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Activity 2.7: Why does the colour leak out of cooked red cabbage?

Planning

The aim of this experiment is to use red cabbage to find out the effect of temperature in cell membranes and to relate the effects observed to membrane structure. When cell membranes are heated, the intermolecular forces holding the bonds together between the fatty acids in the phospholipid bilayer becomes weak(due to irregular shapes of the fatty acids in the phospholipids) and the membrane breaks, releasing cell pigment which is a cell content contained within the vacuole. My **hypothesis** for this experiment is that at higher temperatures there will be more pigment released, which means there will be more absorbance of light at higher temperatures; and vice versa. Also my **null hypothesis** for this experiment is that the phospholipid bilayer will not be affected by the temperature and hence no pigment will be released.

There are several variables I must control and keep constant. The independent variable (the variable I will change) will be the temperature at which the red cabbage is cooked. The dependent variable (the variable that changes and that I take readings of) will be the percentage absorbance of light of the cooked red cabbage samples. My control variables are:

- Size of cabbage sample, are they all the same size?
- Part of cabbage used; is the sample from the same part of the cabbage?
- Time – the cabbage is left to let the pigment to leak out
- Volumes of water; both for the water the cabbage is cooked in and the water it is left in to let the pigment leak out**.**

I will use the following apparatus in my experiment:

- Red cabbage
- White tile
- Knife
- Ruler
- Test tube rack
- Thermometer
- Colorimeter
- Cuvettes
- Stopclock
- Measuring cylinders
- Plastic beaker, about 250 cm^3
- 8 boiling tubes
- Tweezers

Safety precautions

Use of hand gloves when using the knife to cut the cabbage pieces as such the knife can possibly cut if not handled with care. Taking care with the boiling water as it could possibly burn your skin. Use of lab coats at all times so as not spill any red cabbage juice or boiling water on the clothes or on the skin as it can possibly stain or burn.

Method

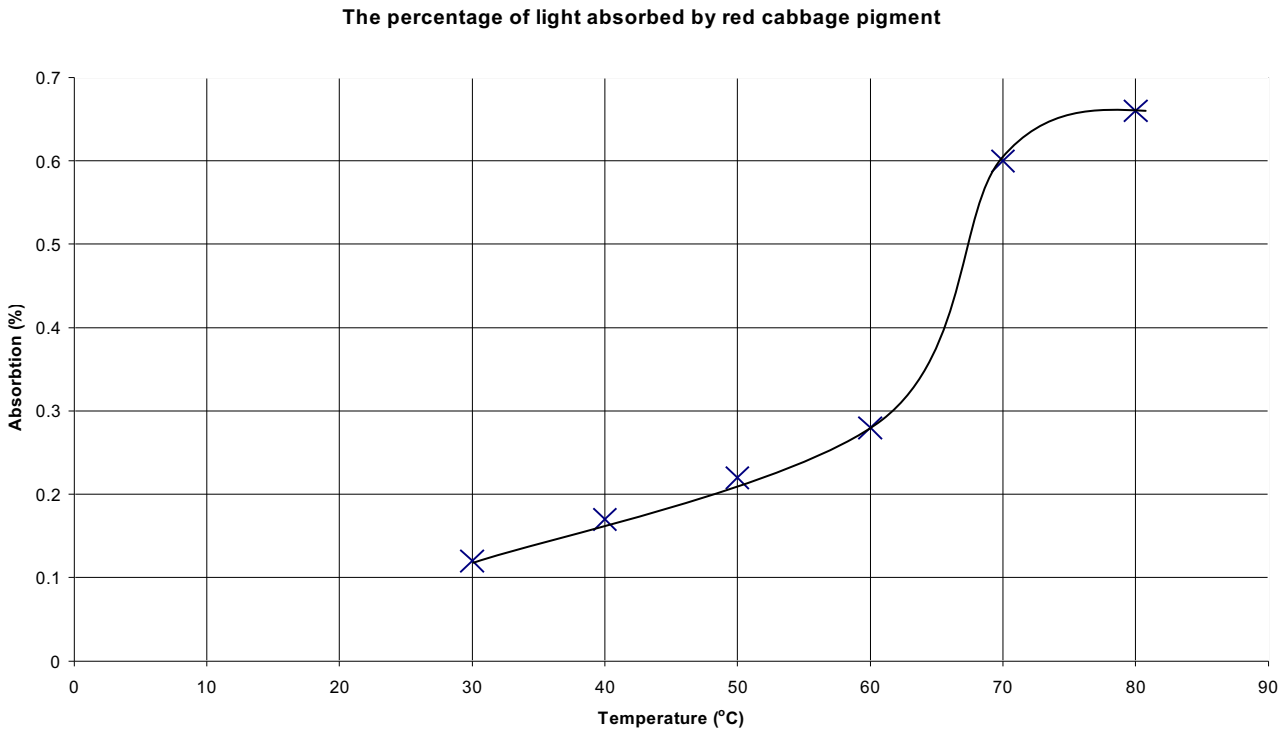
1. Cut sections from a single red cabbage using a knife and cut out 8 sections, 1 cm length slices from these sections.
2. Take 8 boiling tubes in a test tube rack and place one piece of red cabbage into each boiling tube. Label each test tube from 30° C to 80° C.
3. Now take 250cm^3 plastic beaker and roughly half fill it with boiling water. With the help of a thermometer, the temperature of the boiling water should be exactly 80° C.
4. Take the piece of cabbage sample from the boiling tube labeled '80° C' and with the help of tweezers place it in the beaker full of 80° C water. Leave it to cook for a minute and then put it back in to the boiling tube containing 10ml of cold tap water. Record the time after the cooked cabbage sample was placed in the boiling tube and leave for 30 minutes.
5. Now repeat the previous step for the remaining temperature: 70°C to 30° C. If the temperature in the plastic or cooking beaker isn't right then by adding either cold or hot water, try to keep the temperature perfect.
6. Next is to prepare cuvette samples for each of the cabbage samples (prepared and left for 30 minutes). This is done by taking a cuvette (rough sided, leaving clear sided unmarked) and pouring it full with red cabbage sample.
7. Set the colorimeter to a yellow filter as such the water would have gone blue in the cabbage sample test tube; because the tap water is hard water and also quite alkaline.
8. Take a cuvette sample with only tap water and place it in to the colorimeter (to 'zero' the colorimeter) and then put the cabbage sample in. Again place the tap water cuvette back in to the colorimeter so as to ensure that it has read the cabbage sample correctly and that the colorimeter goes back to zero.
9. Repeat the experiment at least 3 times with the same section of the cabbage leaf.

Results

I will record my readings in a table like shown below:

Temperature of cooking sample in (°C)	Light absorbance (%)			Average Light Absorbance (%)
	Run 1	Run 2	Run3	
30	0.14	0.13	0.10	0.12
40	0.17	0.15	0.18	0.17
50	0.24	0.20	0.22	0.22
60	0.32	0.24	0.28	0.28
70	0.60	0.54	0.65	0.60
80	0.65	0.62	0.72	0.66

Analysis & Evaluation



After finishing the experiement, the data that I have obtained which is my results table and the graph clearly show that as the temperature increases more pigment is released and hence the results indicate that I have disproved my null hypothesis and so is being rejected whereas I have proved my hypothesis which is being accepted.

I have eliminated any systematic errors that could have occurred when using the colorimeter by the technique I used, which ensured the colorimeter went back to zero, ready for the next red cabbage sample. This not only eliminated systematic errors with the colorimeter readings, but also gave me precise results. But there are some unavoidable random errors in this experiment. The red cabbage samples didn't all have the same amount of pigment and weren't the same volume. This would have introduced errors that would have created a wide range of results, which would have been above and below the line of best fit.
I could have made several improvements in my experiment. Firstly, instead of using a beaker full of heated water, I could have used several water baths, set to the required temperatures. This would be better than using a beaker full of heated water because the water bath's temperature remains almost constant and the beaker full of heated water's temperature changed when the cabbage was being cooked; hence the biggest change being at higher temperatures. The method of cutting out the pieces of cabbage could have been altered by using a cork borer. Although in my method I have made efforts to keep the pieces roughly to the same dimensions with the help of a knife but the cork borer would have made all pieces to the same dimensions. I also found that not all the pieces from the same leaf were the same volume or had the same amount of pigment in it/colour to it. To eliminate any problems from this, I could have cut many pieces from several sections of the cabbage and chose the ones I would use by a method of random sampling.