The effect of temperature on the vitamin c content of lemon juice essay sample

Bar graph showing the effect of changing temperature on the Vitamin C content of lemon juice shown by the number of drops of lemon juice required to turn DCPIP colourless

Comment on Graph:

My bar graph shows that as the temperature of the lemon juice increases so does the number of drops of lemon juice required to turn DCPIP colourless. The error bars were calculated to show one standard deviation either side of the mean, displaying where 68% of the data lay. Mostly the error bars are small indication that my recorded values were all close to the mean therefore reliable. There is some discrepancy with the error bar for my ‘ 60°C’ result with gave it a larger standard deviation of 3. 7 opposed to the other results which had standard deviations of 0. 42-1. 1, this could have been caused by some systematic errors which I will explore in my evaluation.

Conclusion and Evaluation

Conclusion

In my experiment I investigated the effect of changing temperature on the Vitamin C content of lemon juice by looking at the number of drops of lemon juice required to turn DCPIP colourless. The number of drops of lemon juice required to turn the DCPIP colourless indicates Vitamin C content as vitamin C is a reducing agent. DCPIP is blue in its oxidised form[1], so with the addition of vitamin C (or in this case lemon juice which contains Vitamin C) the DCPIP is reduced, forming a colourless substance. Therefore the higher the

concentration of vitamin C, a smaller volume of vitamin C is needed to decolourise the DCPIP solution.

From my results I can infer that changing the temperature had a significant effect on the Vitamin C content of the lemon juice. There was a positive trend between the variables showing that as temperature of the lemon juice increased the number of number of drops of lemon juice required to turn DCPIP colourless increased. This shows that as the temperature of the lemon juice increased its vitamin C content decreased, as more lemon juice is needed to be added to the DCPIP to cause it to decolourise. The mean amount of lemon juice drops required to turn the DCPIP colourless at 20°C was 2. 8, while at 60°C it was 16, this shows a marked increase in the number of drops of lemon juice required to turn the DCPIP colourless indicating a large decrease in the vitamin C content of lemon juice as the temperature increases.

Ascorbic acid, or Vitamin C, is a naturally occurring compound, its structure is illustrated in the diagram on the left. At high temperatures ascorbic acid is broken down by higher temperatures, by affecting the carbon molecules. Heat breaks down the carbon atom bonds, when these then break up they reduce the stability of the molecular chains[2]. This causes the ascorbic acid to lose its reducing agent ability so it can no longer successfully reduce the DCPIP solution.

My data has a reasonably small systematic error meaning that my results were mostly accurate. We managed to do five trials which meant that my results were quite reliable, and the relatively small error bars mean that my

recorded values were close to the mean and therefore precise. I had one major outlier during the fourth 60°C which only required 10 drops of lemon juice while the result from the other trials was between 16-20 drops. This result would have greatly lowered my mean, if I ignore the value from the fourth trial the mean for 60°C increases to 17. 5 instead of 16 so my results are not as accurate. The consistency of my other results means I can assume that this outlier was due to systematic errors. My results are reflected by these other experiments such as the one a found online which directly measured the concentration of vitamin C in different fruit juices at varying temperatures. Their results are shown in the table below.

The findings were very similar to my own, as the temperature increases the vitamin C content also decreases. “ It can be seen from analytical results that the lower the temperature the better the concentration of Vitamin C in fruit juice.”[3] Therefore I can conclude that my findings and my explanation is correct as it is confirmed by an outside source.

Evaluation:

Limitation of the method

How significantly could this have impacted on your results and why

Improvement

When we diluted our lemon juice we didn’t use distilled water we used tap water.

The distillation process removes many of the impurities present in regular tap water or drinking water. These impurities in the water could have interfered with the experiment. As tap water contains other chemicals, compounds and minerals which have the potential to also reduce or prevent the reduction of the DCPIP solution. This would have effected both the reliability and validity of my results.

Next time we would use distilled water to dilute our lemon juice.

To add the lemon juice we had to hold the test tube outside the water bath so we could visually monitor the colour change of the solution. This meat the temperature of the lemon juice and the DCPIP cooled while we were adding the lemon juice.

As temperatures effect on vitamin c is permanent this wouldn't have affected the vitamin c content of the lemon juice but it would have caused the rate of reaction to change as the kinetic energy of the particles would decrease causing them to make fewer collisions therefore reacting slower. As we only waited a few seconds between drops to see If colourlessness had been achieved we may have added one too many drops as the vitamin c hadn't finished reducing the DCPIP, this effects the reliability of my results.

To fix this we should have either conducted the experiment in the thermostatically controlled water bath or waited longer between each drop.

We had to make two ' batches' of diluted lemon juice as we ran out. This means the ratio of water to lemon juice and hence vitamin c content wasn't exactly the same throughout the experiment.

By having different dilutions of lemon juice the vitamin c content would have been slightly different between some of the trials, this means a different number of drops of lemon juice would be required to reduce and decolourise the DCPIP solution. This would have affected the reliability and validity of my results.

Next time we would have diluted a greater quantity of lemon juice with water (at a ratio of 1: 4) at the start of the experiment. We would have diluted 15mL of lemon juice with 60mL of water which would have given us 75mL of diluted lemon juice.

It was difficult to judge when the colour of the solution became colourless. Before the solution was colourless it was a very light pink and it was hard to tell.

Colour perception is subjective this means that there are differences in how individuals perceive colour so what I think is colourless may be light pink to someone else. This meant that we recorded results that weren't actually completely colourless, effecting both the reliability and validity of my results.

Next time a colourimeter could be used. Distilled water would first be measured to calibrate then that result would be used as the measure of ' colourless', so the solution would be measured when it got light pink, then when the reading from the colourimeter was the same as the distilled water we would know that it was colourless.

As we were using droppers there was some inaccuracy in the size of lemon drops, as there was air in the dropper and it was difficult to only drop one drop at a time.

The inaccuracy in drop size means that the recordings of some of our results may not be completely accurate as some larger drops would have caused more colour change as the DCPIP would have been more reduced and less drops overall would have been needed, while the smaller drops would have had the opposite effect. This would have effected both the reliability and validity of my results.

Instead of using a dropper we could have instead used a diji pipet or we could have conducted the experiment as a titration using a 20mL burette to add the lemon juice to the DCPIP and instead of counting drops we could have recorded the number of mL required to decolourise the solution.

While conducting the experiment our lemon juice samples were left exposed to air.

When oxygen in the air reacts with vitamin C, oxidation occurs which is a chemical change that results in the breakdown of this vitamin. â´ This would have caused some of our lemon juice samples to have a decreased vitamin c content due to the prolonged oxygen exposure, this would have caused more drops to be added to cause the solution to decolourise due to the combined breaking down of vitamin c from oxygen and temperature.

We could cover the test tubes containing our 1ml samples and our beaker with the diluted lemon juice with clingfilm to reduce the exposure to air.

While conducting the experiment our lemon juice samples were left exposed to natural and artificial light.

Photodegradaton occurs when vitamin C is exposed to natural and artificial light. â´ This would have caused some of our lemon juice samples to have a decreased vitamin c content due to the prolonged light exposure, this would have caused more drops to be added to cause the solution to decolourise due to the combined breaking down of vitamin c from light and temperature.

In a future experiment we could conduct it in a cupboard to completely reduce light exposure or we could conduct it in a totally artificially lit room to ensure that the exposure to light remained consistent throughout the experiment.

Sources

1) http://uk. answers. yahoo. com/question/index? qid= 20110221071452AA0OHqv

2) http://www. ask. com/question/how-does-temperature-breakdown-ascorbic-acid

3) http://www. pjbs. org/pjnonline/fin1877. pdf

4) http://www. enotes. com/homework-help/how-does-exposure-air-light-temperature-affect-310886