A Plan of an Investigation of the Effect of Temperature on the Volume of Dye Collected from Beetroot

Aim: - To find out how different temperatures affect the amount of dye diffused from beetroot, using a colorimeter to show the results.

The variables that I will be controlling, measuring and varying within this experiment:

Volume of distilled water used, if more distilled water were to be used in some boiling tubes, the solution that was then obtained at the end would be more dilute and so would allow a higher percentage of light through. However, if less distilled water were to be used in some boiling tubes, then the solution that was obtained would be more concentrated and so would allow a lower percentage of light to pass through.

The percentage of light that is able to pass through the solution of distilled water and pigment, which has leaked out of the beetroot samples.

The length/width of the beetroot samples. It would be impossible for me to get all of the samples to all be 100% the same in size, mass and shape. However, I can make them as similar to each other in size as possible. This is done by using the cork borer (so all samples should have the same diameter), the knife and ruler help in keeping them the same length. If the width/length of the samples differed, then those that were longer and wider would have a greater surface area and more pigment within them that could leak out. Those that are shorter and smaller in width would have less pigment and a smaller surface area and so less pigment would leak out of them.

The time that the beetroot are left in the distilled water for. If some beetroot are left in longer than others then the pigment within those samples will have had more time in which to leak out of the cells, and so the percentage of light that is able to pass through these samples will be less than it should be. However, if some have been left in for a shorter period of time than others, the pigment within them will have had less time in which to leak out and so the percentage of light that will be able to pass through these samples will be greater than it should be.

All the samples should come from the same beetroot. If some samples came from one beetroot and others came from another, then the investigation would become invalid. This is because the cell membranes from one beetroot to another will differ in their permeability. Even within the same beetroot, the permeability of the membranes can differ. However, by using one beetroot, we are ensuring that the membranes of the cells are as similar as we can possibly get them to be. Other beetroots may have less permeable membranes, which would mean that less of the pigment would be able to leak out, others may have a more permeable membrane and so more pigment would be able to leak out of the samples from them.

The shape of the samples. The shape of the samples should be the same, as the volume of two shapes can be the same, but one may have a greater surface area than the other. If some samples are different shapes and so have different surface areas to other, there will be a greater chance for the pigment to leak out through diffusion, as the rate of diffusion can be increased by the amount of

surface area that is available. So, those with a smaller surface area would have less pigment leaking out of them than they could possibly have.

The solution that the beetroot is immersed in. This must be kept the same, as different solutions would affect the permeability of the cell membrane, either making it more permeable or less so. This would mean that some samples would leak out more pigment, whereas others would leak out less pigment, than if all the samples had been put into the same solution.

The pH of the water in which the beetroot is in. This is because pH is a factor that can affect proteins, the hydrogen bonds in the proteins will break if too alkaline or acidic, denaturing the proteins. Therefore this has to stay constant to make sure it does not denature the proteins in anyway, consequently we will use distilled water, which has a constant pH of 7.

Ensuring that the beetroot samples are fully submerged. This is so that the maximum surface area is available for the water to diffuse through by osmosis and so draw the pigment out. If some are not fully submerged, then a lower concentration of pigment will leak out than if it was fully submerged.

Apparatus: -

- Beetroot
- Core Borer (size 9)
- Scalpel
- Tile
- Colorimeter
- Cuvettes
- 250ml Beakers
- Bunsen Burner
- Wire Gauze
- Heat-proof Mat
- Boiling tubes
- Ruler
- 25ml Measuring Cylinder
- Tissue Paper
- Thermometer
- Stopwatch

None of the equipment that I will be using will allow my measurements to be 100% accurate. However, as the same equipment will be used for all samples, these inaccuracies and loss of exactness will not affect the investigation greatly.

Method: -

Using a size 9 core borer, a 4cm cylinder of beetroot will be cut (this will be checked using a ruler) and prepared on a cutting tile. Using a scalpel and the ruler again, the cylinder will be divided into four 1cm cylinders as accurately as possible. This dissection is carried out in order to increase surface area.

The cylinders will be placed into the boiling tube containing 20ml of water. The boiling tube has already been prepared and allowed to sit in a water bath before the preparation of the beetroot has been carried out. This is because as soon as the beetroot pieces enter the boiling tube, the water is already at the correct

temperature, allowing the experiment to happen efficiently. The temperature throughout the experiment will be checked using a thermometer.

Using a stopwatch, I will allow the beetroot at least 30 seconds to become used to the temperature of the water. Bearing in mind the length of experiment time available, I will allow 10 minutes for the beetroots dye to diffuse into the solution. This should be an efficient amount of time for the pigment to diffuse into its surrounding solution.

I shall pour a sufficient amount of pure water into a cuvette. This shall then be placed into the colorimeter. Because it's set to pure water, when the cuvette containing the "dye solution" is added it'll show you how much light is getting through compared to pure water, as a percentage. By moving the dial to 100 on the colorimeter it is set to read 100% light transmission, through pure water. This is called calibrating the colorimeter.

Once carrying out the experiment, the solution containing the dye shall be added to the colorimeter in another cuvette. By using the pure water as previously mentioned, it is then clear to see what percentage of the solution is dye. For example, if the colorimeter was to read 60, (compared to the 100 set on the dial with the pure water) we can see that 40% of the solution is dye. This will be the same for all the other temperatures.

When completing this, I shall then pour the solution into the cuvette, ensuring no spillages, which will then be placed into the colorimeter. These results will then be recorded in a results table, and subsequently plotted onto a graph.
I shall repeat this experiment another 4 times so I have 5 sets of data, at the temperatures, 20, 40, 60, 80 and 100 degrees.