Candidate 4 evidence

Vitamin C content in Fruit Juices

Aim: To investigate the vitamin C concentration of several varieties of Tropicana fruit juices

Underlying Chemistry:

Vitamin C (chemical name ascorbic acid) is a white solid that is soluble in water and ethyl alcohol. It is ~~reacona~~ fairly stable in acidic conditions, but is easily oxidised in neutral or basic solutions by dissolved oxygen. This is because of the many hydroxyl groups present in the molecule, which allow for hydrogen bonding. This also makes the molecule polar, and differences in electronegativity create polar bonds between ~~carbons~~ carbonyl groups as well as hydroxyl. This makes the molecule very soluble ~~in water melting point~~ in water.

Vitamin C acts as a reducing agent, which loses (donates) electrons to another element or ion and is itself oxidised. This means it acts as an antioxidant, preventing unwanted oxidation reactions in the body occuring. It can also act as a free radical scavenger, a substance that protects cells from damage caused by free radicals, unstable molecules with at least one unpaired electron.

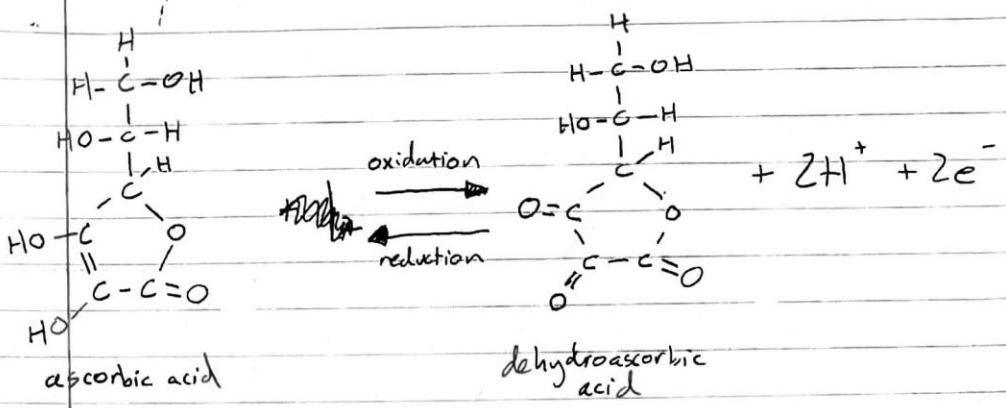
Reduction:

~~$I_2 + 2e^- \rightarrow 2I^-$~~ $I_2 + 2e^- \rightarrow 2I^-$

Oxidation: $C_6H_8O_6 \rightarrow C_6H_6O_6 + 2H^+ + 2e^-$

REDOX:

$C_6H_8O_6 + I_2 \rightarrow C_6H_6O_6 + 2H^+ + 2I^-$



ascorbic acid

dehydroascorbic acid

In this REDOX reaction, ascorbic acid is the reducing agent. It itself is oxidised, resulting in an increase in the O : H ratio.

Iodine acts as the oxidising agent. It is itself reduced, gains electrons from another ion or atom, and causes oxidation reactions to take place.

The iodine solution was prepared by -

- Weighing the correct amount of iodine crystals
- Dissolving it in distilled water making sure to swirl
- Transfered to a volumetric flask making sure to rinse any remaining iodine into the flask using the water
- Solution filled up to the mark with distilled water

The sample of orange juice is titrated with the iodine solution. The endpoint is determined by the first permanent colour change to a dark blue / black colour because of the starch indicator.

The attraction forces applying are London Dispersion forces, permanent-dipole to permanent dipole bonds work as the molecule is polar, and Hydrogen bonding because of the hydroxyl (-OH) groups.

Method:

Samples of different Tropicana fruit juices were titrated with a sample of 0.005mol (1) iodine solution, with the end point being identified by ~~indicator~~ the starch indicator solution. Experiment was repeated until concordant results were reached.

Although iodine concentration was low enough to ~~per~~ qualify as low hazard, safety measures such as wearing gloves and pouring/handling the solution* were taken to prevent staining and eye damage.

* (below eye level)

Experimental data:

Pineapple

Titration	Rough	1	2	3
Initial Burette Reading (cm^3)	0	5.8	15.8	20.7
End Burette Reading (cm^3)	5.8	10.9	20.7	25.7
Titre (cm^3)	5.8	5.1	4.9	5.0

Average titre $= \frac{5.1+4.9+5.0}{3}$

$= 5.0 cm^3$

Calculation

number of moles (iodine)

$n = C \times V$

$= 0.005 \times 0.005$

$= 0.000025$ moles of iodine

$C_6H_8O_6 + I_2 \rightarrow C_6H_6O_6 + 2H^+ + 2I^-$

1 mol 1 mol

$C_6H_8O_6 : I_2$

1 : 1

$25 cm^3 \rightarrow 0.000025$

$100 cm^3 \rightarrow x = 0.0001$ mol ascorbic acid

GFM

$C_6H_8O_6$

6 × 12 = 72

8 × 1 = 8

6 × 16 = 96

176g

$m = n \times GFM$

$= 0.0001 \times 176$

$= 0.0176 g / 100 cm^3$

$\therefore 17.6 mg / 100 cm^3$

Apple

Titration	Rough	1	2	3
Initiall Burette Reading (cm^3)	25.7	34.7	0	9.2
End Burette Reading (cm^3)	34.7	43.6	9.2	18.3
Titre (cm^3)	9.0	8.9	9.2	9.1

Average titre $= \frac{8.9+9.2+9.1}{3}$

$= 9.07 cm^3$

number of moles (iodine)

$n = cv$

$= 0.005 \times 0.00907$

$= 0.0000045$ moles of iodine

GFM

$C_6H_8O_6$ → 96, 8, 72 → 176g

Calculation

$C_6H_8O_6 + I_2 \rightarrow C_6H_6O_6 + 2H^+ + 2I^-$

1mol 1mol

$C_6H_8O_6 : I_2$

1 : 1

$25 cm^3 \rightarrow 0.0000045$

$100 cm^3 \rightarrow x = 0.00018$ moles of ascorbic acid

$m = n \times GFM$

$= 0.00018 \times 176$

$= 0.032g / 100 cm^3$

$= 32 mg / 100 cm^3$

Orange

Titration	Rough	1	2	3
Initiall Burette Reading (cm^3)	18.3	28.0	37.7	0.0
End Burette Reading (cm^3)	28.0	37.7	47.6	9.7
Titre (cm^3)	9.7	9.7	9.9	9.7

Average Titre $= \frac{9.7+9.9+9.7}{3}$

$= 9.77 cm^3$

number of moles (iodine)

$n = cv$

$= 0.005 \times 0.00977$

$= 0.0000488$ moles of iodine

GFM

$C_6H_8O_6$ → 96, 8, 72 = 176g

Calculations

$C_6H_8O_6 + I_2 \rightarrow C_6H_6O_6 + 2H^+ + 2I^-$

1mol 1mol

$C_6H_8O_6 : I_2$

1 : 1

$25 cm^3 \rightarrow 0.0000488$

$100 cm^3 \rightarrow x = 0.0001954$ moles ascorbic acid

$m = n \times GFM$

$= 176 \times 0.0001954$

$= 0.034g / 100 cm^3$

$= 34 mg / 100 cm^3$

Internet Source data:

1+ weeks

Tropicana Pineapple Juice 850 Ml

Typical Values	Typical Values Per 100ml	Per 150ml (%*)
Energy	182 kJ/42 kcal	273 kJ/63 kcal (3%)
Fat	0g	0g (0%)
of which saturates	0g	0g (0%)
Carbohydrate	10g	15g
of which sugars†	9.5g	14g (16%)
Fibre	0.3g	0.5g
Protein	0.5g	0.7g
Salt	0g	0g (0%)
Vitamin C	8 mg (10%*)	12mg (15%)

(1) Tropicana Pineapple Juice nutritional information

1+ weeks

Tropicana Apple Juice 950 Ml

Typical Values	Typical Values Per 100ml	Per 150ml (%*)
Energy	189 kJ/45 kcal	284 kJ/68 kcal (3%)
Fat	0g	0g (0%)
of which saturates	0g	0g (0%)
Carbohydrate	11g	17g
of which sugars†	10g	15g (17%)
Fibre	0.6g	0.9g
Protein	0.2g	0.3g
Salt	0g	0g (0%)
Vitamin C	30 mg (38%*)	45mg (56%)

(2) Tropicana Apple juice nutritional information

(1) https://www.tesco.com/groceries/en-GB/products/287294534
date accessed: 27/2/2019

(2) https://www.tesco.com/groceries/en-GB/products/296050585
date accessed: 27/2/2019

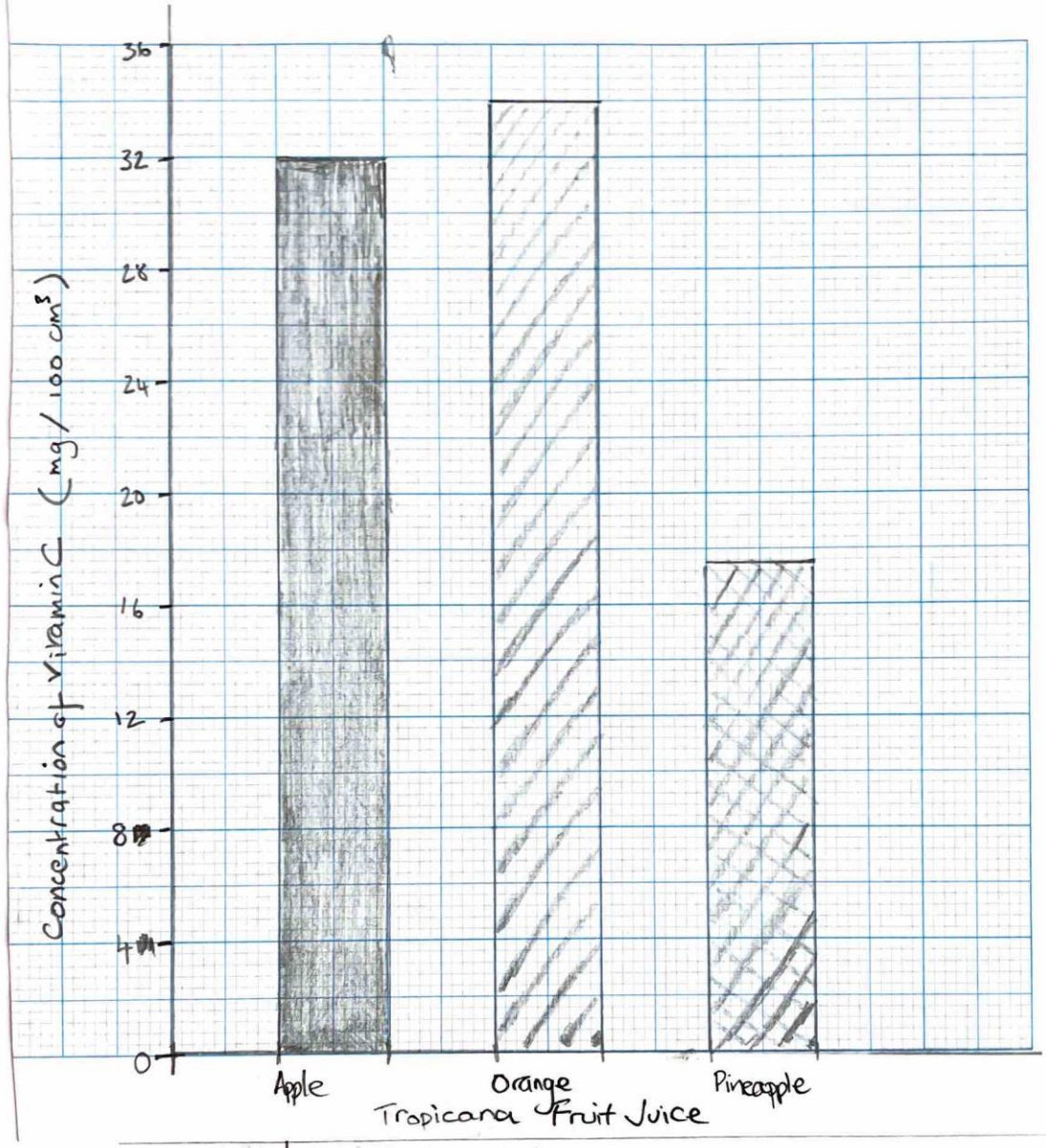
Typical Values	Typical Values Per 100ml	Per 150ml (%*)
Energy	172 kJ/41 kcal	258 kJ/62 kcal (3%)
Fat	0g	0g (0%)
of which saturates	0g	0g (0%)
Carbohydrate	9.3g	14g
of which sugars†	8.4g	13g (14%)
Fibre	0.6g	0.9g
Protein	0.8g	1.2g
Salt	0g	0g (0%)
Vitamin C	24 mg (30%*)	36mg (45%)

(3) Tropicana Orange Juice nutritional ~~fa~~ information

(3) https://www.tesco.com/groceries/en-GB/products/296050487

Graphical Presentation

Results obtained from my



Analysis:

Pineapple

My results showed the concentration of vitamin C in the pineapple juice to be 17.6mg/100cm^3. The official nutritional information from the carton shows concentration of vitamin C to be 8mg/100cm^3.

% difference

$$\% \text{ difference} = \left(\frac{17.6 - 8}{8}\right) \times 100$$

$$= 120\%$$

∴ There is a 120% increase between the official results from the internet source and the results obtained from my experiment

Apple

My results showed the concentration of vitamin C in the apple juice to be 32mg/100cm^3. The official nutritional information from the carton shows concentration of vitamin C to be 30mg/100cm^3.

$$\% \text{ difference} = \left(\frac{32 - 30}{30}\right) \times 100$$

$$= 6.67\%$$

∴ There is a 6.67% increase between the official results from the internet source and the results obtained from my experiment

Orange

My results showed the concentration of vitamin C in the orange juice to be 34mg/100cm^3. The official nutritional information from the carton shows concentration of vitamin C to be 24mg/100cm^3.

$$\% \text{ difference} = \left(\frac{34-24}{24}\right) \times 100$$
$$= 41.7\%$$

∴ There is a 41.7% increase between the official results from the internet source and the results obtained from my experiment.

Conclusion:

From the data collected in the experiment, I can conclude that ~~Pineapple~~ the Tropicana Pineapple juice had the lowest concentration of Vitamin C. Tropicana ~~Mango~~ Orange juice had the highest concentration, & and the ~~Orange~~ Apple juice was only slightly lower in concentration.

Evaluation:

☆ The data obtained from the internet source is regulated very closely by UK* food and drink laws, and they are legally obligated to show the nutritional information of their products. This means the data they present is highly accurate, and ~~was very reliable as a~~ more reliable than the experiment we conducted.

* UK government

☆ Because of the colour of the juices, the colour change was quite difficult to observe, and This meant that it was hard to determine a definitive endpoint of the titration, meaning the results may be less reliable. Results could have been improved by diluting the juice further to easier identify the endpoint of the titration.

☆ Most of the glassware used in the experiment was Class B volumetric glassware. This means the accuracy of measurements may not have been as high as if ~~were~~ used Class A glassware had been used. Class A has a lower tolerance level, meaning that it has a low level of uncertainty in it's measurements, and results obtained using it would be highly reliable and more reliable than Class B.