Beetroot plasma membrane investigation 14/2/2011

The main objective of this investigation is to focus on the effect of ethanol (C_2H_5OH) on the plasma membrane of a beetroot. The colour of Beetroots is due to the presence of a red pigment in the cell sap. The purpose of this experiment is to use different concentrations of ethanol in order to find out what is its effect on the plasma membrane of the beetroot.

Aim – To examine the effect of ethanol on the plasma membrane of beetroots by light transmission percentage.

Hypothesis – Ethanol is an excellent solvent for substances as it is quite polar. Membranes are made of phospholipid bilayers. Ethanol dissolves these phospholipids in the membranes of the beetroot cells. This creates gaps in the phospholipid-bilayer of a beetroot cell. The plasma membrane becomes damaged and more 'fluid' can move more easily. The red pigment, responsible for the beetroot's colour, then leaks out.[1] I believe a higher concentration of ethanol will cause more membranes of beetroot cells to be damaged, therefore there will be more leakage of the pigment and the percentage of light transmitted should decrease.

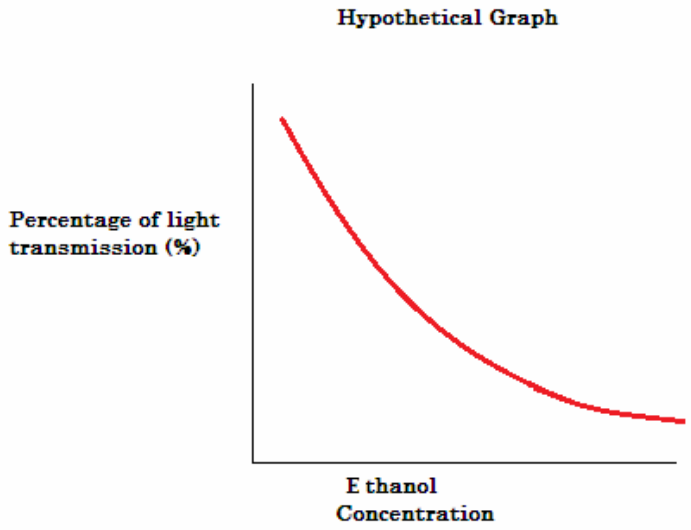


Diagram + Equipment + Method –
Refer to sheet

[1] http://www.madsci.org/posts/archives/2006-03/1143666101.Cb.r.html

Dependent Variable –	• Percentage of Light Transmitted (%)The variable we will be measuring is the percentage transmission of light through the solution of ethanol after the beetroot discs have been in the solution for 15 minutes. It will be measured in percentage transmission by the calorimeter connected to the data logger therefore it will be quite precise.
Independent Variable –	• Concentration of Ethanol: The variable we will be changing is the concentration of ethanol solution used, which will be 0, 20, 40, 60, 80, and 100% ethanol, with an uncertainty of +/- 0.1%.
Controlled Variables –	• Volume of ethanol used – The volume of ethanol will be the same for every slice of beetroot in order to have a just experiment. • Number and size of beetroot slices– The number of beetroot slices in each test tube will be 1 and length of these should be roughly the same. Different numbers of these would prove to be unreasonable as more of the slices would mean more red pigment released. • Time beetroot slices are in solution– This is vital because the time in which they are in the solution is the time by which the red pigment will diffuse out of the disc and dissolve in the solution. Therefore this will have to be kept the same so that the time given for each is fair and equal.

Results –

Table 1. Percentage of light transmissions in each solution of ethanol of all groups (raw data)

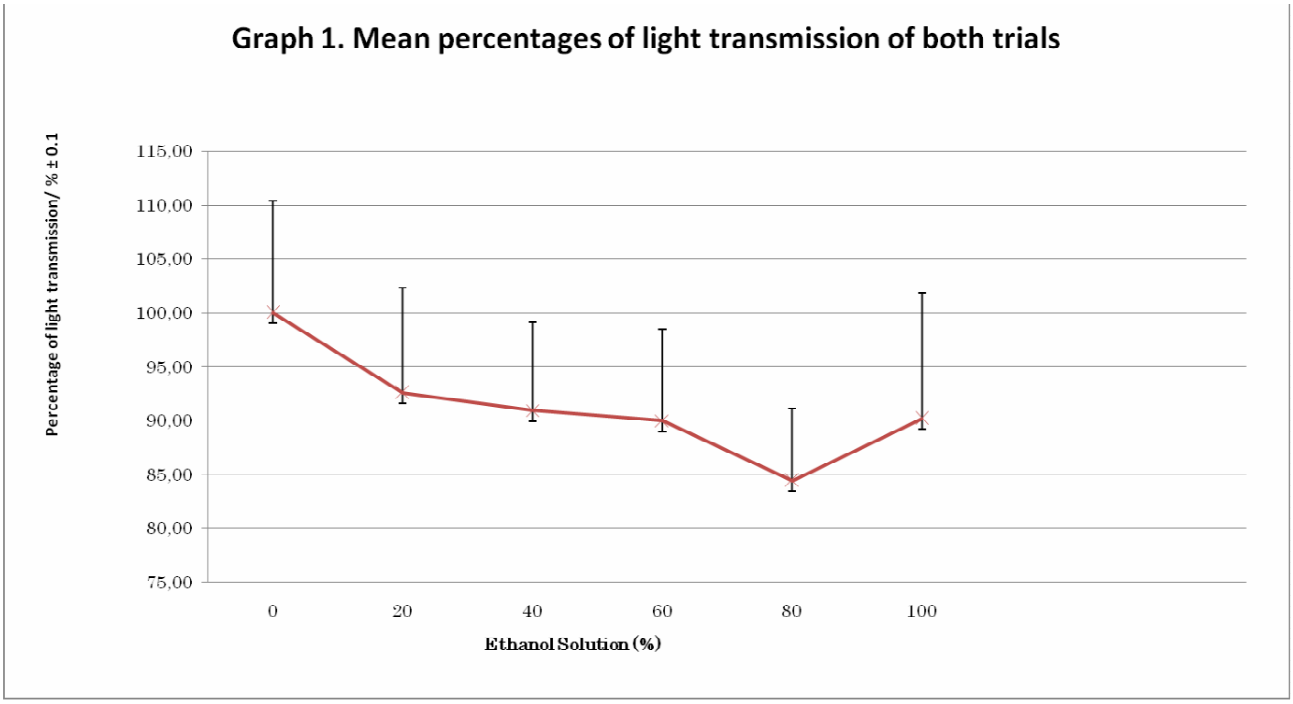
Ethanol Solution/ % ± 0.1	Percentage of Light Transmission/ % ± 0.01									
	Trial 1					Trial 2				
	Group 1	Group 2	Group 3	Group 4	Group 5	Group 1	Group 2	Group 3	Group 4	Group 5
0	100,17	100,23	111,21	100,17	88,06	100,17	100,23	114,24	108,18	86,63
20	93,74	92,41	91,56	100,17	84,79	87,90	76,45	100,50	100,17	72,71
40	86,96	90,15	94,28	94,81	88,45	89,29	88,38	100,01	100,14	71,60
60	82,02	89,66	100,01	100,21	77,90	85,26	82,71	100,01	82,17	86,50
80	78,86	76,45	94,21	86,73	85,66	90,79	75,90	91,29	83,04	91,75
100	87,10	88,45	88,99	85,90	100,35	85,12	61,30	92,85	85,52	105,57

Table 2. Mean percentage of light transmission of each trial and both trials combined

Trial 1 Mean		Trial 2 Mean		Both Trial's Mean	
Ethanol solution/% ± 0.1	Percentage of light transmission/ % ± 0.01	Ethanol solution/% ± 0.1	Percentage of light transmission/ % ± 0.01	Ethanol solution/% ± 0.1	Percentage of light transmission/ % ± 0.01
0	99,97	0	101,89	0	100,93
20	92,53	20	87,55	20	90,04
40	90,93	40	89,88	40	90,41
60	89,96	60	87,33	60	88,65
80	84,38	80	86,55	80	85,47
100	90,16	100	86,07	100	88,12

Table 3. Standard deviation of both the trial's mean combined

Ethanol solution/% ± 0.1	Standard Deviation of percentage of light transmission/ % ± 0. 01
0	8,87
20	9,74
40	8,14
60	8,47
80	6,68
100	11,63



Error bars = Standard Deviation

Calculations –

To calculate the mean all the values for each trial and each value was added for each concentration and divided by the number of samples

E.g.: For trial 1

$$\frac{Group\ 1 + Group\ 2 + Group\ 3 + Group\ 4 + Group\ 5}{5}$$

To calculate the standard deviation of the values in the graph this general formula was used:

$$\sigma = \sqrt{\frac{\sum (x - \bar{x})^2}{n}}$$

σ = standard deviation

$\sum$ = sum of

x = each value in the data set

$\bar{x}$ = mean of all values in the data set

n = number of value in the data set [2]

Conclusion –

With the results shown a certain conclusion can be reached. It seems that the percentage of light transmission is generally directly proportional to the concentration of ethanol. The higher the ethanol concentration the lower the percentage of light transmission measured by the colorimeter was. Hence as more ethanol was put into the beetroot slices, the more membranes were dissolved allowing the pigment to leave the cells and stain the solution outside.

Scientifically, this is because ethanol is a great solvent which means substances can easily dissolve in it. Because of the nature of ethanol as a chemical is it able to get into the cell very easily. This disrupts the balance of the cells' diffusion and osmotic environment. This will therefore lead to more leakage of the cells fluid to the outside, resulting in more red pigment to leave the cell. This will tinge the solution and so less light will be able to pass through in the colorimeter. Clearly if there is more in the solution of

[2] http://geographyfieldwork.com/standa5.gif

ethanol the more it will dissolve the lipids of the membranes and allow this to happen.

Also, more dye would be present as the lipids are essential to the structure of the cell membrane as they control the substances that enter and leave the cell. Ethanol could also destroy some the proteins or denature the structure because protein has a tertiary structure. The ethanol would destroy the hydrogen bonds that hold the protein structure.[3] Therefore, with the lipids and proteins destroyed in the cell membrane, the pigment is allowed to escape from the cell due to there being no cell membrane holding substances in the cell. These results therefore, backup most of my hypothesis except the results with 100% concentrate on which will be discussed later.

Evaluation –

The results from this investigation were quite pleasing and had almost no anomalies. Some anomalous results were found but generally the mean percentage of light decreased proportionally to the concentration of ethanol. The results went from 100,93 down to 88,12% at roughly a constant rate. Most groups had the anomaly of an increase in the 100% concentration. However, some of the groups didn't, therefore no reasonable explanation can be given as it was most likely due to chance. A suggestion of improvement would be to repeat this concentration in order to have more data.

There is still however some variety of results in groups. A reason for this was that the time the discs were in the solution was not generally the same for each. This is because while we took samples from the 0% and 20% the rest were still some seconds longer in the solution which may have created this strange variety.

The number of groups could also cause this variety of results. Some groups could have interpreted data wrong or proceeded differently with the procedure. 5 groups in my opinion are too many groups a more suitable figure would be 3 or 4 as a bigger number of groups would increase the chance of errors and cause uncertainties

One thing we did not control correctly was the volume of samples taken from the test tubes to be put in the colorimeter. A pipette was used but this is considerably inaccurate and difficult to measure exactly (as the numbers are transparent). If more of the sample was taken then the results in the recorder would be most affected as different volumes of solutions have different percentages of transmissions of light. A small measuring cylinder

[3] www.studyzone.com

($10cm^3$) would be most appropriate for this and decrease the chance of mistakes or anomalies.

The standard deviation in both the first graph and the table gives us clues as to where errors might have occurred. Where the standard deviation is large the variety of results for a trial was large, such as the part using 100% ethanol, where the standard deviation was as large as 11.63. I also think that there no substantial errors, like systematic errors, were made but mainly human errors if possible which have been discussed earlier.

Some errors and anomalies can be explained, some not and others we do not know for certain. In all I believe the effect of the anomalous results on the investigation was partly insignificant and can be explained with human errors. Therefore I believe the data is reliable and that this investigation and research was effective and efficient as a whole. The only serious problem is indeed the concentration of 100% ethanol solution.