Candidate 4 evidence

Lab Report- Chemical Analysis
Determination of Vitamin C content

Aim: To determine and compare the mass of Vitamin C in 3 different brands of Vitamin C effervescent tablets.

Underlying Chemistry

Vitamin C (ascorbic acid, $C_6H_8O_6$) reacts with Iodine in a redox reaction. Redox reactions involve the transfer of electrons between substances and involve both oxidation (loss of electrons) and Reduction (gain of electrons) these processes are complementary and occur simultaneously.

The balanced redox equation for this reaction is as follows:

$$C_6H_8O_{6(aq)} + I_{2(aq)} \longrightarrow C_6H_6O_{6(aq)} + 2H^+_{(aq)} + 2I^-_{(aq)}$$

This reaction can also be shown as two ion electron equations:

$$C_6H_8O_6 \longrightarrow C_6H_6O_6 + 2H^+ + 2e^- \quad \text{Oxidation}$$

$$I_2 + 2e^- \longrightarrow 2I^- \quad \text{Reduction}$$

The above equation show Iodine is the oxidising agent in this reaction causing Vitamin C to lose electrons the oxidised ~~and~~ while itself gaining electrons. And inversly Vitamin C acts as a reducing agent donating electrons to Iodine and losing them itself.

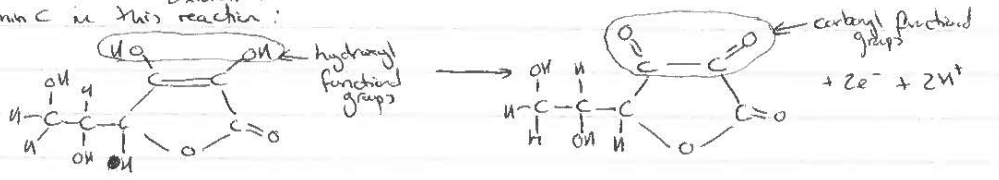
Vitamin C also loses Hydrogen in this reaction which can be shown by in an Oxygen: Hydrogen ratio equation:

$C_6H_8O_6 \longrightarrow C_6H_6O_6 + 2H^+$

O : H
6 : 8
3 : 4

O : H
6 : 6
1 : 1

This can also be seen by the change in functional groups when looking at the full structural formula of Vitamin C in this oxidation reaction:



The mass of Vitamin C ~~can~~ be in a tablet can be determined experimentally by dissolving the tablet in deionised water to create a standard solution and then titrating this against a known concentration and volume of Iodine solution in a redox titration. Starch solution is added to the Vitamin C solution as an indicator and causes a color change ~~from~~ the vit C solution from yellow/orange (dependant on clearing in the tablet) to blue/black. ~~Titre~~ Volume readings for the Iodine solution are taken from a burette when it is first filled at the start of the titration and again at the end when a permanent color change of the Vitamin C solution has occured, these readings allow the titre volume to be calculated

and used in subsequent calculations to determine the mass of vitamin C in the solution / tablet.

Method

Three standard solutions of vitamin C were made one with each tablet, the tablets were dissolved in deionised water and the solution made up to 250 cm^3 in a volumetric flask. 25 cm^3 of Vitamin C solution was then added to a conical flask using a pipette and 1 cm^3 of 1% starch solution was also added to the flask. A burette was filled with 0.025 mol l^{-1} of Iodine solution this was then titrated against the vitamin C solution until the end point was reached – determined by a permanent blue/black color change of vitamin C solution. The titrations were repeated until concordant results were achieved.

Iodine was identified as a potential hazard as it can be harmful to and stain skin so glass were worn throughout the experiment to avoid this risk.

Results

Titration Readings

Tablet 1 – Hollimorange

	Initial (cm^3)	Final (cm^3)	Titre (cm^3)
1	3.5	27.0	23.5
2	1.5	24.6	23.1
3	24.6	48.0	23.4
4	1.0	24.4	23.4

Tablet 2 – Morrisons

	Initial (cm^3)	Final (cm^3)	Titre (cm^3)
1	0.6	25.9	25.3
2	0.2	24.7	24.5
3	0.4	24.8	24.4

Tablet 3 – Tesco

	Initial (cm^3)	Final (cm^3)	Titre (cm^3)
1	0.4	23.4	23.0
2	23.4	46.5	23.1
3	9.1	32.3	23.2

Results

Calculations

Tablet 1 – Heliborange

Average titre = 23.4 cm³

$n = c \times v$

$= 0.025 \times 0.0234$

$= 5.85 \times 10^{-4}$ moles

$c = 0.025$ mol L^{-1}

$v = 0.0234$ L

Ratio

I : $C_6H_8O_6$

1 : 1

5.85×10^{-4} : 5.85×10^{-4}

moles of $C_6H_8O_6$

25 cm³ = 5.85×10^{-4} moles

250 cm³ = 5.85×10^{-3} moles

$m = n \times gfm$

$= 5.85 \times 10^{-3} \times 176$

$= 1.0296$ g

$= 1030$ mg

gfm for $C_6H_8O_6$

$6 \times 12 = 72$ g

$8 \times 1 = 8$ g

$6 \times 16 = 96$ g

176 g

Tablet 2 – Morrisons

Average titre = $(24.5 cm^3 + 24.4 cm^3)/2 = 24.45 cm^3$

$n = c \times v$ $c = 0.025$ mol L^{-1} $v = 0.02445$ L

$= 0.025 \times 0.02445$

$= 6.11 \times 10^{-4}$ moles

Ratio

I : $C_6H_8O_6$

1 : 1

6.11×10^{-4} mole : 6.11×10^{-4} mole

moles of $C_6H_8O_6$

25 cm³ = 6.11×10^{-4} moles

250 cm³ = 6.11×10^{-3} moles

$m = n \times gfm$

$= 6.11 \times 10^{-3} \times 176$ g

$= 1.075$ g

$= 1075$ mg

gfm of $C_6H_8O_6$ = 176 g (see above calculation)

Tablet 3 – Tesco

Average titre = $(23.1 cm^3 + 23.2 cm^3)/2 = 23.15 cm^3$

$n = c \times v$ $c = 0.025$ mol L^{-1} $v = 0.02315$ ~~ter~~

$= 0.025 \times 0.02315$

$= 5.79 \times 10^{-4}$ moles

Ratio

I : ~~$C_6H_8O_6$~~ $C_6H_8O_6$

1 : 1

5.79×10^{-4} mol : 5.79×10^{-4} mol

Moles of $C_6H_8O_6$

25 cm³ = 5.79×10^{-4} moles

250 cm³ = 5.79×10^{-3} moles

$m = n \times gfm$ gfm of $C_6H_8O_6 = 176g$ (see first calculation for working)

$= 5.79 \times 10^{-3}$ mole $\times 176g$

$= 1.019g$

$= 1019mg$

Analysis

Graph - See graph paper (Page 6)

~~All of the calculated experimental values of~~

Data from reference sources for the mass of vitamin C per tablet

Haliborange: Vitamin C 1000mg [1]

Morrisons: Vitamin C 1000mg [2]

Tesco: Vitamin C 1000mg [3]

The table below shows both the data for the mass of vitamin C in a tablet from the reference sources and ~~taken~~ from my experimental data and the calculated % difference.

Tablet	Source data	Experimental data	% difference between Source + experimental data
Haliborange	1000mg [1]	1030mg	3%
Morrisons	1000mg [2]	1075mg	7.5%
Tesco	1000mg [3]	1019mg	1.9%

From these values it is clear that my data shows a higher mass of vitamin C for all tablets with Morrisons tablets having the greatest mass of vitamin C and Tesco tablets the least.

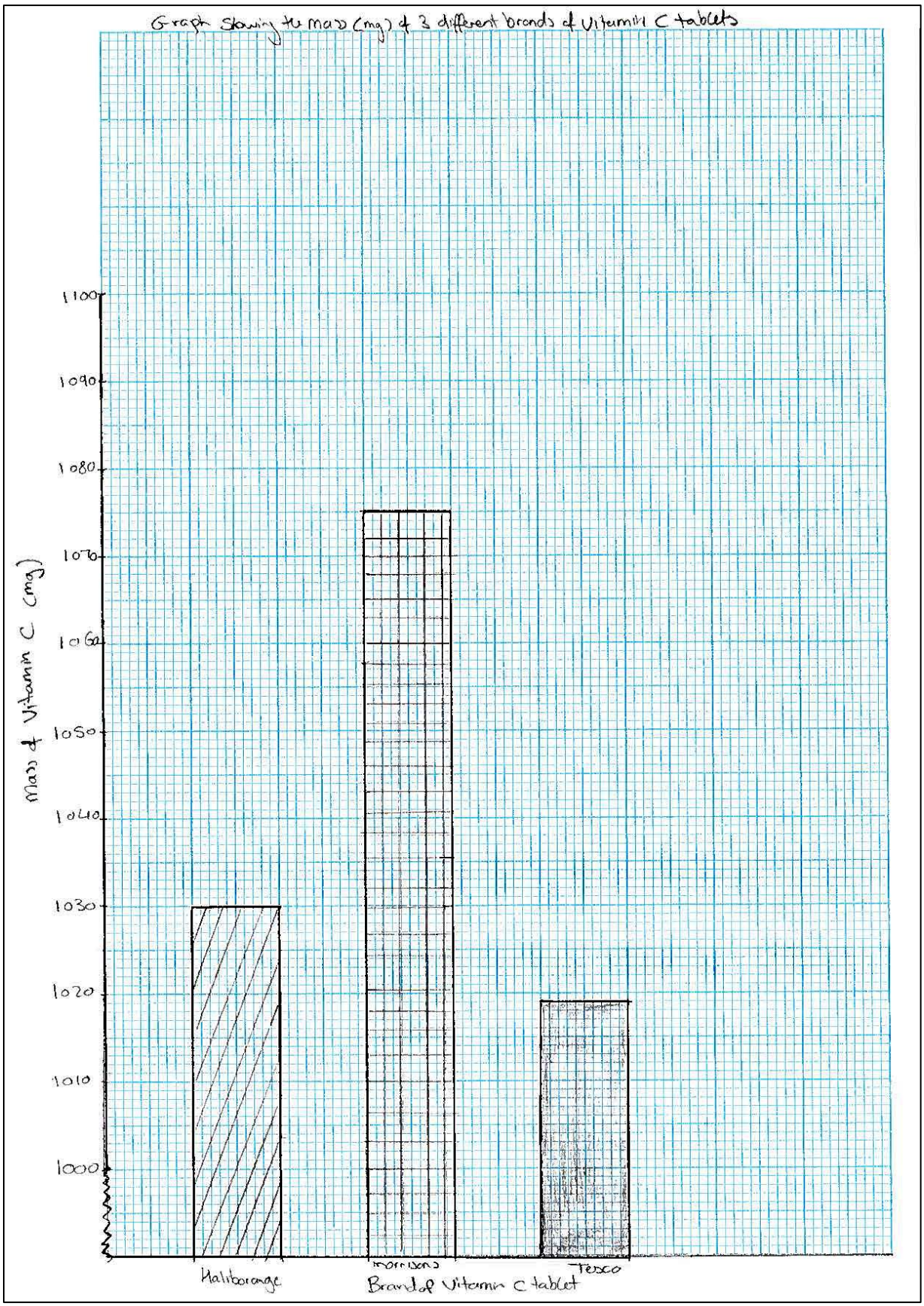
~~As~~ The source data shows that all tablets should have equal ~~amounts~~ masses of vitamin C as each other however this is not supported by the experimental data not only does the experimental data show a higher mass of vitamin C for all tablets the amount and % percentage increase in mass is different for each tablet.

Conclusion

The mass of vitamin C in the 3 brands of tablets chosen are as follows:

Haliborange - 1030mg; Morrisons - 1075mg; Tesco - 1019mg

These values show a difference ~~in~~ is most when compared to each other with Morrisons tablets having the greatest mass of vitamin C and Tesco tablets the lowest mass, they are also different when compared to the reference source values with ~~each~~ all showing a higher mass of vitamin C compared to the reference source each by different amounts.


Graph showing the mass (mg) of 3 different brands of Vitamin C tablets
Mass of Vitamin C (mg)
1100
1090
1080
1070
1060
1050
1040
1030
1020
1010
1000
Halibarange
Morrisons
Tesco
Brand of Vitamin C tablet

Evaluation

The reference sources selected should be reliable as they are from one pharmacy and two supermarket websites which sell the Vitamin C tablets. Sale and supply of vitamins is a subject to UK government standards and food Safety Standards which require accurate labeling of the contents and nutritional values of food/vitamins/supplements produced and sold by all suppliers/retailers.

Although the my results did not match the source values they were quite close. All of the Vitamin C tablets also contain other substances/excipients in addition to Vitamin C and these vary for each tablet. It is possible that some of these other substances could also be oxidised/react in this experiment with the Iodine solution causing inaccurate titration reading/volumes. If I were to run the experiment again to get more accurate results I could look for a chemical other than Iodine that would react only with the vitamin C present in the tablets and not the other substances, this could lead to more accurate titrations and results for the mass of vitamin C.

References

1. https://www.boots.com/haliborange-vitamin-c-1000mg-effervescent-tablets-20-10001469 (accessed 10/02/2024)

2. https://groceries.morrisons.com/products/morrisons-vitamin-c-effervescent-vitamins-505157011 (accessed 10/02/2024)

3. https://www.tesco.com/groceries/en-GB/products/252479807 (accessed 10/02/2024)