AS Biology Coursework

Investigation into the diffusion of pigment from the cell membrane of Beetroot

Plan

I will be taking sections of unpickled Beetroot and placing it in a test tube with water which will be placed in a beaker of water. The independent variable will be the temperature. I will place the beakers in different temperatures to see how it affects the permeability of the beetroot membrane. This will be measured by how much pigment is released, therefore by the colour of the water. The colorimeter will be used for this in order to make the colour a numerical value meaning it is quantitative not qualitative, meaning it can be plotted on a graph.

Factor	How will it be controlled	Why could it affect Data
Volume of Water	Use a measuring cylinder to produce accurate amounts	Would mean higher concentration of water, therefore pigment will be dispersed more leading to lighter colours
Size	Use a scalpel and ruler for accurate cutting	Bigger pieces would mean more pigment is available and so more could leak out leading to darker colours
Shape/Section of piece of beetroot	Take/use pieces from the same section of beetroot	Will increase Surface Area meaning again more pigment available.
Time beetroot spends in the water	Use a stopwatch to measure the time	Will give the pigment more chance to diffuse.
Colour of the piece of beetroot	Cut from the same section, check to make sure colour looks the same	If it is darker/lighter it will have more/less pigment.
Degree of Dilution	Use distilled water	When pigment diffuses out, it will not show as much as it gets diluted

Equipment

Beetroot – Chosen as it has pigment that will easily diffuse and is also easily detectable. Each piece will be 1cm.

Scalpel – To produce accurate cuts of the beetroot.

Ruler – To accurately measure the size of the pieces of beetroot, allowing extremely similar sized beetroot pieces.

Stopwatch – To monitor/check how long the beetroot has been in the water, ensuring each piece gets the same amount. Each test will last for 10 minutes.

Waterbath – To monitor and maintain the independent variable (temperature). Also, to change the independent variable to what is required using a thermostat.

Beaker – To hold test tube.

Test Tube – To provide place to let the beetroot diffuse.

Distilled Water – Use to let beetroot diffuse. It is clear and so any colour change can easily be monitored. I will be using 10ml in each test tube.

Thermometer – To measure temperature of water, enabling water to be kept at constant temperature. There will be tests every 10° between 10°-80° (including 10° and 80°)

Colorimeter – To measure colour change and make it quantitative so it can be plotted.

Cork Borer – To extract the same sized/section beetroot to allow accurate cutting.

Independent and Dependant Variables

The independent variable is the temperature. I will change the temperature accurately by using the waterbath which has a thermostat and can keep water at the desired temperature. The range I aim to test is every 10° between 10°C and 80°C. This is a good range because it allows a wide range but can easily be achieved. It also covers both hot and cold water. The range is wide enough so that the enzymes should become denatured when reaching the high temperatures and this should show in the results.

I will use colour as my dependant variable. I will measure how much change in the colour of water there is using a colorimeter. A colorimeter is good equipment to use because it is much more accurate at measuring the change of colour, it also gives it a quantitative value meaning that it is numerical and can be used in graphs when producing the results.

Method

I will cut pieces of beetroot out of the beetroot using the corer. They will then be cut to measure 1cm each. Each 1cm piece will be placed into one of the three test tubes. They will then be left at the desired temperature (between 10°-80°) for 10 minutes. It will be ensured that that temperature stays the same by using the thermometer to keep check on the temperature and by heating the waterbath to the correct temperature before putting the beetroot into the test tubes. The temperature (independent variable) will be changed using a bunsen burner to heat the water if needed, or, ice to cool the water if needed.

After the ten minutes the test tubes will be shaken and a sample of the liquid produced will be poured into a cuvette. The colour change (dependant variable) will then be measured by placing the cuvette into the colorrimeter and measuring the absorbance. Each will be given a absorbance value (unit) which will then be put into the results table.

Precautions

I will repeat the experiment three times to make sure that the data can be seen as reliable. This should mean that any errors can be detected resulting in more reliable data.

I will ensure my data is accurate by making sure that I make accurate cuts with the scalpel and follow how to control the factors in the table. Also things such as sing a thermometer to make sure all water starts at right temperature.

Another precaution is to make sure that the colour is consistent all the way through. If it is not then it must be shaken until it is.

There are also health and safety precautions to be taken, such as, wearing goggles when the Bunsen burner is on and eliminate any running around the laboratory.

Diagram

The results will need to be recorded into a table. The table needs to be easy to read and easy to be able to plot on a graph. Here is an example of the table.

Temperature	Absorbance (of beetroot)			
	Experiment 1	Experiment 2	Experiment 3	Average

Once the average has been worked out the values can then be plotted onto the graph. The data will be analysed by looking at the graph and working out a relationship between the temperature and the amount of pigment released. Scientific knowledge will then be used to explain the graph scientifically.

Modifications to the plan

After conducting tests it was decided to wash the beetroot first to produce fairer, more accurate results

A manual waterbath was used instead of an electronic one due to lack of time.

Further Precautions

Heating the test tubes the correct temperature not just the temperature of the waterbath needed to be done.

Analysis

Generally a pattern can be seen on the graph although there is no perfect line and blips are present, a trend can be seen in the fact that there is a decrease in the absorbency. It appears that the higher the pemperature the more it dropped although it is not a solid line. Lower absorbance would mean that the proteins are denaturing and a higher volume of pigment is being released.

The results agree with my prediction. A big factor was that the enzymes denatured after about 40°-50° meaning that the membranes lost control of substances entering and exiting the cell, resulting in more diffusion.

Evaluation

Although the method was quite successful there were things that could have been done to improve the experiment.

I would ensure that I used a electronic waterbath with a thermostat to change the temperature. This would produce more accurate results as the temperature would be able to be kept almost exactly constant for the whole 10 minutes.

Although a general trend in the graph could be seen there were several blips meaning that there was not a constant pattern. To try to eliminate this if the experiment was done again I would try to make sure that the beetroot was extremely similar in colour, they were all washed for the exact same time and that they were cut more accurately so that they were all the exact same size.