Katie Ruck

An investigation to determine the effect of temperature on the permeability of beetroot cells

Evaluation

Although an apparent trend is illustrated by the experimental data plotted, I am reluctant to formulate a valid conclusion on the effect of temperature on the permeability of beetroot cells due to the variability of the results obtained.

Although five repeats were performed, the data collected is not reliable because of variation within the sets of results. This could have been due to various limitations of the experiment. At 30°C for example, the reading for absorbance of light in arbitrary units, was 0.12%. When compared to the results collected from other repeats at this temperature, this appears to be an unusually high value. Further examples of possible anomalous data were 0.03% at a heat treatment of 40°C together with 0.06% at 50°C. If these anomalous results were not included in the mean absorbance plotted, this could have had a significant effect on the overall conclusion. For example, had the reading at 40°C not been included in the mean, the reading plotted at this temperature of heat treatment may not have been lower than the mean result plotted at 30°C, as is shown on the graph by a slight dip.

The size of the range bars causes one to question the reliability of the experimental data. These are especially large at higher temperatures of heat treatment (i.e. 70°C) where the gradient is steepening. At the lower temperatures of 30°C and 40°C, the range bars are overlapping. This means that one cannot be sure whether absorbance of light by the solution at 40°C does indeed decrease when compared to the previous reading. The range bars can be seen to overlap for the remaining temperatures of heat treatment, which means that it is hard to say within the error of the apparatus, what the exact value is. I am reluctant to draw a valid conclusion from the experimental data due to the significantly large percentage range at each temperature of heat treatment. At 60°C for example, the percentage range of the data from each repeat is approximately 300%.

The limitations of the experiment lead one to question the precision of the experimental data and the conclusions drawn from them. A mechanised cutter was used to produce pieces of beetroot with the same cross sectional area. It was made

certain that we cut downwards so that the bores did not converge. However the beetroot samples were not all of the same length. This could result in the beetroot discs having different surface areas and so causing different volumes of anthocyanin to leak out into the surrounding medium at each repeat of every temperature. This source of inaccuracy would have contributed to the variation and unreliability of the results and could be avoided through a technical improvement in the experimental design.

When the discs were impaled on to a mounted needle, a small volume of dye leaked out from the damaged cells. This could not be measured and could have been potential dye lost into the medium, thus affecting the majority of readings for the absorbance of light. To overcome this source of unreliability, the beetroot discs could have undergone heat treatment in a fully permeable bag.

The reliability of the results can be questioned because no accurate method for shaking the solutions before they were poured into cuvettes was employed. The resulting intensities of the solutions could therefore have been incorrect. To avoid this source of inaccuracy a mechanical technique could be used to shake the solutions.

The scales of the apparatus employed influenced the results obtained. For both $70^{o}C$ and $80^{o}C$ a reading of 2.00% was recorded. This was not the actual absorbance of light by the solutions at these temperatures because the scales of the colorimeters did not exceed 2.00. As a result the mean value plotted was inaccurate, thus any conclusions drawn from the data are unreliable. The experiment should therefore be re-planned using either fewer disks, reducing the time periods the samples of beetroot were left in water for or alternatively leaving the discs in increased volumes of water for 20 minutes. The scale of the colorimeter was only accurate to 0.01%. This may have affected the results at $30^{o}C$ and $40^{o}C$, where there was a 0.01 difference. To overcome this source of imprecision and therefore unreliability the scale of the colorimeter used could be altered to give a reading correct to three decimal place. Although it is not certain whether using different colorimeters would have had any affect on the readings obtained, to ensure precision of the experimental data, the same colorimeter should be used to measure the absorbance of light by the solutions.

Although a graduated pipette with $0.1cm^3$ markings was used to measure $6cm^3$ of cold tap water, to ensure high precision of the experimental data, apparatus with

finer divisions could be used. This would allow a valid conclusion to be drawn from more accurate results.

In order to improve the precision of the experimental data, a digital stop clock could be used. The usage of a manual stop clock meant that there were slight variations in the incubation and staggered timings, and even slight variations in timing would introduce a high percentage area. A one-minute delay in removing the disks from the test tube following heat treatment for example would result in an error of 5%.

Further improvements that would provide considerable additional evidence for the conclusion would be to investigate an increased number of temperatures including a wider range between 50^{o}C and 60^{o}C, as an increased number of intervals would show exactly where the phospholipid bilayer of beetroot melts.