The effect of temperature on beetroot membranes essay sample

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Introduction

The cells of beetroot contain a pigment called betalain in their vacuoles. It is kept inside the cells by the membranes. If these membranes are damaged, then the betalain leaks out. The amount that leaks out can be assessed, as the leaked out pigment will color the water surrounding the cells. This information can be used to find out how temperature affects cell membranes.

Hypothesis

Exposing the beetroot cells to a liquid environment (in this case water) with a temperature of 0 oC will keep the membranes intact because there is not energy transferred to the membrane and so it will not be bursting. The results are going to be more or less the same, until we exceed a temperature of 50 oC, because at this temperature most proteins will begin to denature. Then, if we increase the temperature above this, the cell membranes (which are made of proteins) will denature and soon burst and then the betalain will leak out and color the water red. As we keep increasing the temperature, the more betalain will leak out because the cell wall ought to burst faster with higher temperature and it is more certain that all cells will burst. When a cell wall bursts, it requires energy.

This energy it takes from the nearby heat that is in the surrounding water. As it takes energy, the temperature of water in the surroundings will decrease. If we have the cells in a temperature of 50 oC, some cells will denature, but then the temperature of the surrounding water will decrease and the remaining cell membranes will not burst. Therefore it is more secure to state

that all cells will denature in a water temperature 80 oC than 50 oC. It is also safe to state that the amount of leaked betalain will only continue to some level, but then, when there are no more cells with intact cell walls, more cells cannot be burst there will not be more betalain to extract from the vacuoles.

Concluding this gives: If the temperature is increased, then more betalain will leak out of the cell to a certain point.

The fact that the beetroots differed a bit from one to another (some were dryer than other) could be an observation that could affect the results. Also the color of the betalain in water was slight red in the beginning and more red when reaching 80 oC and then suddenly turned yellow when reaching 100 oC. The fact that the beetroot slices did not have precisely same size did also affect the results, because if it has a greater surface area compared to the volume it will be a faster reaction.

PROCESSING OF DATA

For the different calculations the different functions of Excel were used.

In order to do that, table 1 was inserted in Excel.

To find the mean value, go in the column next to Group H, in the same row as Temperature 0. Then point at “ Formula”, then “ Insert Function” and there, pick “ mean”. Press OK. Thereafter, hold down Ctrl, and click on the different values that the different groups got for temperature 0. Press Ok. The mean value is present.

To find the standard deviation, click on the square next to the mean value that just was found. Then point at “ Formula”, then “ Insert Function” and there, pick “ statistics”. In there, pick “ STDAV”. Press Ok. The standard deviation is presented.

The mean value was calculated because the systematic errors become reduced with repetition of trials. The mean value is a more accurate value than if the conclusion is based on one group.

The standard deviation was calculated in order to find out the spread. To know how much the different group’s raw data differed. The mean value would have been more accurate if the standard deviation had been smaller because then the different values would have been approximately the same.

Tab. 1: The mean amount of betalain leaked out from beetroot cells that were placed in different temperatures and the standard deviation for the temperatures.

The “ coloring” of the water increases with the temperature until we reach 100 oC. The standard deviation is also to some extent rising with the temperature. These will be discussed later.

Fig. 1: The mean absorbance of betalain color that was leaked out of the beetroot cells when placed in different temperatures of water. The error bars shows the standard deviation of the data.

The line of best fit would not be relevant in this case because as explained in hypothesis, the betalain will leak out only to some extent, and if we increase

the temperature further, there will be no more betalain left to leak out and color the water.

As shown in the graph, the amount of leaked out betalain increases with temperature.

Conclusion and Evaluation

CONCLUSION

As shown in the graph, the temperature in which the cell membranes begin to denature is about 40 oC – 60 oC. This can be interpreted from the fact that the color absorbance increases dramatically from 40 oC – 60 oC, meaning more betalain has leaked out, and so the denaturing point of protein ought to lie within this interval.

After this temperature, the arbitrary unit kept rising until about 80 oC, where the absorbance of the color is reduced. When reaching 100 oC the absorbance of the color was approximately the same as when having it in 50 oC. But it is safe to state that this means that the cell membranes leaks out the same amount of betalain in 50 oC as 100 oC, because when reaching a temperature of 100 oC surely will lead to that all the betalain from the cell walls have denatured and all the betalain must have leaked out.

Betalains can be divided into betacyanins and betaxanthins. Betacyanins generally appear red to red violet in color and absorb in the 535-550nm range. Betaxanthins generally appear yellow in color and is absorbed in the 475-480nm range.

It is now good to guess that because of the intense heat, the betacyanins transformed to betaxanthins and since the spectrometer was set at 540 nm, it could not absorb so much of the betaxanthins which are best absorbed in the range of 475-480 nm. This proves that it does not at all mean that less betalain has leaked out when the beetroot cells were placed in an environment with a water temperature of 100 oC. It would pretty safe to state that all the betalain has leaked out in a water temperature of 100 oC.

If the real values are compared with the hypothesis it can be said that most of the hypothesis seems to be correct, because it proved to be so that the betalain leakage increased with temperature. On the other hand it has not been stated in the hypothesis that the betalain could change from betacyanins to betaxanthins and therefore show less absorbance though the amount of leaked betalain has increased/stayed same from 80 oC to 100 oC.

WEAKNESSES AND IMPROVEMENTS

A major weakness is that we used a spectrometer. This measures the absorption rate of the liquid, not the real amount of betalain leaked out, which obviously would have given us a better result. That would have been an improvement, because then the fact that the betacyanins became betaxanthins would not matter.

Also, if we had had a more precise way to have equal size of the beetroot pieces it would have helped to get a more accurate and correct result.

Further experiments that could explain the result of the lab in more detail could be if the amount of betalain leaked out would not have been measured at all but only maybe look at cells under microscopes as they get exposed for various temperatures. A more precise denaturation temperature would have been found that way.

References:

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