**Vitamin C**

Teacher / Technician Guide





**Researching Chemistry**

**Higher**

Photo: Wikipedia, GDFL

Higher Physics Topical Investigation Skin Cancer—Prevention and Cure

2

**Investigation Brief**

Suntan creams stop harmful UV radiation reaching the skin. Manufacturers’ products are rated with a Sun Protection Factor (SPF). Suntan creams can have SPF values from 6 to over 50.

UV radiation monitors normally measure irradiance in output intensity per unit area. Thus, a typical low intensity UV lamp may emit approximately 10 mWcm-2.

The aim of this investigation is to determine the effect of various suntan creams on the transmission of UV radiation. In particular, the relationship between SPF and absorption should be found.

**Investigation Notes**

UV lamps can be harmful. Make sure that you read the safety leaflet which is supplied with the UV lamp. Some cheap UV monitors do not measure the irradiance of UV radiation. Rather, they give an indication of UV index. It is possible to undertake this investigation with such a monitor, but results will be less reliable and accurate. UV radiation does not pass through many transparent materials (including glass). However, UV transparent acrylics are readily available.

3

**Contents**

Page 3 Overview of the unit and activities

Page 5 Introduction

Page 6 Why is this topical?

Page 8 Media items

**Investigations**

Page 10 **Investigation A** – “Which vegetables contain the most vitamin C?”

Page 14 **Investigation B** – “Does Cooking affect the concentration of vitamin C in vegetables?”

Page 19 **Investigation C** – “Comparing The Vitamin C Content of Fresh with Frozen Vegetables.”

**Technicians Guide**

Page 23 Technicians Guide

Page 29Risk Assessment

**Overview of the assignment and activities.**

**Mandatory Course Key Area:**

**Chemical analysis**

Volumetric titration

Volumetric analysis for quantitative reactions. Standard solutions, acid base and redox titrations.

**Resource Pack: Vitamin C**

This pack provides support and background information for the researching chemistry element of the course. It should be used in conjunction with:

**Researching Chemistry (Higher)Unit**

**Higher Chemistry Course Assessment Specification**

**Higher Chemistry Course Support Notes**

**Chemistry Assignment General Assessment Information**

The assignment has two stages:

• Research stage

• Communication stage

The research stage involves gathering information/data from the internet, books, newspapers, journals, experiment/practical activity or any other appropriate source. Candidates must select, use and record their referenced sources.

Group work approaches are acceptable as part of the research stage when gathering information/data or undertaking an experiment/practical activity, but assessors must ensure that candidates are able individually to meet the evidence requirements of this assessment.

In the course of their assignment, candidates are required to:

* choose a relevant topic in chemistry (the assessor must review the appropriateness of the topic chosen)
* state appropriate aim (s)
* research the topic by selecting relevant data/information
* carry out risk assessment of procedure
* process and present relevant data/information
* analyse data/information
* state conclusions
* evaluate their investigation
* explain the underlying chemistry of the topic researched
* present the findings of the research in a report

The evidence for this assignment will consist of the report. Of the total of 20 marks available for the assignment, the marking instructions provide 16 marks for skills and 4 marks for knowledge and understanding. The table below shows how these marks are allocated to each of the criteria against which the evidence will be assessed.

|  |  |
| --- | --- |
| Criteria | Mark allocation |
| Aim(s) | 1 |
| Applying knowledge and understanding of chemistry | 4 |
| Selecting information | 2 |
| Risk assessment | 1 |
| Processing and presenting data/information | 4 |
| Analysing data/information | 2 |
| Conclusion(s) | 1 |
| Evaluation | 3 |
| Presentation | 2 |

Detailed marking instructions for the Higher Assignment can be found using the following link:

<http://www.sqa.org.uk/files_ccc/GAInfoHigherChemistry.pdf>

**Introduction**

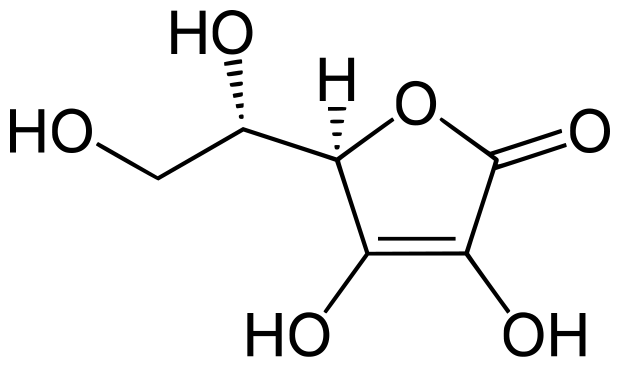
The support pack contains a list of suggested investigative practical work related to the theme of ‘vitamin C’ content in foods. Teachers should feel free to edit these investigations to suit the needs of their own students. For example, some teachers may wish to remove some of the experimental guidance to make the planning process more challenging for able students. Additionally, the list of investigations is by no means exhaustive; teachers are free to develop their own alternative investigation topics to enhance the experience for students.

The Vitamin C support pack for the Researching Chemistry unit contains a selection of three suggested investigations.

|  |  |
| --- | --- |
| Investigation | Title |
| A | A. Which vegetables contain the most vitamin C? |
| B | B. Does Cooking affect the concentration of vitamin C in vegetables |
| C | C. Comparing The Vitamin C Content of Fresh with Frozen Vegetables. |

Many schools are likely to organise the learners into groups for investigative work issuing a different brief with each group. It is vital that teachers ensure that pupil’s research and write up of the investigation is their own work (with the exception of raw data/ results).

**Why is this topical?**

[](http://upload.wikimedia.org/wikipedia/commons/e/e7/L-Ascorbic_acid.svg)Vitamin C

Scurvy, the symptoms of which are haemorrhages, diarrhoea, exhaustion and the tell-tale “scurvy” ulcerated gums, killed many seamen during long sea voyages until, in 1795, the British Navy ordered a daily ration of lime juice for every sailor. This practice earned them the nickname “limeys”, but all but eradicated the disease. The component of the lime juice that prevented scurvy is the reduced form of ascorbic acid, now called vitamin C.

Vitamin C is the compound ascorbic acid with the molecular formula C6H8O6.

The body uses ascorbic acid when making collagen, a protein which helps skin, bone, hair and blood vessels stick together.

Ascorbic acid also helps the body absorb iron.

We need to take in about 90 mg each day. We can store up to one month's supply of vitamin C, but no more. As we cannot make it in the body, we need a constant supply in our diet..

Anyone under stress needs extra vitamin C, because the body will use it up more quickly than in a non-stressed state. Smokers need more vitamin C, because smoking is a 'stress' on the body.

Lots of things are said about vitamin C, for example, taking large amounts is supposed to stop us getting colds and it may help us stop getting some types of cancer.

Ascorbic acid is found in many fruit juices and some vegetables such as broccoli and potatoes.

**Cooking Methods**

Cooking can reduce the vitamin content of food because some vitamins are sensitive to heat, water and air. Water-soluble vitamins are most vulnerable to heat, particularly vitamin C and the B vitamins. The type of food preparation influences the loss of vitamins. Choose cooking methods that use minimal heat and water to preserve the vitamin contents of food.

Vitamin C, is a water-soluble vitamin found in fruits and vegetables, including oranges, strawberries, broccoli, tomatoes and green peppers. It is easily destroyed by excessive heat and water, as well as exposure to air. In studies, boiling caused the most loss, while steaming retained the most vitamin C. An earlier Danish study showed that boiling for just five minutes caused 45 to 64 percent of vitamin C to be lost.

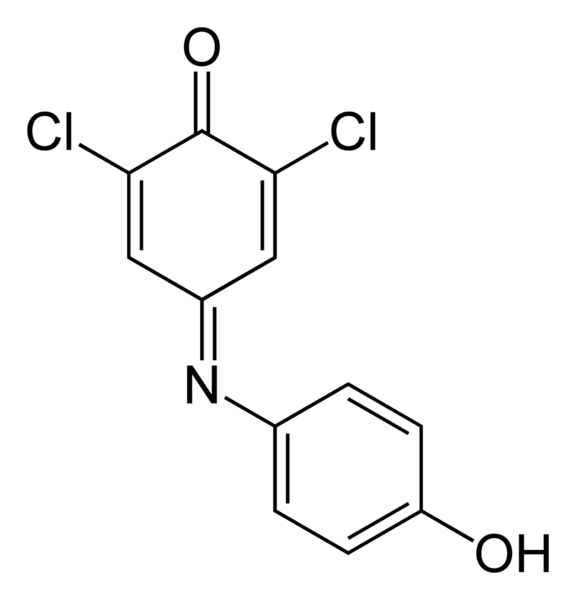
Steaming, microwaving or using a pan or wok with a small amount of water are the preferred cooking methods. The most vitamins are retained when there is less contact with water and a shorter cooking time. In the Danish study, steaming broccoli for five minutes retained almost 100 percent of the water-soluble vitamins. Microwaving and stir-frying reduce vitamin loss because they cook food quickly. Avoid deep-frying. The high heat required for frying destroys heat-sensitive vitamins.

**Fresh v Frozen**

And as winter approaches, fresh produce is limited (or expensive)in much of the country, which forces many of us to turn to canned or frozen options. While canned vegetables tend to lose a lot of nutrients during the preservation process (notable exceptions include tomatoes and pumpkin), frozen vegetables may be even more healthful than some of the fresh produce sold in supermarkets. Why? Fruits and vegetables chosen for freezing tend to be processed at their peak ripeness, a time when—as a general rule—they are most nutrient-packed.

While the first step of freezing vegetables—blanching them in hot water or steam to kill bacteria and arrest the action of food-degrading enzymes—causes some water-soluble nutrients like vitamin C and the B vitamins to break down or leach out, the subsequent flash-freeze locks the vegetables in a relatively nutrient-rich state.

On the other hand, fruits and vegetables destined to be shipped to the fresh-produce aisles around the country typically are picked before they are ripe, which gives them less time to develop a full spectrum of vitamins and minerals. Outward signs of ripening may still occur, but these vegetables will never have the same nutritive value as if they had been allowed to fully ripen on the vine. In addition, during the long haul from farm to fork, fresh fruits and vegetables are exposed to lots of heat and light, which degrade some nutrients, especially delicate vitamins like C and the B vitamin thiamin.

[](http://upload.wikimedia.org/wikipedia/commons/4/42/DCPIP-2D-skeletal.png)**Testing for Vitamin C Content**

2,6-dichlorophenolindophenol (DCPIP) can be used to estimate the concentration of vitamin C in food.

DCPIP is blue when dissolved in water, is red in acid conditions, and is reduced by ascorbic acid (vitamin C) to a colourless compound. However, in this titration, the end point colour change will be from blue to pink due to the presence of the phosphoric(V) acid used to prepare the vegetable extract.

In this unit learners will be find out through experimentation, the concentration vitamin C in particular foods or drinks. The practical experiment includes a titration that is similar to that done at higher level and is often chosen by students as part of their investigation at advanced higher. Experimental procedures are included in the pupil support pack; however you may wish to provide less guidance with more able students.

**Media Items**

**NHS**

<http://www.nhs.uk/Conditions/vitamins-minerals/Pages/vitamin-c.aspx>

**health.com**

<http://www.health.com/health/gallery/0,,20745689,00.html>

**rsc.org**

<http://www.rsc.org/learn-chemistry/resource/res00000569/the-hunt-for-vitamin-c-the-effect-of-cooking-processes-on-the-vitamin-c-content-of-cabbage>

**sserc.org**

<http://www.sserc.org.uk/index.php/higher-chemistry-revised/principles-to-production-h/1136-subject-areas/chemistry/higher-chemistry-revised/principles-to-production-h/3057-vitamin-c-in-vegetables>

**progressive nutritional.com**

<https://progressivenutritional.com/10-health-benefits-of-vitamin-c/>

**nlm.nih.gov**

<http://www.nlm.nih.gov/medlineplus/druginfo/natural/1001.html>

**Healthy Eating Diamond Media**

<http://healthyeating.sfgate.com/cooking-food-reduce-vitamin-content-5164.html>

**livestrong.com**

<http://www.livestrong.com/article/547867-what-does-cooking-do-to-vitamin-c/>

**whfoods.com**

<http://www.whfoods.com/genpage.php?tname=nutrient&dbid=109>

<http://www.whfoods.com/genpage.php?tname=nutrient&dbid=109>

**Eating well.com**

[**http://www.eatingwell.com/nutrition\_health/nutrition\_news\_information/fresh\_vs\_frozen\_vegetables\_are\_we\_giving\_up\_nutrition\_fo**](http://www.eatingwell.com/nutrition_health/nutrition_news_information/fresh_vs_frozen_vegetables_are_we_giving_up_nutrition_fo)

**food preservation.about.com**

[**http://foodpreservation.about.com/od/Freezing/a/Fresh-Vs-Frozen-Vegetables.htm**](http://foodpreservation.about.com/od/Freezing/a/Fresh-Vs-Frozen-Vegetables.htm)

**daily mail**

[**http://www.dailymail.co.uk/health/article-2449843/Frozen-food-IS-better-Higher-levels-vitamins-antioxidants.html**](http://www.dailymail.co.uk/health/article-2449843/Frozen-food-IS-better-Higher-levels-vitamins-antioxidants.html)

**the grocer**

[**http://www.thegrocer.co.uk/fmcg/fresh/frozen-food-makers-hit-back-at-fruit-and-veg-health-study/356096.article**](http://www.thegrocer.co.uk/fmcg/fresh/frozen-food-makers-hit-back-at-fruit-and-veg-health-study/356096.article)

**Investigation A:**

*“Which vegetables contain the most vitamin C?”*

Students determine the vitamin C content of fresh vegetables. It is suggested that each student has results for 3-4 different vegetables.

**Preparing the Solutions**

All literature consulted for this experiment detailed standardising the DCPIP before the experiment using a solution of ascorbic acid. This is because the DCPIP will quickly deteriorate in solution and its concentration is needed for the calculation.

There was a difference in the titration for standardising the solution even between morning and afternoon, indicating the DCPIP concentration could indeed have been changing. However, ascorbic acid solution also deteriorates so this could have been a contributing factor to the DCPIP results being different. To standardise the DCPIP we recommend a fresh solution of the ascorbic acid be prepared each time.

1. Ensure a fresh solution of the indicator is prepared each morning or afternoon prior to doing the experiment.
2. When preparing all solutions (DCPIP, phosphoric(V) acid, and vegetable extracts), it is vital that deionised water is used. Distilled water still contains ions, and any copper (II) ions present will oxidise the ascorbic acid present leading to non-concordant titres being obtained from the vegetable extracts.

**For each group:**

Equipment

* Apparatus for titration, 25 cm3 pipette, 50 cm3 burette, 250 cm3 conical flask, pipette filler
* Measuring cylinder, 500 cm3 and 250 cm3
* Beaker, 250 cm3
* Liquidiser
* Filter funnel
* Muslin for filtration
* Vegetables to test, 100 g
* A 5% phosphoric(V) acid solution prepared using deionised water
* A solution of 2,6-dichlorophenolindophenol sodium salt (DCPIP) prepared using deionised water. HARMFUL

Instructions

* Accurately weigh out approximately 0.4 g of the sodium salt (Mol. Wt. 290.08 g)
* dissolve it in 1 litre of solution.
* Accurately calculate its concentration.
* This concentration must be made available to students for their calculations.

**Preparing the Vegetables**

* Accurately weigh out about 50 g of your vegetable and put it in a liquidiser with 250 cm3 of 5.0% phosphoric(V) acid.
* Ensure the lid is securely fitted and liquidise at high speed.

(The purpose of the 5% phosphoric(V) acid solution is to provide acid conditions to inactivate the enzyme ascorbic acid oxidase and to extract the ascorbic acid from the food).

* Filter off using a muslin filter.
* Make up the volume of extract plus washings to 300 cm3 with deionised (not distilled) water.

**Specimen results for fresh vegetables:**

The Savoy Cabbage and the parsley supernatant were dark green in colour making end points difficult to see. A second filtration of the supernatant once settled after the muslin treatment may help?

The vegetables marked \* had light colour supernatant and the end point was easier to see.

The end point was taken when pink colour persisted for 30s.

|  |  |  |
| --- | --- | --- |
| Name of Vegetable | Average DCPIP titre | Concentration of Vitamin C  (mg/100 g) |
| Cauliflower\* | 5.60 cm3 | 32.64 |
| Brussel Sprouts \* | 11.30 cm3 | 65.87 |
| Parsley | 18.65 cm3 | 108.71 |
| Potato \* | 2.70 cm3 | 15.74 |
| Savoy Cabbage | 16.35 cm3 | 95.30 |
| Green Pepper \* | 12.35 cm3 | 71.99 |
| White Cabbage \* | 8.70 cm3 | 50.71 |

**Calculating the Vitamin C Content of a Fruit/Vegetable.**

*This depends on the fact that one mole of DCPIP will react with one mole of vitamin C.*

*One mole of DCPIP = 290.08g*

*One mole of vitamin C (ascorbic acid) = 176.13g*

***Specimen calculation:***

*Suppose the DCPIP was made by dissolving exactly 0.4g in 1 litre of solution.*

*This means the concentration of DCPIP = 0.4 = 1.3789 x 10-3 mol l-1*

*290.06*

*Assuming 50g of the vegetable was used*

*Assuming the total volume of vegetable extract was 300 cm3*

*Assuming that the volume of vegetable extract used in the titration was 25 cm3*

*Assuming the average titre of DCPIP used in the experiment was 32 cm3*

*Then the calculation will be as follows:*

*Number of moles of DCPIP used in the titration = Concentration of DCPIP x the titre (litres)*

*= 1.3789 x 10-3 x 32*

*1000*

*= 4.41 x 10-5 moles*

*The number of moles of DCPIP used = The number of moles of Vitamin C*

*25cm3 of the vegetable extract contained 4.41 x 10-5 moles of vitamin C*

*Therefore 300cm3 of the vegetable extract contained 4.41 x 10-5 x 300 moles of*

*25 vitamin C*

*= 5.292 x 10-4 moles of vitamin C*

*The mass of vitamin C in 50g of the vegetable = Number of moles x Mass of 1 mole*

*= 5.292 x 10-4 x 176.13*

*= 9.3208 x 10-2 g*

*= 93.208 mg*

*So the mass of vitamin C in 100g of the vegetable = 2 x 93.208 mg*

*= 186.416 mg*

***Concentration of vitamin C in the vegetable = 186.416 mg/100 g***

**Student instructions**

This experiment uses 2,6-dichlorophenolindophenol (DCPIP) in a titration, to estimate the concentration of vitamin C in food. DCPIP is blue when dissolved in water and is red in acid conditions, and is reduced by ascorbic acid (vitamin C) to a colourless compound. However, in this titration, the end point colour change will be from blue to pink due to the presence of the phosphoric(V) acid used to prepare the vegetable extract.

**You will need:**

|  |  |
| --- | --- |
| Apparatus for titration, 25 cm3 pipette, 50 cm3 burette, 250 cm3 conical flask, pipette filler | Measuring cylinders, 500 cm3 and 250 cm3 |
| Beaker, 250 cm3 | Liquidiser |
| Filter funnel and muslin for filtration | Vegetables to test, 100 g |
| 5% phosphoric(V) acid solution | A solution of 2,6-dichlorophenolindophenol (DCPIP) |

**What you do:**

* Accurately weigh out about 50 g of your vegetable and put it in a liquidiser with 250 cm3 of 5.0% phosphoric(V) acid.
* Ensure the lid is securely fitted and liquidise at high speed.

*(The purpose of the 5% phosphoric(V) acid solution is to provide acid conditions to inactivate the enzyme ascorbic acid oxidase and to extract the ascorbic acid from the food).*

* Filter off using a muslin filter.
* Make up the volume of extract plus washings to 300 cm3 with deionised (not distilled) water.
* Set up the burette filled with DCPIP.
* Using a pipette filler, pipette 25 cm3 of the vegetable extract into a conical flask.
* Titrate with the DCPIP indicator solution until a pink end point is reached.

*Note: If the vegetable extract solution is a greenish colour, the colour change to pink at the end point may be very difficult to see. The pink colour may appear as a brownish tinge!*

Stop when you think you have reached the end point and ask your teacher.

All titrations should be carried out in duplicate and concordant titres obtained.

Average your titres.

* Repeat the experiment with other fruit/vegetables.

**Investigation B:**

“Does Cooking affect the concentration of vitamin C in vegetables?”

Students determine the vitamin C content of raw and then cooked vegetables (10 mins cooking). Cooked vegetables will contain less vitamin C than raw vegetables.

Samples of vegetables processed in these ways can be made available to students for them to calculate their vitamin C content, or they can be asked to prepare them. Giving students prepared vegetables will of course save time.

There are various methods of cooking vegetables which affect Vitamin C content. The following should be taken into account

* Since vitamin C is water-soluble it is readily leached out. Washing and boiling considerably reduce the vitamin C content.
* Boiling in a large amount of water will increase the loss; steaming, on the other hand, will reduce the loss, unless it is carried out for a long time.
* The presence of the enzyme ascorbic acid oxidase will readily destroy the vitamin C. By putting vegetables in small amounts of hot water, the enzyme is destroyed before it can have any effect.
* On the other hand, if vegetables are put in cold water and brought to the boil slowly, or if the water is cooled by putting a large amount of cold vegetables in the hot water, the enzyme can destroy a large proportion of the vitamin C before the enzyme itself is destroyed.
* If vegetables are put in briskly boiling water, although a large proportion of the vitamin C will be leached out, very little will be destroyed.
* The minimum quantity of water should be used in cooking vegetables so that large amounts of vitamin C are not dissolved. This is very important with vegetables such as cabbage, which have a large surface area from which the vitamin can be lost. With potatoes, which have a smaller surface area, and in which gelatinisation of the starch prevents the diffusion and the subsequent loss of vitamin C, cooking has a much smaller effect on the vitamin C lost.
* Cooked vegetables should not be kept hot for long periods before being eaten, because this can destroy a large proportion of the vitamin C. It has been found that approximately 25% of the vitamin C of cooked vegetables is lost on keeping hot for 15 minutes, and 75% on keeping hot for 90 minutes.

**Preparing the Solutions**

All literature consulted for this experiment detailed standardising the DCPIP before the experiment using a solution of ascorbic acid. This is because the DCPIP will quickly deteriorate in solution and its concentration is needed for the calculation.

There was a difference in the titration for standardising the solution even between morning and afternoon, indicating the DCPIP concentration could indeed have been changing. However, ascorbic acid solution also deteriorates so this could have been a contributing factor to the DCPIP results being different. To standardise the DCPIP we recommend a fresh solution of the ascorbic acid be prepared each time.

1. Ensure a fresh solution of the indicator is prepared each morning or afternoon prior to doing the experiment.
2. When preparing all solutions (DCPIP, phosphoric(V) acid, and vegetable extracts), it is vital that deionised water is used. Distilled water still contains ions, and any copper (II) ions present will oxidise the ascorbic acid present leading to non-concordant titres being obtained from the vegetable extracts.

**Each group will need**

* Apparatus for titration, 25 cm3 pipette, 50 cm3 burette, 250 cm3 conical flask, pipette filler
* Measuring cylinder, 500 cm3 and 250 cm3
* Beaker, 250 cm3
* Liquidiser
* Filter funnel
* Muslin for filtration
* Vegetables to test, 100 g
* A 5% phosphoric(V) acid solution prepared using deionised water
* A solution of 2,6-dichlorophenolindophenol sodium salt (DCPIP) prepared using deionised water. HARMFUL

**Preparing DCPIP solution**

* Accurately weigh out approximately 0.4 g of the sodium salt (Mol. Wt. 290.08 g)
* dissolve it in 1 litre of solution.
* Accurately calculate its concentration.
* This concentration must be made available to students for their calculations.

**Preparing the Vegetables**

* Accurately weigh out about 50 g of your vegetable and put it in a liquidiser with 250 cm3 of 5.0% phosphoric(V) acid.
* Ensure the lid is securely fitted and liquidise at high speed.

(The purpose of the 5% phosphoric(V) acid solution is to provide acid conditions to inactivate the enzyme ascorbic acid oxidase and to extract the ascorbic acid from the food).

* Filter off using a muslin filter.
* Make up the volume of extract plus washings to 300 cm3 with deionised (not distilled) water.

**Specimen results for fresh vegetables:**

The Savoy Cabbage and the parsley supernatant were dark green in colour making end points difficult to see. A second filtration of the supernatant once settled after the muslin treatment may help?

The vegetables marked \* had light colour supernatant and the end point was easier to see.

The end point was taken when pink colour persisted for 30s.

|  |  |  |
| --- | --- | --- |
| Name of Vegetable | Average DCPIP titre | Concentration of Vitamin C  (mg/100 g) |
| Cauliflower\* | 5.60 cm3 | 32.64 |
| Brussel Sprouts \* | 11.30 cm3 | 65.87 |
| Parsley | 18.65 cm3 | 108.71 |
| Potato \* | 2.70 cm3 | 15.74 |
| Savoy Cabbage | 16.35 cm3 | 95.30 |
| Green Pepper \* | 12.35 cm3 | 71.99 |
| White Cabbage \* | 8.70 cm3 | 50.71 |

**Percentage of ascorbic acid lost in cooking**

Brussels sprouts 25–50%

Cabbage 40–60%

Cauliflower 25–40%

**Potatoes 15–30%**

**Calculating the Vitamin C Content of a Fruit/Vegatable.**

*This depends on the fact that one mole of DCPIP will react with one mole of vitamin C.*

*One mole of DCPIP = 290.08g*

*One mole of vitamin C (ascorbic acid) = 176.13g*

***Specimen calculation:***

*Suppose the DCPIP was made by dissolving exactly 0.4g in 1 litre of solution.*

*This means the concentration of DCPIP = 0.4 = 1.3789 x 10-3 mol l-1*

*290.06*

*Assuming 50g of the vegetable was used*

*Assuming the total volume of vegetable extract was 300 cm3*

*Assuming that the volume of vegetable extract used in the titration was 25 cm3*

*Assuming the average titre of DCPIP used in the experiment was 32 cm3*

*Then the calculation will be as follows:*

*Number of moles of DCPIP used in the titration = Concentration of DCPIP x the titre (litres)*

*= 1.3789 x 10-3 x 32*

*1000*

*= 4.41 x 10-5 moles*

*The number of moles of DCPIP used = The number of moles of Vitamin C*

*25cm3 of the vegetable extract contained 4.41 x 10-5 moles of vitamin C*

*Therefore 300cm3 of the vegetable extract contained 4.41 x 10-5 x 300 moles of*

*25 vitamin C*

*= 5.292 x 10-4 moles of vitamin C*

*The mass of vitamin C in 50g of the vegetable = Number of moles x Mass of 1 mole*

*= 5.292 x 10-4 x 176.13*

*= 9.3208 x 10-2 g*

*= 93.208 mg*

*So the mass of vitamin C in 100g of the vegetable = 2 x 93.208 mg*

*= 186.416 mg*

***Concentration of vitamin C in the vegetable = 186.416 mg/100 g***

**Student instructions**

This experiment uses 2,6-dichlorophenolindophenol (DCPIP) in a titration, to estimate the concentration of vitamin C in food. DCPIP is blue when dissolved in water and is red in acid conditions, and is reduced by ascorbic acid (vitamin C) to a colourless compound. However, in this titration, the end point colour change will be from blue to pink due to the presence of the phosphoric(V) acid used to prepare the vegetable extract.

**You will need:**

|  |  |
| --- | --- |
| Apparatus for titration, 25 cm3 pipette, 50 cm3 burette, 250 cm3 conical flask, pipette filler | Measuring cylinders, 500 cm3 and 250 cm3 |
| Beaker, 250 cm3 | Liquidiser |
| Filter funnel and muslin for filtration | Vegetables to test, 100 g |
| 5% phosphoric(V) acid solution | A solution of 2,6-dichlorophenolindophenol (DCPIP) |

**What you do:**

* Accurately weigh out about 50 g of your vegetable and put it in a liquidiser with 250 cm3 of 5.0% phosphoric(V) acid.
* Ensure the lid is securely fitted and liquidise at high speed.

*(The purpose of the 5% phosphoric(V) acid solution is to provide acid conditions to inactivate the enzyme ascorbic acid oxidase and to extract the ascorbic acid from the food).*

* Filter off using a muslin filter.
* Make up the volume of extract plus washings to 300 cm3 with deionised (not distilled) water.
* Set up the burette filled with DCPIP.
* Using a pipette filler, pipette 25 cm3 of the vegetable extract into a conical flask.
* Titrate with the DCPIP indicator solution until a pink end point is reached.

*Note: If the vegetable extract solution is a greenish colour, the colour change to pink at the end point may be very difficult to see. The pink colour may appear as a brownish tinge!*

Stop when you think you have reached the end point and ask your teacher.

All titrations should be carried out in duplicate and concordant titres obtained.

Average your titres.

* Repeat the experiment with other fruit/vegetables.

**Investigation C:**

*“Comparing The Vitamin C Content of Fresh with Frozen Vegetables.”*

Students determine the vitamin C content of fresh and then frozen vegetables.

Samples of fresh and recently defrosted vegetables can be made available to students for them to calculate their vitamin C content, or they can be asked to prepare them. Giving students prepared (defrosted and fresh!) vegetables will of course save time.

**Preparing the Solutions**

All literature consulted for this experiment detailed standardising the DCPIP before the experiment using a solution of ascorbic acid. This is because the DCPIP will quickly deteriorate in solution and its concentration is needed for the calculation.

There was a difference in the titration for standardising the solution even between morning and afternoon, indicating the DCPIP concentration could indeed have been changing. However, ascorbic acid solution also deteriorates so this could have been a contributing factor to the DCPIP results being different. To standardise the DCPIP we recommend a fresh solution of the ascorbic acid be prepared each time.

1. Ensure a fresh solution of the indicator is prepared each morning or afternoon prior to doing the experiment.
2. When preparing all solutions (DCPIP, phosphoric(V) acid, and vegetable extracts), it is vital that deionised water is used. Distilled water still contains ions, and any copper (II) ions present will oxidise the ascorbic acid present leading to non-concordant titres being obtained from the vegetable extracts.

Each group will need

* Apparatus for titration, 25 cm3 pipette, 50 cm3 burette, 250 cm3 conical flask, pipette filler
* Measuring cylinder, 500 cm3 and 250 cm3
* Beaker, 250 cm3
* Liquidiser
* Filter funnel
* Muslin for filtration
* Vegetables to test, 100 g
* A 5% phosphoric(V) acid solution prepared using deionised water
* A solution of 2,6-dichlorophenolindophenol sodium salt (DCPIP) prepared using deionised water. HARMFUL

Instructions

* Accurately weigh out approximately 0.4 g of the sodium salt (Mol. Wt. 290.08 g)
* dissolve it in 1 litre of solution.
* Accurately calculate its concentration.
* This concentration must be made available to students for their calculations.

**Preparing the Vegetables**

* Accurately weigh out about 50 g of your vegetable and put it in a liquidiser with 250 cm3 of 5.0% phosphoric(V) acid.
* Ensure the lid is securely fitted and liquidise at high speed.
  + (The purpose of the 5% phosphoric(V) acid solution is to provide acid conditions to inactivate the enzyme ascorbic acid oxidase and to extract the ascorbic acid from the food).
* Filter off using a muslin filter.
* Make up the volume of extract plus washings to 300 cm3 with deionised (not distilled) water.

**Calculating the Vitamin C Content of a Fruit/Vegetable.**

*This depends on the fact that one mole of DCPIP will react with one mole of vitamin C.*

*One mole of DCPIP = 290.08g*

*One mole of vitamin C (ascorbic acid) = 176.13g*

***Specimen calculation:***

*Suppose the DCPIP was made by dissolving exactly 0.4g in 1 litre of solution.*

*This means the concentration of DCPIP = 0.4 = 1.3789 x 10-3 mol l-1*

*290.06*

*Assuming 50g of the vegetable was used*

*Assuming the total volume of vegetable extract was 300 cm3*

*Assuming that the volume of vegetable extract used in the titration was 25 cm3*

*Assuming the average titre of DCPIP used in the experiment was 32 cm3*

*Then the calculation will be as follows:*

*Number of moles of DCPIP used in the titration = Concentration of DCPIP x the titre (litres)*

*= 1.3789 x 10-3 x 32*

*1000*

*= 4.41 x 10-5 moles*

*The number of moles of DCPIP used = The number of moles of Vitamin C*

*25cm3 of the vegetable extract contained 4.41 x 10-5 moles of vitamin C*

*Therefore 300cm3 of the vegetable extract contained 4.41 x 10-5 x 300 moles of*

*25 vitamin C*

*= 5.292 x 10-4 moles of vitamin C*

*The mass of vitamin C in 50g of the vegetable = Number of moles x Mass of 1 mole*

*= 5.292 x 10-4 x 176.13*

*= 9.3208 x 10-2 g*

*= 93.208 mg*

*So the mass of vitamin C in 100g of the vegetable = 2 x 93.208 mg*

*= 186.416 mg*

***Concentration of vitamin C in the vegetable = 186.416 mg/100 g***

**Student instructions**

This experiment uses 2,6-dichlorophenolindophenol (DCPIP) in a titration, to estimate the concentration of vitamin C in food. DCPIP is blue when dissolved in water and is red in acid conditions, and is reduced by ascorbic acid (vitamin C) to a colourless compound. However, in this titration, the end point colour change will be from blue to pink due to the presence of the phosphoric(V) acid used to prepare the vegetable extract.

**You will need:**

|  |  |
| --- | --- |
| Apparatus for titration, 25 cm3 pipette, 50 cm3 burette, 250 cm3 conical flask, pipette filler | Measuring cylinders, 500 cm3 and 250 cm3 |
| Beaker, 250 cm3 | Liquidiser |
| Filter funnel and muslin for filtration | Vegetables to test, 100 g |
| 5% phosphoric(V) acid solution | A solution of 2,6-dichlorophenolindophenol (DCPIP) |

**What you do:**

* Accurately weigh out about 50 g of your vegetable and put it in a liquidiser with 250 cm3 of 5.0% phosphoric(V) acid.
* Ensure the lid is securely fitted and liquidise at high speed.

*(The purpose of the 5% phosphoric(V) acid solution is to provide acid conditions to inactivate the enzyme ascorbic acid oxidase and to extract the ascorbic acid from the food).*

* Filter off using a muslin filter.
* Make up the volume of extract plus washings to 300 cm3 with deionised (not distilled) water.
* Set up the burette filled with DCPIP.
* Using a pipette filler, pipette 25 cm3 of the vegetable extract into a conical flask.
* Titrate with the DCPIP indicator solution until a pink end point is reached.

*Note: If the vegetable extract solution is a greenish colour, the colour change to pink at the end point may be very difficult to see. The pink colour may appear as a brownish tinge!*

Stop when you think you have reached the end point and ask your teacher.

All titrations should be carried out in duplicate and concordant titres obtained.

Average your titres.

* Repeat the experiment with other fruit/vegetables

**Technician’s Guide**

**Investigation A**

Students determine the vitamin C content of fresh vegetables. It is suggested that each student has results for 3-4 different vegetables.

**Preparing the Solutions**

All literature consulted for this experiment detailed standardising the DCPIP before the experiment using a solution of ascorbic acid. This is because the DCPIP will quickly deteriorate in solution and its concentration is needed for the calculation.

There was a difference in the titration for standardising the solution even between morning and afternoon, indicating the DCPIP concentration could indeed have been changing. However, ascorbic acid solution also deteriorates so this could have been a contributing factor to the DCPIP results being different. To standardise the DCPIP we recommend a fresh solution of the ascorbic acid be prepared each time.

1. Ensure a fresh solution of the indicator is prepared each morning or afternoon prior to doing the experiment.
2. When preparing all solutions (DCPIP, phosphoric(V) acid, and vegetable extracts), it is vital that deionised water is used. Distilled water still contains ions, and any copper (II) ions present will oxidise the ascorbic acid present leading to non-concordant titres being obtained from the vegetable extracts.

**For each group:**

Equipment

* Apparatus for titration, 25 cm3 pipette, 50 cm3 burette, 250 cm3 conical flask, pipette filler
* Measuring cylinder, 500 cm3 and 250 cm3
* Beaker, 250 cm3
* Liquidiser
* Filter funnel
* Muslin for filtration
* Vegetables to test, 100 g
* A 5% phosphoric(V) acid solution prepared using deionised water
* A solution of 2,6-dichlorophenolindophenol sodium salt (DCPIP) prepared using deionised water. HARMFUL

Instructions

* Accurately weigh out approximately 0.4 g of the sodium salt (Mol. Wt. 290.08 g)
* dissolve it in 1 litre of solution.
* Accurately calculate its concentration.
* This concentration must be made available to students for their calculations.

**Preparing the Vegetables**

* Accurately weigh out about 50 g of your vegetable and put it in a liquidiser with 250 cm3 of 5.0% phosphoric(V) acid.
* Ensure the lid is securely fitted and liquidise at high speed.

(The purpose of the 5% phosphoric(V) acid solution is to provide acid conditions to inactivate the enzyme ascorbic acid oxidase and to extract the ascorbic acid from the food).

* Filter off using a muslin filter.
* Make up the volume of extract plus washings to 300 cm3 with deionised (not distilled) water.

**Investigation B:**

“Does Cooking affect the concentration of vitamin C in vegetables?”

Students determine the vitamin C content of raw and then cooked vegetables (10 mins cooking). Cooked vegetables will contain less vitamin C than raw vegetables.

**Preparing the Solutions**

All literature consulted for this experiment detailed standardising the DCPIP before the experiment using a solution of ascorbic acid. This is because the DCPIP will quickly deteriorate in solution and its concentration is needed for the calculation.

There was a difference in the titration for standardising the solution even between morning and afternoon, indicating the DCPIP concentration could indeed have been changing. However, ascorbic acid solution also deteriorates so this could have been a contributing factor to the DCPIP results being different. To standardise the DCPIP we recommend a fresh solution of the ascorbic acid be prepared each time.

1. Ensure a fresh solution of the indicator is prepared each morning or afternoon prior to doing the experiment.
2. When preparing all solutions (DCPIP, phosphoric(V) acid, and vegetable extracts), it is vital that deionised water is used. Distilled water still contains ions, and any copper (II) ions present will oxidise the ascorbic acid present leading to non-concordant titres being obtained from the vegetable extracts.

**Each group will need**

* Apparatus for titration, 25 cm3 pipette, 50 cm3 burette, 250 cm3 conical flask, pipette filler
* Measuring cylinder, 500 cm3 and 250 cm3
* Beaker, 250 cm3
* Liquidiser
* Filter funnel
* Muslin for filtration
* Vegetables to test, 100 g
* A 5% phosphoric(V) acid solution prepared using deionised water
* A solution of 2,6-dichlorophenolindophenol sodium salt (DCPIP) prepared using deionised water. HARMFUL

**Preparing DCPIP solution**

* Accurately weigh out approximately 0.4 g of the sodium salt (Mol. Wt. 290.08 g)
* dissolve it in 1 litre of solution.
* Accurately calculate its concentration.
* This concentration must be made available to students for their calculations.

**Preparing the Vegetables**

* Accurately weigh out about 50 g of your vegetable and put it in a liquidiser with 250 cm3 of 5.0% phosphoric(V) acid.
* Ensure the lid is securely fitted and liquidise at high speed.

(The purpose of the 5% phosphoric(V) acid solution is to provide acid conditions to inactivate the enzyme ascorbic acid oxidase and to extract the ascorbic acid from the food).

* Filter off using a muslin filter.
* Make up the volume of extract plus washings to 300 cm3 with deionised (not distilled) water.

**Investigation C:**

*“Comparing The Vitamin C Content of Fresh with Frozen Vegetables.”*

Students determine the vitamin C content of fresh and then frozen vegetables.

Samples of fresh and recently defrosted vegetables can be made available to students for them to calculate their vitamin C content, or they can be asked to prepare them. Giving students prepared (defrosted and fresh!) vegetables will of course save time.

**Preparing the Solutions**

All literature consulted for this experiment detailed standardising the DCPIP before the experiment using a solution of ascorbic acid. This is because the DCPIP will quickly deteriorate in solution and its concentration is needed for the calculation.

There was a difference in the titration for standardising the solution even between morning and afternoon, indicating the DCPIP concentration could indeed have been changing. However, ascorbic acid solution also deteriorates so this could have been a contributing factor to the DCPIP results being different. To standardise the DCPIP we recommend a fresh solution of the ascorbic acid be prepared each time.

1. Ensure a fresh solution of the indicator is prepared each morning or afternoon prior to doing the experiment.
2. When preparing all solutions (DCPIP, phosphoric(V) acid, and vegetable extracts), it is vital that deionised water is used. Distilled water still contains ions, and any copper (II) ions present will oxidise the ascorbic acid present leading to non-concordant titres being obtained from the vegetable extracts.

Each group will need

* Apparatus for titration, 25 cm3 pipette, 50 cm3 burette, 250 cm3 conical flask, pipette filler
* Measuring cylinder, 500 cm3 and 250 cm3
* Beaker, 250 cm3
* Liquidiser
* Filter funnel
* Muslin for filtration
* Vegetables to test, 100 g
* A 5% phosphoric(V) acid solution prepared using deionised water
* A solution of 2,6-dichlorophenolindophenol sodium salt (DCPIP) prepared using deionised water. HARMFUL

Instructions

* Accurately weigh out approximately 0.4 g of the sodium salt (Mol. Wt. 290.08 g)
* dissolve it in 1 litre of solution.
* Accurately calculate its concentration.
* This concentration must be made available to students for their calculations.

**Preparing the Vegetables**

* Accurately weigh out about 50 g of your vegetable and put it in a liquidiser with 250 cm3 of 5.0% phosphoric(V) acid.
* Ensure the lid is securely fitted and liquidise at high speed.
  + (The purpose of the 5% phosphoric(V) acid solution is to provide acid conditions to inactivate the enzyme ascorbic acid oxidase and to extract the ascorbic acid from the food).
* Filter off using a muslin filter.
* Make up the volume of extract plus washings to 300 cm3 with deionised (not distilled) water.

Risk Assessment: (based on HSE 5 Step Risk Assessment

|  |  |
| --- | --- |
| Activity assessed | Testing fruit and vegetables for Vitamin C |
| *Date of assessment* | July 2014 |
| *Date of review (****Step 5****)* |  |
| *School* |  |
| *Department* |  |

| Step 1 | Step 2 | Step 3 | | Step 4 | | |
| --- | --- | --- | --- | --- | --- | --- |
| *List Significant hazards here:* | *Who might be harmed and how?* | *What are you already doing?* | *What further action is needed?* | *Action by whom?* | *Action by when?* | *Done* |
| DCPIP powder – is of low hazard but may be Irritant and harmful by ingestion.  Avoid inhaling powder | Technician (possibly teacher) by inhalation of powder. | Avoid raising dust. |  |  |  |  |
| Phosphoric (V) Acid 85% is corrosive | Technician (possibly teacher) by splashes when preparing the dilute solution. | Wear gloves and goggles (BS EN166 3), for preparation of 5% solution |  |  |  |  |
| DCPIP solution is of no significant hazard. |  |  |  |  |  |  |
| 5% phosphoric acid is of no significant hazard |  |  |  |  |  |  |

|  |
| --- |
| **Description of activity:**  Vitamin C is extracted from fruit / vegetables by blending with 5% phosphoric acid.  The extract is then titrated against DCPIP solution and the titre values are used to calculate the concentration of vitamin C in the original sample. |

|  |
| --- |
| **Additional comments:**  All solutions can be washed to waste with cold running water. |