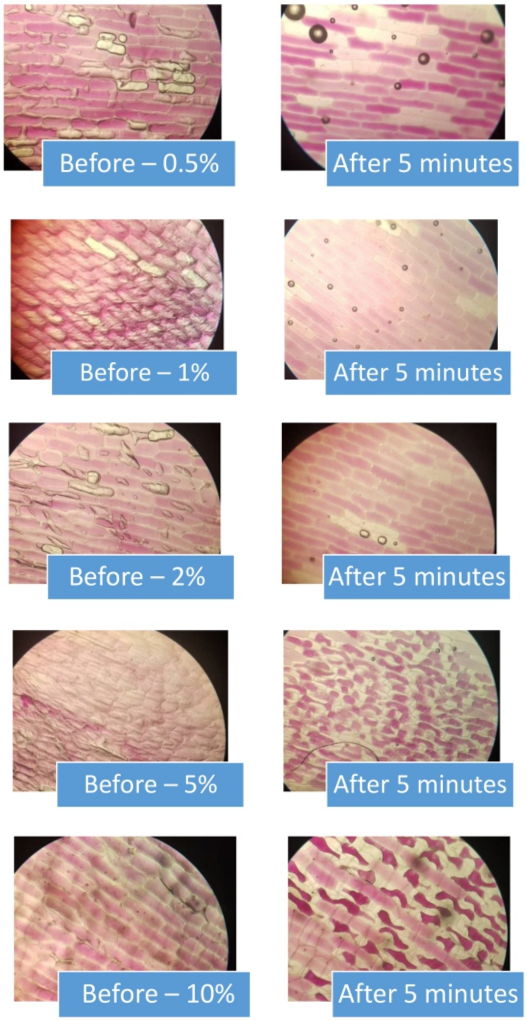

Fig. 8: Different changes in onion cells by different percentage of salts

5 Discussion and Analysis

The cause of cell plasmolysis:

The concentration of the solutes outside the cell is higher than the inside of the cell, and this is true for all the salt solutions we have used. This type of solutions is called hypertonic solutions. As a result, the osmotic pressure of the salt solution is higher than the osmotic pressure inside of the cell.

Osmosis occurs when two solutions, containing different concentrations of solute, are separated by a selectively permeable membrane. Solvent molecules pass preferentially through the membrane from the low-concentration solution to the solution with higher solute concentration. The transfer of solvent molecules will continue until equilibrium is attained so the water molecules will move from the cell to the outside of it. Both salt ions used in each of the four salts are large in size so they can't pass through the cell membrane and also the cell membrane has selective permeability because it is a semipermeable membrane and the cell membrane doesn't let the ions to pass, in fact the system of transportation in our experiments is osmosis because every salt ion doesn't have the necessary conditions to pass through the cell membrane by other transportation systems. so the osmosis occurs and Osmosis only permits water to pass and for balancing the pressure on both sides of the membrane, the water moves from inside of the cell to outside of it so, the cell would shrink.

The largest part of the cell is vacuole where most of the cell's water is stored so most of the water would exit from this organelle and the shrinkage of vacuole affects the shape of cytoplasm so the size of cytoplasm will be lower with the size of vacuole but the size of cell wall wouldn't change (Fig.9).

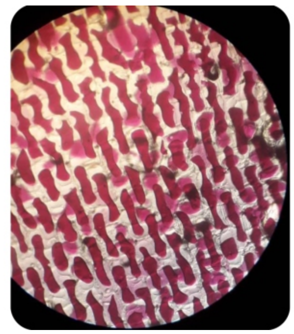

Fig. 9: The shrinkage of vacuole affects the shape of cytoplasm

Analysis of the results of the first part of the experiments:

As mentioned cells placed in salt solutions with lower molar mass had more plasmolysis. This results are because in this section the mass concentrations of our solutions are equal so the molar concentrations of them are different. The mass of one mol of those salts which have less molar mass, is lower. So in the same mass concentrations the salts with lower molar mass have higher molar concentration. As a result, the number of salt molecules in those solutions are higher so they attract more water molecules and because of that the plasmolysis in those solutions would be higher too.

Finally, the aim of this project is to understand the effect of the type of salts on the amount of osmosis, so this type of experiment isn't correct because, the molar concentrations aren't equal so it makes experimental errors. In the next section, the effect of different salts is investigated.

Analysis of the results of the second part of the experiments:

According to this part, the downward trend of cell length and width in all four types of salts was close to each other. So from this section it can be concluded that the type of salt is not effective in the amount of cell osmosis. For proving this part, the van't hoff's equation is needed. With this law the osmotic pressure of a solution can be measured.

The osmotic pressure of a solution is the minimum amount of pressure needed to prevent water from flowing into it across a semipermeable membrane.

The van't hoff equation:

$$\Pi = iMRT$$

Π is the osmotic pressure in atm
I = van 't Hoff factor of the solute
M = molar concentration in mol/L
R = universal gas constant = 0.08206 L·atm/mol·K
T = absolute temperature in K

Osmotic pressure obeys a form of the ideal gas law and can be calculated provided you know the concentration of the solution in molar and the temperature in kelvin because other factors are constant. In this part of the experiments, the molar concentrations and the temperature of the solutions are equal with each other and the other factors are constant. therefore, the osmotic pressure of the solutions is equal with each other. Thus, the amount of pressure required to prevent the water from exiting the cell is the same for all of them, therefore the amount of water would exit from the cell for all four types of salts are equal, so the amount of plasmolysis would be equal too and because of that their downward trend on the chart is almost similar to each other.

Analysis of the results of the third part of the experiments:

The purpose of this section was to show that the effect of salt on the onion cell is not just plasmolysis and the shrinkage of the cell, and various effects can be observed by changing the concentration of the salts in the solutions. The effects of it are divided into three cases, depending on the concentration of solution relative to the concentration of solutes in the cell:

Case One: In this case, the concentration of solution is higher than the concentration of the solutes in the cell, so the water exits from the cell to the outside of it therefore, the cell shrinks. This type of solution is called hypertonic solution and this shape of cell is called plasmolysis.

Case Two: In this case, the concentration of solution is lower than the concentration of the solutes in the cell, so the water enters into the cell therefore, the cell swells. This type of solution is called hypotonic solution and this shape of cell is called cytolysis.

Case Three: In this case, the concentration of solution is equal with the concentration of the solutes in the cell, so the shape of the cell wouldn't change. This type of solution is called isotonic solution.

According to the figures in this section the shape of the cell after the experiment was like this:

0.5 percent solution	Turgid
1percent solution	No change
2 percent solution	little plasmolysis
5 percent solution	plasmolysis
10 percent solution	high plasmolysis

Another thing we can conclude from this part is that by increasing the concentration of the salt in the solution, the molar concentration would be higher so the plasmolysis would be higher too (Fig. 10).

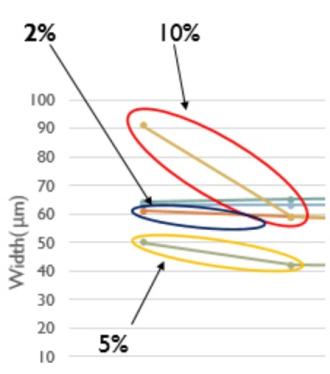

Fig. 10: The molar concentration would be higher so the plasmolysis would be higher too

The approximate range of hypertonic, isotonic and hypotonic sodium chloride solutions are equal with the red onion cell we experimented (Table 2).

Table 2: The approximate range of hypertonic, isotonic and hypotonic sodium chloride solutions

	Lower than 0.5% or equal to it	1 percent	Higher than 2 percent
The type of solution	Hypotonic solution	Isotonic solution	Hypertonic solution
cell shape	Cytolysis and turgid	No changes	Plasmolysis and shrinkage

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